

# 存储稳定性测试与数据一致性校验工具和系统

DISK/MEMORY stability testing & DATA consistency verifying tools and system

-- Y O U P L U S ( 微信 : [Y O U P L U S 2 0 2 2](#) )

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# **个人简介：**

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深交所上市科技公司，前员工持股平台合伙人之一(9000+员工，100+合伙人)，资深技术专家；  
现云计算公司，员工持股平台合伙人之一，虚拟化团队负责人，资深架构师、技术专家；

# **15年研发经验：**

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3年网络安全；

12年虚拟化、内核、存储；

目前仍在研发一线；

工欲善其事，必先利其器！  
遥遥领先！

## ➤ 使用过LBA工具及自动化测试系统之前：

Q: fio和vdbench等工具已经有了verify功能，为什么还要自己写一个？

A: fio和vdbench等工具，很多场景测试不了，很多场景测试发现不了问题。

Q: LBA工具的数据校验功能与fio和vdbench等工具的verify功能相比较如何？

A: fio和vdbench等工具能测试出来的问题，LBA工具都能测试出来；

LBA工具能测试出来的很多问题，fio和vdbench等工具却不一定能测试出来；

## ➤ 使用过LBA工具及自动化测试系统之后：

-- fio, vdbench等工具的verify功能不香了！

-- LBA工具的实现原理和使用方法？

-- 存储稳定性测试和数据一致性校验，LBA工具的功能丰富、完善并且强大！

(八年+，经历上千例存储稳定性和数据一致性问题，不断总结经验和持续改进后的产品)

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# 分布式存储三大难：什么工具可以高效地测试并发现问题？

同样经过两年多的研发，华为存储在2019年正式发布了新一代智能分布式存储—OceanStor分布式存储。华为北京、上海、深圳、成都等地的存储研发团队跨地域紧密协同，设计出一套全新的存储架构，进行了数千万行代码开发，并先后进行了近十个版本的迭代，反复打磨、优化的成果。

华为OceanStor分布式存储产品不仅实现分布式存储性能全球第一，单节点性能高端16.8万 IOPS和1毫秒以内时延，在业界标准SPC-1测试中排名第一；还首次在一套存储中实现了同时支持块、文件、对象、HDFS协议；并且，率先将人工智能技术融入到存储全生命周期管理。

在OceanStor分布式存储为用户数据中心提供一套简单却功能强大的存储背后，其实是研发团队反复打磨与优化的成果。比如，为解决性能波动的“隐形瓶颈”，华为存储研发团队动用了全球研发体系内的操作系统调度专家、网络专家，让性能波动彻底解决，实现了非ARM节点14万IOPS、ARM节点16.8万IOPS的稳定性能。

**分布式存储有三大难**，其一是数据不一致情况如何解决，由于数据打散在各个节点上，很容易出现数据不一致的情况，尤其是在高性能、大并发的数据读写情况下如何保持数据一致性。这需要华为存储在并发机制上做到精准无比。为此，华为存储研发团队研发出一套新的日志机制与工具，在海量数据中去追踪和查看IO异常，实现了上千个节点不同场景下的数据不一致情况检验。

其二是分布式存储功能与性能如何平衡，像重复数据删除功能对存储性能影响很大。为此，华为存储研发团队专门开发出一种加权算法，让重删功能实现自适应调整，为用户减去了过去需要不断手动配置的复杂性，呈现出极为简单的易用性。

最后则是如何防范数据丢失。通常，分布式存储所承载的应用场景是多样化和复杂化，这也直接促使了数据丢失潜在因素的增多。针对这种情况OceanStor分布式存储在只有64个字节的可靠性校验的空间容纳了30多个场景的预防方案，每个预防方案的“植入”需要精准到每个比特位，堪称手术刀般精准。

## 华为存储发展史：从筚路蓝缕到星辰大海

<https://mp.ofweek.com/cloud/a545693321986>

## 软件定义存储，看这一篇就够了！

[https://www.sohu.com/a/397070625\\_505795](https://www.sohu.com/a/397070625_505795)

### 4.技术门槛

存储圈流传这样一个说法，搞存储是一个危险系数很高的职业。

为啥呢？计算出问题通常都是局部单机故障，重启试试大概率就能解决，而存储一旦出问题就是全局系统故障，搞不好就成背锅侠。存储作为IT基础设施的底座，重要性不言而喻，谁整谁知道。

存储圈内人士总是对存储有无穷的敬畏，越是大牛越是如此。而存储圈外人士往往低估存储的门槛，认为只要投钱花时间就能搞出牛逼的存储产品。这里面直接忽略了科学理论、工程技术的系统复杂性和人的决定性因素。如果是这样，哪有什么卡脖子关键技术一说。

存储系统软件是一个复杂的系统软件工程，需要严谨的理论架构和工程化来保证数据安全性和系统稳定性，存储的底线和红线是不允许丢失数据。存储算法理论、系统架构、硬件结构、操作系统、软件工程等各个环节都非常复杂。系统复杂性决定了存储研发不可能是一件容易的事，对于存储新产品技术要在无人区不断摸索和试错，对理论创新、系统架构、工程化能力要求很高，这些都直接决定了存储的极高门槛。

# LBA工具介绍

- 雉形源于SF科技前CTO、科力锐科技(<http://www.clerware.com/>)创始人张勇---给冬瓜哥《大话计算机》写序的前同事(当时办公位前后座, 得到过他的很多帮助), 编写的1000行左右C代码的windows程序;
- 当时的程序功能还不完善、存在不少问题, 使用场景受限, 数据可视化的功能少, 当使用工具排查存储数据问题时, 总是要换算十六进制的数据等, 非常不方便;
- 前同事2015年离职后代码无人维护、工具逐渐无人使用。

## 序 六

当年我看游戏《半条命：反恐精英》的二三百万行源代码时，有同事说，网传看完就只剩下半条命了。当我看到冬瓜哥这本《大话计算机》时，瞬间感觉我看完这本书可能也只剩下半条命了。并不是因为这本书的难度摧残大脑，相反，这完全是另一种感觉，它太通俗了，把事物的关系、流程、架构讲得太清晰了，信息量太大了，看完之后就是身体被掏空感。因为，我发现自己这么多年习得的仅有的一点点计算机方面的绝招、秘密在这本书里竟然一点不落的都有，而且还通俗易懂，让我瞬间感觉之前自己耗费在学习计算机上的时间，简直成了浪费人生。如果当年能够看到这本书，不知道能省下多少时间，少走多少弯路，而我现在可能会走得更高，看得更远。遗憾！

这本书知识面之广令人惊讶！从数字电路原理到简单的数值计算器，从电子管到数字集成电路，从半导体物理与器件到硅集成电路工艺基础，从FPGA到CPU到GPU，从片间总线到PCI-E总线到USB总线，从SAS接口到SCSI协议，从以太网设备到多媒体设备，从文本显示到VGA到3D渲染，从实模式到保护模式，从分页到内存管理，从OSI七层标准模型到文件系统。大量的从电子到芯片到工艺到总线到接口到操作系统到驱动的干货。

这本书知识面之深令人感到不可思议！从乱序执行、分支预测到CPU缓存一致性，从PIO到UDMA，从PCI配置空间到MSI，从点阵到矢量，从GDT到TLB，从IRQ到LAPIC到IDT，从SCSI的INQUIRY到READ CAPACITY，各种无法描述的高深干货。更重要的是，这本书还从计算机发展历史上，剖析了计算机技术发展的起点及设计思路，能让人的大脑更容易地建立起完整计算机体系和模型。阅读时不禁拍案惊奇，这是何等的奇迹，需要作者付出多少心血来凝结！

这是计算机领域的一本巨作，在市场上很难觅得一本能如此翔实讲解整个计算机体系的工作原理的书籍。不管是在校的大学生，还是一线的“攻城狮”，在书中总能找到他们感兴趣的知识点，快速领悟计算机体系里面各个组件的设计精髓。这本书像各种芯片手册、协议规范、接口文档一样，值得放在床头柜上，每天睡前看半小时，疗效远大于各种鸡汤。每看一遍，总有更多不同的收获。

冬瓜哥为这本书连续4年奋战，每天写作到凌晨，仔细推敲每个逻辑和流程。有时在三四点还能看到他的留言。这种苦心孤诣的工匠精神非常值得学习。如若我等都像冬瓜哥这样勤奋研究，中国的计算机底层产业哪能没有希望？

# LBA工具介绍

- 借鉴于前同事编写的程序的实现原理，创新实现LBA工具：[HD\\_WRITE\\_VERIFY & HD\\_WRITE\\_VERIFY\\_DUMP](#)，全部代码由本人重新编写实现(先完成Linux版本的代码，然后移植完成Windows版本的代码)，并制作成自动化测试系统的系列ISO，完全拥有相关工具和自动化测试系统的知识产权；
- LBA工具从2016年的V0.01版本升级到现在的V8.0版本(代码经过八年无数次的迭代、优化)，功能非常完善和强大：将复杂的存储/文件系统稳定性和数据一致性问题降维转化为直观、易懂、数据可视化的问题(测试校验完全自动化或者手动简单敲几个命令即可---谁用谁知道，不要看广告，看疗效😊)，并附带多个原创高级功能。
- 目前LBA工具有Linux(x86和arm)和Windows三种版本([https://github.com/zhangyoujia/hd\\_write\\_verify](https://github.com/zhangyoujia/hd_write_verify))，1.8万行左右C代码。

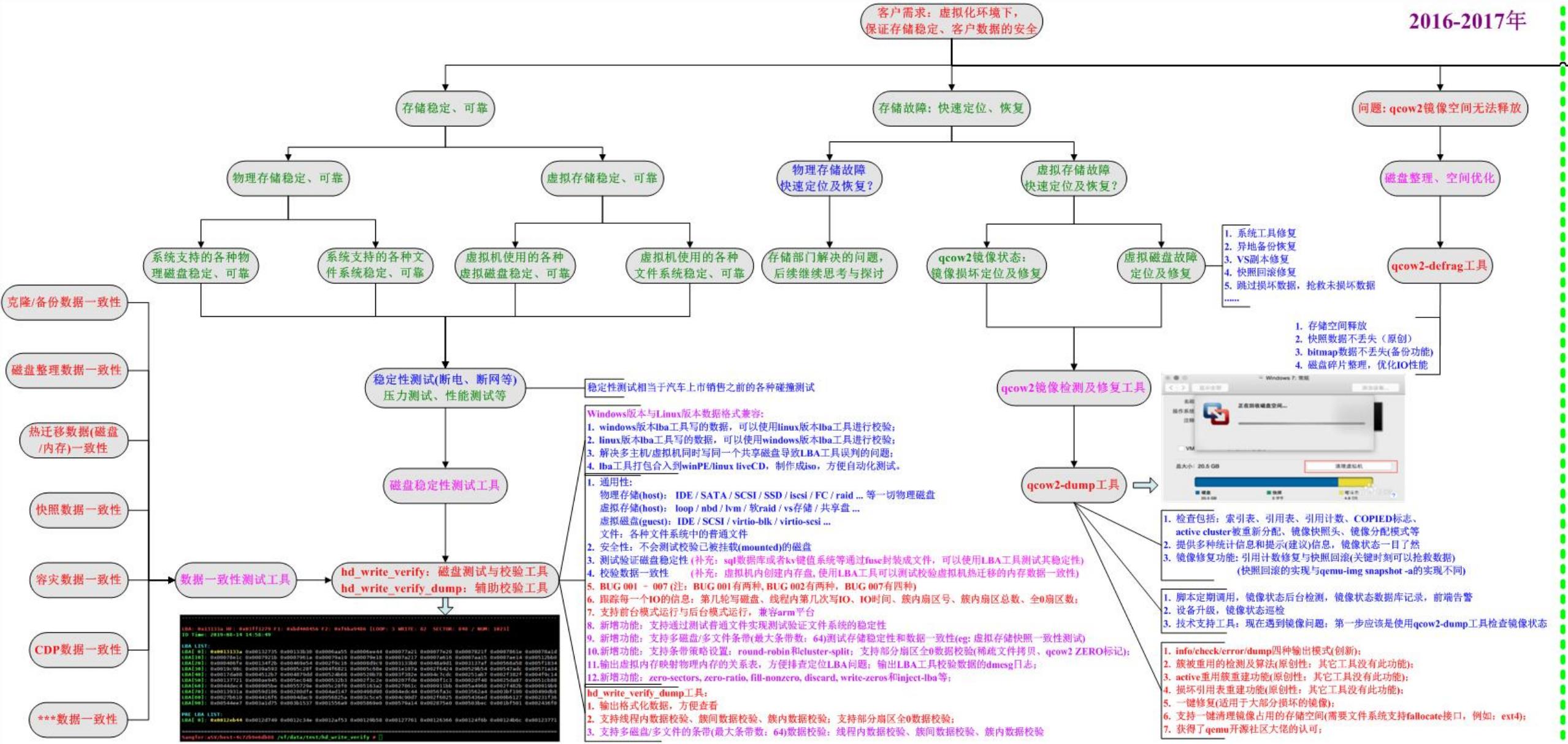
linux版本LBA工具移植成了windows版本，两个版本使用是一样的，并且数据格式兼容。  
1. windows版本lba工具写的数据，可以使用linux版本lba工具进行校验；  
2. linux版本lba工具写的数据，可以使用windows版本lba工具进行校验；  
windows版本与linux版本检查同一个磁盘的数据，结果一样。

好的，比以前的windows好用很多

hd_write_verify > V4.0 > bin > linux_x86 > release				hd_write_verify > V4.0 > bin > linux_arm > release				hd_write_verify > V4.0 > bin > windows > release			
名称	修改日期	类型	大小	名称	修改日期	类型	名称	修改日期	类型	大小	
hd_write_verify	2023/7/6 17:33	文件	108 KB	hd_write_verify	2023/7/6 16:20	文件	hd_write_verify.exe	2023/7/7 0:23	应用程序	38 KB	
hd_write_verify_dump	2023/7/6 17:33	文件	43 KB	hd_write_verify_dump	2023/7/6 16:20	文件	hd_write_verify_dump.exe	2023/7/7 0:23	应用程序	18 KB	
md5.txt	2023/7/6 17:34	TXT 文件	1 KB	md5.txt	2023/7/6 16:20	TXT 文件	md5.txt	2023/7/7 0:35	TXT 文件	1 KB	
名称				修改日期	类型	大小	名称				
hd_write_verify.with.stripe.robin.64K.整体校验+批量校验.V10.iso	2023/7/7 1:00	光盘映像文件	66,154 KB	hd_write_verify.with.stripe.robin.128K.整体校验+批量校验.V10.iso	2023/7/7 0:59	光盘映像文件	66,154 KB				
hd_write_verify.with.stripe.split.64K.整体校验+批量校验.V10.iso	2023/7/7 1:15	光盘映像文件	66,154 KB	hd_write_verify.with.stripe.robin.256K.整体校验+批量校验.V10.iso	2023/7/7 0:57	光盘映像文件	66,154 KB				
hd_write_verify.with.stripe.split.128K.整体校验+批量校验.V10.iso	2023/7/7 1:14	光盘映像文件	66,154 KB	hd_write_verify.with.stripe.robin.512K.整体校验+批量校验.V10.iso	2023/7/7 0:55	光盘映像文件	66,154 KB				
hd_write_verify.with.stripe.split.256K.整体校验+批量校验.V10.iso	2023/7/7 1:13	光盘映像文件	66,154 KB	hd_write_verify.with.stripe.robin.1M.整体校验+批量校验.V10.iso	2023/7/7 0:54	光盘映像文件	66,154 KB				
hd_write_verify.with.stripe.split.512K.整体校验+批量校验.V10.iso	2023/7/7 1:08	光盘映像文件	66,154 KB	hd_write_verify.mem_lba.with.stripe.robin.1M.x86_64.V10.iso	2023/7/7 0:52	光盘映像文件	66,154 KB				
hd_write_verify.with.stripe.split.1M.整体校验+批量校验.V10.iso	2023/7/7 1:06	光盘映像文件	66,154 KB	hd_write_verify.mem_disk_lba.with.stripe.robin.1M.x86_64.V10.iso	2023/7/7 0:51	光盘映像文件	66,154 KB				
hd_write_verify.with.stripe.robin.4K.整体校验+批量校验.V10.iso	2023/7/7 1:04	光盘映像文件	66,154 KB	hd_write_verify.mem_lba.with.stripe.robin.8K.x86_64.V10.iso	2023/7/7 0:50	光盘映像文件	66,154 KB				
hd_write_verify.with.stripe.robin.8K.整体校验+批量校验.V10.iso	2023/7/7 1:02	光盘映像文件	66,154 KB	hd_write_verify.mem_disk_lba.with.stripe.robin.16K.x86_64.V10.iso	2023/7/7 0:49	光盘映像文件	66,154 KB				

# LBA工具介绍：功能简图

2016-2017年



# LBA工具介绍：版权声明与数据布局

## ➤ 设计介绍：

**数据结构**: 数组、队列、强双向链表(每个节点99个指针指向后向节点，10个指针指向前向节点)组成的混合体；  
**算法**: 非常复杂、精巧，部分高级功能的算法借鉴了dpdk、qemu和rsync等开源代码；

```
/*
 * HD_WRITE_VERIFY & HD_WRITE_VERIFY_DUMP v23.06
 *
 * Copyright (c) 2016-2023 YOUPLUS.
 *
 * Author: YOUPLUS <zhang_youjia@126.com>
 */

/*
 * -----
 * | HF           | | HF           | | HF           | | HF           |
 * -----| MAGIC       | | MAGIC       | | MAGIC       | | MAGIC       |
 * -----| PRE_LBA[10] | | PRE_LBA[10] | | PRE_LBA[10] | | PRE_LBA[10] |
 * -----| LBA_LIST[100]| | LBA_LIST[100]| | LBA_LIST[100]| | LBA_LIST[100]|
 * -----| TIME         | | TIME         | | TIME         | | TIME         |
 * -----| RANDOM        | | RANDOM        | | RANDOM        | | RANDOM        |
 * -----| NUM           | | NUM           | | NUM           | | NUM           |
 * -----| INDEX          | | INDEX          | | INDEX          | | INDEX          |
 * -----
 *
 * |<---sector--->| |<---sector--->| ... |<---sector--->| |<---sector--->|
 * |<-----cluster----->| ... |<-----cluster----->| ... |<-----cluster----->|
 *
 * |-----cluster-----| |-----cluster-----| |-----cluster...-----| |-----cluster-----| |-----cluster-----| |-----cluster-----|
 * |-----disk----->|
```

DATA LAYOUT:		
offsetof HF:	0	[4 bytes]
offsetof MAGIC:	4	[4 bytes]
offsetof PRE_LBA[10]:	8	[40 bytes]
offsetof LBA_LIST[100]:	48	[400 bytes]
offsetof TIME:	448	[56 bytes]
offsetof RANDOM:	504	[4 bytes]
offsetof NUM:	508	[2 bytes]
offsetof INDEX:	510	[2 bytes]



# LBA工具介绍：工具的作用与价值

➤ SF科技分布式存储早期版本存在各种数据丢失、数据错误的问题，经过几年的更新迭代，才趋于稳定。

The screenshot shows a software interface for managing defects. The main window displays a table of issues related to LBA (Logical Block Addressing). The columns include: 缺陷编号 (Defect ID), 状态 (Status), 指派给 (Assigned To), 严重性 (Severity), 发现人 (Reporter), 发现时间 (Discovery Time), 概要 (Summary), 4. 所属模块 (Module), 1. 发现版本和阶 (Version and Phase), Fix日期 (Fix Date), 修改Bug审核 (Review Bug), 老版本存在 (Old Version Exist), and 修复状态 (Status). A search bar at the top contains the text '\*lba\*'. The bottom status bar indicates 'Defect 1 of 406' and 'Server Time: 08:23 PM 06-25-19'.

缺陷编号	状态	指派给	严重性	发现人	发现时间	概要	4. 所属模块	1. 发现版本和阶	Fix日期	修改Bug审核	老版本存在
4011	Closed		4-Urgent		2016-6-25	【数据损坏】【asv】【可靠性自动化】：asv, adesk版本断电出现读错读缓存			2016-6-28		存在
4141	Open		4-Urgent		2016-6-29	【数据损坏】【可靠性自动化】执行可靠性自动化网络故障用例，两台主数据可靠性					存在
4385	Closed		2-Medium		2016-7-5	【自动化测试】有bad文件，替换主机失败，虚拟机出LBA[kvm] [xhza] 其他			2016-8-6		存在
4548	Closed		4-Urgent		2016-7-6	【数据丢失】【可靠性自动化】【adesk】：执行可靠性断电故障后，出历史遗留			2016-7-8		存在
4634	Closed		4-Urgent		2016-7-11	【数据丢失】【asv】：跑私网故障之后，出现读出错误LBA问题	数据可靠性		2016-7-13		存在
4673	halt_2		3-High		2016-7-12	【数据丢失】【adesk】：正在运行iso虚拟机，注入断电故障之后，历史遗留					存在
4727	Closed		4-Urgent		2016-7-12	【数据丢失】【asv】【可靠性自动化】：出现断电故障和断电故障之后数据可靠性			2016-7-12		存在
4828	Closed		4-Urgent		2016-7-14	【数据丢失】【asv】【可靠性自动化】：跑私网案例，迁移出现数据丢失数据可靠性			2016-7-21		存在
4924	Closed		4-Urgent		2016-7-18	【数据丢失】【asv】【可靠性自动化】：一个主机数据盘用尽，跑私网数据可靠性			2016-7-22		存在
5044	Closed		4-Urgent		2016-7-20	【数据丢失】【asv】【可靠性自动化】：跑私网故障，迁移时出LBA问题数据可靠性			2016-7-29		存在
5045	Closed_Dup		4-Urgent		2016-7-20	【数据丢失】【asv】【可靠性自动化】：执行频繁拔插磁盘案例出现读数据可靠性					
5143	Closed		4-Urgent		2016-7-20	【数据损坏】【可靠性自动化】【asv】：执行两主机频繁私网交互断开数据可靠性			2016-8-1		存在
5522	Closed		4-Urgent		2016-7-28	【LBA】【数据损坏】【LBA】进行磁盘拔插故障案例出现LBA	数据可靠性		2016-8-26		存在
5547	New		4-Urgent		2016-7-30	【数据丢失】【VMP】【可靠性自动化】：跑网络故障后出现数据丢失LE	数据可靠性				
5621	Closed		4-Urgent		2016-8-2	【LBA】【数据损坏】【LBA】【可靠性自动化】仲裁版本跑可靠性副本仲裁					
5671	New		4-Urgent		2016-8-3	【数据丢失】执行可靠性自动化网络故障用例，出现虚拟机LBA	其他		2016-9-2		否
5804	Closed		4-Urgent		2016-8-5	【LBA】【数据损坏】【LBA】【可靠性自动化】虚拟机正在迁移的是时候数据可靠性			2016-8-26		存在
6107	Closed		4-Urgent		2016-8-12	【LBA】【数据损坏】【LBA】【可靠性自动化】跑可靠性自动化网络故障副本仲裁			2016-8-26		否
6217	Closed_Dup		4-Urgent		2016-8-13	【数据损坏】【可靠性自动化】跑可靠性自动化网络故障案例，出现LBA副本仲裁					
6310	Closed		4-Urgent		2016-8-15	【LBA】【数据损坏】【文件损坏】oracle虚拟机循环进行开机和关机操作其他			2016-8-26		否
6377	Closed		4-Urgent		2016-8-17	【LBA】【数据损坏】【文件损坏】oracle RAC 虚拟机数据损坏无法ope其他			2016-8-26		否
6577	Closed		2-Medium		2016-8-20	【升级包】【脚本更新】mysqldump打错误包的脚本，不能通过升级包升级			2016-8-23		存在
6594	Closed		4-Urgent		2016-8-20	【LBA】【数据损坏】【文件损坏】共享盘是非DirectIO，如果断电会老功能			2016-8-23		存在
6992	Closed		4-Urgent		2016-8-27	【LBA】【数据损坏】【LBA】【可靠性自动化】可靠性BVT案例，出现LE	其他		2016-8-30		存在
7099	Closed		4-Urgent		2016-8-30	【LBA】【数据损坏】【文件损坏】【可靠性自动化】跑案例，虚拟机锁副本仲裁			2016-9-3		否
7146	Closed		4-Urgent		2016-8-31	【LBA】【数据损坏】【LBA】【可靠性自动化】跑主机断电故障，出现LE	其他		2016-9-8		存在
7189	Closed		4-Urgent		2016-9-1	【LBA】【数据损坏】【LBA】【可靠性自动化】执行随机故障案例，出现副本仲裁			2016-9-6		否
7282	Closed		4-Urgent		2016-9-2	【LBA】【数据损坏】【LBA】【可靠性自动化】执行随机故障出现LBA	副本仲裁		2016-9-6		否
7342	Won't Fix		4-Urgent		2016-9-3	【数据损坏】【LBA】【可靠性自动化】两主机执行新的磁盘对其他					存在
7563	Rejected		4-Urgent		2016-9-7	【数据损坏】【NFS解耦】【可靠性自动化】：跑磁盘拔插案例，出现数NFS解耦					
7754	Rejected		4-Urgent		2016-9-12	【紧急必须项】【数据损坏】【920beta】【vs2.3】【可靠性自动化】共享盘UI					
7852	Closed		4-Urgent		2016-9-13	【数据损坏】【LBA】【可靠性自动化】磁盘拔插中克隆的虚拟机5台有其他			2016-9-19		存在
7934	Closed_Dup		4-Urgent		2016-9-17	镜像文件引用计数错误，多磁盘虚拟机出LBA-1cg回归	副本仲裁				
7947	Rejected		4-Urgent		2016-9-17	【紧急必须项】【数据损坏】【920beta】【可靠性自动化】linux版本和其他					
8194	Closed		2-Medium		2016-9-22	外置存储环境multipath_blacklist_callback.log日志非常频繁【回归】外置存储			2016-9-27		否
8290	Closed		4-Urgent		2016-9-24	【LBA】【数据损坏】【LBA】【可靠性自动化】【可靠性跟踪】克隆操作其他			2016-10-5		存在
8444	Closed		4-Urgent		2016-9-28	【LBA】【数据损坏】【镜像损坏】【HCl5.2】测试中心环境，告警日志虚拟机			2016-10-6		存在
9815	Closed		2-Medium		2016-11-1	【vmp5.0】vmp5.0跑功能自动化，出lba	其他		2016-11-7		否

2016-2019三年，  
LBA工具测试发  
现的SF科技分布  
式存储数据不一  
致问题，问题单  
记录：400+ (简单  
过滤，数据有遗  
漏，不完整)

节省了多少研发  
成本？

如左图数据丢失、  
数据错误的问题，  
其中有很多典型  
案例，可惜没有  
保存当时排查、  
解决问题的相关  
资料，只有后面  
贴出的几张截图。

# LBA工具介绍：产品发布标准

- SF科技产品发布标准 -- 在断电、断网、故障注入的环境至少稳定运行两周，不出数据问题

版本稳定性运行日报 (7.1) ( 稳定运行6天；无新增AB类问题 )					
A类问题进展跟踪【0621】					
79776	本地磁盘发生簇重用 在本地盘创建了两个虚拟机跑iso工具			重现中	//6.13 1、分析磁盘元数据，元数据特征、bitmap泄漏检查   对bitmap进行了调试，未发现异常点  //6.14 1、继续分析磁盘元数据 2、开始重现，使用loop挂载一个文件，多进程并发， 重现。重现方法和脚本 [REDACTED] 确认。  //6.19 一个vs存储，一个本地存储，每个存储上创建2个raw文 件并挂载点目录下又创建2个qcow2文件，因此每个存储上 （qcow2文件），大概15~20min跑一轮。目前未重现出来  //6.21 仍未重现出来，目前无其他重现方案。问题分析人力投 影像损坏问题。
80711	虚拟机bitmap损坏 虚拟机仅执行开关机操作。			分析中	//6.19 检查bitmap簇是否被重新分配了  //6.21 未发现簇重用，需要继续分析。
80427	4主机集群，将1台物理主机连续强制 关机了2次，虚拟机镜像损坏了。 虚拟机4月份创建了（通过克隆创 建），虚拟机执行了备份、迁移、电源 开关操作。主机执行过强制宕机、关机 操作。			分析中	//6.19 L2表对应的簇重用了，与快照对应的簇重用。 需要确认镜像损坏的时间点，目前根据虚拟机的镜像文 件和簇重用信息，查看6月6日的虚拟机相关日志。  //6.21 1、关机克隆vs存储的镜像是两条路径 2、增加overlap检查 3、分析一下管理面关机克隆的流程，判断关机条件是

文件系统出问题：出现数据块重用的错误，即：一个数据块被两个或者多个虚拟机的镜像引用，导致两个虚拟机写数据时，被重用的数据块出现数据被相互覆盖的情况，LBA工具测试发现数据不一致。

LBA工具磁盘稳定性自动化测试：(winPE的iso运行后自动测试)

```
ca管理员: X:\windows\system32\cmd.exe
ca管理员: X:\windows\system32\cmd.exe -hd_write_verify.exe -c -D -F -S 1024 -V all -T 10 \\.\physicaldrive0
Disk size: 10737418240 / 10240M / 10G
硬盘: \\.\physicaldrive0 | 线程数: 10 | 扇区总数: 20971520 | 簇总数: 20480 | 簇内扇区数: 1024 | DIRECT IO & 刷新硬盘缓存 | 校验模式: 3 | 通知: 0

Current Time: 2019-01-04 11:03:47
Thread 0: Start check disk ...
Thread 9: Start check disk ...
Thread 1: Start check disk ...
Thread 0: Start check disk ...
Thread 2: Start check disk ...
Thread 3: Start check disk ...
Thread 4: Start check disk ...
Thread 5: Start check disk ...
Thread 6: Start check disk ...
Thread 7: Start check disk ...

Current Time: 2019-01-04 11:03:47
WARNING! Thread 6 DIFFER FLAGS
LBA_0: 0x405000 - LBA_1: 0x405400 Flags is different | read[5]: 524288

LBA_0 IO Time: 2019-01-04 10:43:59
LBA_0: 0x405000 MF: 0x00001276 F1: 0xb9ac75e0 F2: 0xb19e577e [LOOP: 6 WRITE: 4 SECTOR: 0 / NUM: 1024]
LBA_1 IO Time: 2019-01-04 10:51:13
LBA_1: 0x405400 MF: 0x00001276 F1: 0xb9ac75e0 F2: 0xb19e577e [LOOP: 6 WRITE: 296 SECTOR: 0 / NUM: 1024]

Current Time: 2019-01-04 11:03:47
BUG 004: Thread: 6 DATA LOST | read[3]: 524288
PREV LBA: 0x405000 | LOST LBA: 0x405400 | NEXT LBA: 0x405e00

PREV LBA: 0x405e00 | DATA | LBA: 0x405000 MF: 0x00001276 F1: 0xb9ac75e0 F2: 0xb19e577e [LOOP: 6 WRITE: 4 SECTOR: 0 / NUM: 1024]
PREV IO Time: 2019-01-04 10:43:59

LOST LBA: 0x405400 | DATA | LBA: 0x405400 MF: 0x00001276 F1: 0xb9ac75e0 F2: 0xb19e577e [LOOP: 6 WRITE: 296 SECTOR: 0 / NUM: 1024]
LBA: 0x405400 | thread_count: 10, bitmap: 0 0 0 0 0 0 0 0 0 0
LOST IO Time: 2019-01-04 10:51:13

NEXT LBA: 0x405e00 | DATA | LBA: 0x405e00 MF: 0x00001276 F1: 0xb9ac75e0 F2: 0xb19e577e [LOOP: 6 WRITE: 4 SECTOR: 0 / NUM: 1024]
```

第6轮测试中的第5和第6个写IO丢失

```
this will take a long time
don't break when repair option opened, otherwise may damage the file system
please wait...
inodepno=143363, pno=165302 not mark on bitmap, name:vm-disk-1.qcow2
inodepno=143363, pno=165303 not mark on bitmap, name:vm-disk-1.qcow2
file[vm-disk-1.qcow2] blocks error:inodepno=143363,blocks=21847,used=21847,errs=0,unmark=2
file[vm-disk-3.qcow2] blocks error:inodepno=339971,blocks=87015,used=88108,errs=0,unmark=0
inodepno=348163, pno=493038 used 2, name:vm-disk-4.qcow2
inodepno=348163, pno=493039 used 2, name:vm-disk-4.qcow2

BitmaFree=1688596, CountFree=1688594
FileUsed=215575, Total=1904640
RGPUUsed=465, ErrorCount=80
ResuedBlock=54
```

2019-6-6: 见附件 4.png

一个数据块，被physicaldrive3和physicaldrive4同时使用了，导致的lba

# LBA工具介绍：工具的作用与价值

➤ Windows Server 2016系统上安装的iscsi target server出现数据不一致问题

案例一：重庆XXXX学院

案例二：广西XX投资集团

案例三：意大利FastXXX

```
BUG 004: [Thread: 2] DATA LOST | read[4641]
PREV LBA: 0x60a85d0 | LOST LBA: 0x7904050 | NEXT LBA: 0x9d008b0

PREV LBA: 0x60a85d0 | DATA | LBA: 0x60a85d0 HF: 0x00101272 F1: 0xb8e2a4a6 F2: 0xde427884 [LOOP: 1 WRITE: 4639 SECTOR: 0 / NUM: 16]
PREV IO TIME: 2019-10-11 20:23:15

LOST LBA: 0x7904050 | DATA | LBA: 0x78fc800 HF: 0x00801277 F1: 0x3848b187 F2: 0x945d2e0c [LOOP: 1 WRITE: 3901 SECTOR: 80 / NUM: 128]
LOST IO TIME: 2019-10-10 15:48:24

NEXT LBA: 0x9d008b0 | DATA | LBA: 0x9d008b0 HF: 0x00101272 F1: 0xb8e2a4a6 F2: 0xde427884 [LOOP: 1 WRITE: 4641 SECTOR: 0 / NUM: 16]
NEXT IO TIME: 2019-10-11 20:23:15

PRE LBA: 0x01f62600 0x059e6000 0x03120c80 0x01d89400 0x03686880 0x089ecb00 0x00006400 0x041c8b80 0x081d3c80 0x01f53e00
=====
```

(1) [Thread: 2] DATA LOST表示数据丢失

(2) 2号线程的第4640次写的数据丢失，数据的偏移：第0x7904050扇区

(3) 第0x7904050扇区中的当前数据是一份旧数据，时间：2019-10-10 15:48:24

Windows 2016 iscsi target 问题，目前整体情况总结如下：

1、研发内部搭建了 windows 2016 iscsi target 环境，已将问题复现出来，经过调试分析，基本确定是 windows 2016 iscsi target 存储存在一个潜在 bug。此 bug 的触发条件是：

(1) 主机 A 和 B 共享此存储；  
(2) 主机 A 不断从存储读数据，且读请求块大小超过 256K；  
(3) 主机 B 通过 SCSI RESERVE/RELEASE 指令对存储进行加锁/解锁操作。以上条件同时出现，主机 A 会有一定概率读到错误的数据。

2、此问题我们已经找到必现方法，在 centos7.5 环境，简单几步操作可以复现出来。从 bug 的表征看，猜测是 windows 存储端的分片处理逻辑与加锁解锁逻辑之间配合有问题，导致读取到的数据内容错误。我们验证了其它物理 iscsi 存储和 vs 虚拟 iscsi 存储，没有此问题。

3、此存储 bug 触发的必要条件之一是：读请求的块大小超过 256K。因此，可以通过下面的方法，将存储的请求块大小限制为不超过 256K，可以临时避开这个 bug。

```
echo 256 > /sys/block/dm-X/queue/max_sectors_kb
```

## 1. 问题描述

虚拟机从 iscsi 存储迁移到虚拟存储后，数据库日志提示有坏块，但虚拟机运行正常，检查虚拟机磁盘镜像也正常，问题分析如下。

## 2. 原因及过程分析

### 2.1 问题现象

一台跑 oracle 数据库的虚拟机，在开机热迁移之后出现坏块，影响业务运行；虚拟机首次从虚拟存储迁移到 iscsi 正常，数据库也没有报错；通过构造环境，对热迁移过程进行分析，可以重现 iscsi 上热迁移虚拟机到虚拟存储报错的问题。

### 2.2 故障分析与重现

#### 1、数据库报错日志分析

```
Incident details in: /home/oracle/app/oracle/diag/rdhms/easdbs/easdbs_ora_31240_i36804.t
Wed Sep 04 08:02:27 2019
Process reporting: perfmon id:[cdmp_20190904080227]
Errors in file: /home/oracle/app/oracle/diag/rdhms/easdbs/easdbs_ora_31240_i36803.trc:
ORA-00354: 日志损坏接近最近的坏块地址
ORA-00353: 日志损坏最近的坏块地址
ORA-00312: 联机日志 4 段程 1: '/home/oracle/app/oradata/easdbs/redo04.log'
ORA-01578: ORACLE 数据块损坏 (文件号 6, 块号 2398786)
ORA-01110: 数据文件 6: '/home/oracle/oradata/EAS_D_GXJT_STANDARD02.ORA'
Wed Sep 04 08:02:27 2019
Sweep [inc][36804]: completed
Checker run found 1 new persistent data failures
Errors in file: /home/oracle/app/oracle/diag/rdhms/easdbs/easdbs_ora_31240.trc (incident=36805):
ORA-00354: 日志损坏最近的坏块地址
ORA-00334: 归档日志: '/home/oracle/app/oradata/easdbs/redo05.log'
ORA-01578: ORACLE 数据块损坏 (文件号 6, 块号 2398786)
ORA-01110: 数据文件 6: '/home/oracle/oradata/EAS_D_GXJT_STANDARD02.ORA'
Incident details in: /home/oracle/app/oracle/diag/rdhms/easdbs/easdbs_ora_31240_i36805.t
Wed Sep 04 08:02:30 2019
```

在迁移数据库虚拟机后，可以明显看到数据库日志中有坏块提示；此时业务无法正常访问数据库。同时，分析迁移后的虚拟机还是正常运行状态，那么能否有方法通过重现来

### 3、结论

通过以上的测试对比发现，测试时的 IO 块大小为 512K 和 1M，AC 虚拟机内部发现异常的是 IO 块大小为 256K，测试时无论是使用 nbd 的方式模拟虚拟机读写大块 IO，还是测试裸设备直接读写大块的 IO，都出现了读写的数据不一致，可以确定是存储的问题，大概率和块 size、边界对齐这些条件有关系。有可能是外置存储的 cache 的按条带对齐的处理有问题，非条带对齐写入后从 cache 读出数据是旧的。

把 lba 工具改造了一下，基本实锤了，就是存储那边返回的数据内容不对，触发因素就是 scsi 保留锁指令影响了读操作返回结果，这种属于存储侧的严重 bug，vmware 那边的情况只是问题还没暴露，按照我们对接 vs 的经验，存储层面的问题，需要专业工具配合各种场景构造，才有可能撞出来。

用其它厂商的 iscsi 进行测试没有问题，用 windows 的 iscsi 测试几秒钟就跑出来了，基本可以确认是 windows iscsi 的 bug。客户纠结 vmware 没问题，只是问题没有暴露或没有被发现，换一个角度去看，windows iscsi 的 bug，vmware 没有发现，而我们发现了，刚好体现了我们测试工具的专业性以及备份数据检查的严格性。

# LBA工具介绍：工具的作用与价值

➤ arm平台：测试iscsi裸盘没问题，测试iscsi格式化后的ocfs2出现数据丢失

`mkfs.ocfs2 -b 4K -C 64K device;` 格式化时指定cluster-size<=64K进行规避

```
[root@node-1 test12345]# uname -a
Linux 5.15.67-12.c19.aarch64 #1 SMP Mon Sep 18 20:45:26 CST, 2023 aarch64 aarch64 aarch64 GNU/Linux
[root@node-1 test12345]# 
[root@node-1 ~]# /root/hd_write_verify -c -D -S 1024 -V all -T 10 /dev/mapper/3600507670881083f4800000000001lf46
```

```
Device Topology:
Disk: /dev/mapper/3600507670881083f4800000000001lf46
Logical block size: 512
Physical block size: 512
Minimum I/O size: 32768
Optimal I/O size: 0 (0: unknown)
Alignment offset: 0
Disk Size: 42949672960 / 40960M / 40.00G
```

```
Disk: /dev/mapper/3600507670881083f4800000000001lf46 | Thread: 10 | Total Sectors: 83886080 | Total Clusters: 81920 | Sectors of Cluster: 1024 | DIRECT IO & NO Flush | Verify: 6 | Notify: 0
```

```
Current Time: 2023-11-27 16:12:34
Thread 3 [tid: 279134]: Starting check disk ...
Thread 8 [tid: 279139]: Starting check disk ...
Thread 7 [tid: 279138]: Starting check disk ...
Thread 1 [tid: 279132]: Starting check disk ...
Thread 5 [tid: 279136]: Starting check disk ...
Thread 2 [tid: 279133]: Starting check disk ...
Thread 6 [tid: 279137]: Starting check disk ...
Thread 4 [tid: 279135]: Starting check disk ...
Thread 0 [tid: 279131]: Starting check disk ...
Thread 9 [tid: 279140]: Starting check disk ...
```

```
Starting write disk: Thread ID | Read MB - Write MB |
KEY: <P> = pause, KEY: <S> = start, KEY: <Q> = quit
```

```
Loop 1: .
Current Time: 2023-11-27 16:12:34
5933, 4033 | 5975, 4069 | 5954, 4041 | 5952, 4048 | 5960, 4044 | 5978, 4056 | 5978, 4057 | 5963, 4051 | 5969, 4052 | 5956, 4044 |
```

```
Current Time: 2023-11-27 16:15:27
Thread 9 [tid: 279140]: Starting check disk ...
Thread 8 [tid: 279139]: Starting check disk ...
Thread 3 [tid: 279134]: Starting check disk ...
Thread 1 [tid: 279132]: Starting check disk ...
Thread 5 [tid: 279136]: Starting check disk ...
Thread 2 [tid: 279133]: Starting check disk ...
Thread 7 [tid: 279138]: Starting check disk ...
Thread 6 [tid: 279137]: Starting check disk ...
Thread 0 [tid: 279131]: Starting check disk ...
Thread 4 [tid: 279135]: Starting check disk ...
```

```
[root@node-1 ~]# mount -t ocfs2 /dev/mapper/3600507670881083f4800000000001lf46 /mnt/share-storage/test12345 type ocfs2 (rw,noatime,nodiratime,_netdev,heartbeat-local,nointr,data=ordered,errors=recover)
/dev/mapper/3600507670881083f4800000000001lf46 on /mnt/share-storage/test12345 type ocfs2 (rw,noatime,nodiratime,_netdev,heartbeat-local,nointr,data=ordered,errors=recover)
[root@node-1 ~]#
[root@node-1 test12345]# truncate --size 20G lba.raw
[root@node-1 test12345]# rm lba.raw
[root@node-1 test12345]# rm lba.raw
[root@node-1 test12345]# /root/hd_write_verify -c -D -S 1024 -V all -T 10 lba.raw
-----
```

```
File Information:
File: lba.raw
Size: 2147483648B
Blocks: 0
IO Block: 0x048576
Device: 64894
Inode: 1035777
Links: 1
File Size: 2147483648B / 20480M / 20.00G
```

```
File: lba.raw | Thread: 10 | Total Sectors: 41943040 | Total Clusters: 40960 | Sectors of Cluster: 1024 | DIRECT IO & NO Flush | Verify: 6 | Notify: 0
Current Time: 2023-11-27 16:20:31
Thread 2 [tid: 342913]: Starting check file ...
Thread 7 [tid: 342918]: Starting check file ...
Thread 5 [tid: 342910]: Starting check file ...
Thread 1 [tid: 342912]: Starting check file ...
Thread 0 [tid: 342911]: Starting check file ...
Thread 4 [tid: 342915]: Starting check file ...
Thread 9 [tid: 342920]: Starting check file ...
Thread 6 [tid: 342917]: Starting check file ...
Thread 8 [tid: 342919]: Starting check file ...
Thread 3 [tid: 342916]: Starting check file ...
```

```
Starting write file: Thread ID | Read MB - Write MB |
KEY: <P> = pause, KEY: <S> = start, KEY: <Q> = quit
```

```
Loop 1: .
Current Time: 2023-11-27 16:20:31
```

```
Current Time: 2023-11-27 16:20:32
BUSES [0]: (Thread: 23 BATCH VERIFY: SECTOR(64) DIFFER: 000 | CONNECT LBA[0]: 0x1580000 | ERROR LBA[64]: 0x1536004 | filename: lba.raw
LBA: 0x1536004 | thread_num: 16, bitmap: 0 1 0 0 0 0 0 0 0
```

```
LAST CORRECT WRITE:
LBA: 0x1ed9400 | HF: 0x04001272 F1: 0x4aa3a9e F2: 0x9e36d54c [LOOP: 1 WRITE: 28 SECTOR: 0 / NUM: 1024 / ZERO: 262]
LAST WRITE IO TIME: 2023-11-27 16:20:32
```

```
Buffer addr: 0xffffe2c6090000 | Physical addr: 0x17b920000
```

```
LBA LIST:
LBA[ 0]: 0x01ed9400 0x0001d000 0x01ba0000 0x022c8000 0x01e30000 0x013b0000 0x01a85000 0x00217400 0x00c00000 0x00bd7000
LBA[10]: 0x01be8000 0x0f204000 0x018d0000 0x00f86000 0x00569000 0x00081000 0x0035c00 0x01f31000 0x0151000 0x00c00000
LBA[19]: 0x01900000 0x0001f000 0x0147f000 0x00147f000 0x0025f400 0x01a4400 0x00a35000 0x0075e00 0x005ff400 0x00e15000 0x02260000
LBA[18]: 0x018a5000 0x0000f000 0x0147f000 0x00147f000 0x0025f400 0x01a4400 0x00a35000 0x0075e00 0x005ff400 0x00e15000 0x02260000
LBA[17]: 0x00469000 0x003f3000 0x00e0f000 0x00744800 0x0028c000 0x0027e5000 0x00040000 0x00209c00 0x00e56000
LBA[16]: 0x0009f000 0x02315000 0x01c1f7000 0x01923400 0x00679800 0x00024000 0x009ee000 0x0020a4800 0x00704000 0x01732000
LBA[15]: 0x01c70800 0x00e40000 0x00564000 0x00744800 0x0028c000 0x00016000 0x00143800 0x0020e000 0x01280000
LBA[14]: 0x01901000 0x1d164000 0x00764400 0x00796800 0x002447c00 0x0017a000 0x00316000 0x0056d000 0x00240000 0x01ac3400
LBA[13]: 0x015a1800 0x00944000 0x01918000 0x002447c00 0x0017a000 0x00311800 0x01615900 0x001612000 0x01918000
LBA[12]: 0x01b4d000 0x01e26000 0x00c590000 0x02960000 0x0007c800 0x00100000 0x00192800 0x00e80000 0x02590000
PRE LBA LIST:
LBA[ 0]: 0x005d5400 0x00f6f000 0x01ff8000 0x022b300 0x01fdf000 0x015cb000 0x00670800 0x010eb000 0x01a23000 0x01fd3000
```

```
BATCH VERIFY:
LBA: 0x1530000 | HF: 0x04001272 F1: 0x4aa3a9e F2: 0x9e36d54c [LOOP: 1 WRITE: 3 SECTOR: 0 / NUM: 1024 / ZERO: 262]
BATCH VERIFY IO TIME: 2023-11-27 16:20:31
```

```
Buffer addr: 0xfffffe2c6090000 | Physical addr: 0x23fb90000
```

```
LBA LIST:
LBA[ 0]: 0x01530000 0x02430400 0x02483400 0x01548000 0x0231e800 0x01475000 0x00e99000 0x0122b000 0x00e0b400
LBA[10]: 0x021f4000 0x01a1e000 0x00528000 0x00e3e3000 0x00208000 0x01f39000 0x01a23000 0x00e98000 0x015cb000
LBA[19]: 0x01900000 0x0001f000 0x0147f000 0x00147f000 0x0025f400 0x01a4400 0x00a35000 0x0075e00 0x005ff400 0x00e15000 0x02260000
LBA[18]: 0x018a5000 0x0000f000 0x0147f000 0x00147f000 0x0025f400 0x01a4400 0x00a35000 0x0075e00 0x005ff400 0x00e15000 0x02260000
LBA[17]: 0x00017000 0x000174000 0x000174000 0x000174000 0x000174000 0x000174000 0x000174000 0x000174000 0x000174000 0x000174000
LBA[16]: 0x00018000 0x000635000 0x001174000 0x0015d1000 0x000cd000 0x00026fb000 0x0017cc00 0x001676800 0x001e0000
LBA[15]: 0x0010a1c00 0x022474000 0x0181fb000 0x00248000 0x018a5000 0x0006f8000 0x0147c800 0x0026f9400 0x01444400
LBA[14]: 0x001a5000 0x0076e000 0x00400000 0x0001e0000 0x00250800 0x000460000 0x0003f800 0x000ef800 0x00744800 0x0228c000
LBA[13]: 0x0027e5000 0x032751000 0x00098000 0x00209c00 0x000691000 0x023f5900 0x01017900 0x00679800 0x01924400 0x001679800
LBA[12]: 0x00024000 0x0099e000 0x00208000 0x00704000 0x01732000 0x00164000 0x00536400 0x001924400 0x01978000
LBA[11]: 0x000272000 0x001e0000 0x00043000 0x00268000 0x01280000 0x01901000 0x01084400 0x003f56000 0x00cb4000 0x0176c000
PRE LBA LIST:
LBA[ 0]: 0x002f2c00 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
```

```
DETECT READ ERROR:
LBA: 0x1530040 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
DETECT ERROR IO TIME: 1900-01-00 00:00:00
```

```
Buffer addr: 0xfffffe2c6090000 | Physical addr: 0x21fb90000
```

```
LBA LIST:
LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[10]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[19]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[18]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[17]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[16]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[15]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[14]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[13]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[12]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[11]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
PRE LBA LIST:
LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
```

```
Current Time: 2023-11-27 16:20:32
pause_and_exit_work: Press KEY: <0> to exit!
```

# LBA工具介绍：工具的作用与价值

➤ 文件存储(nas): 虚拟机磁盘使用nfs上的qcow2镜像，测试出数据丢失

<https://github.com/sahlberg/libnfs/tags>

```
BUG 004: [Thread: 8] DATA LOST | read[9931] | filename: /dev/vda
PREV LBA: 0x88a2390 | LOST LBA: 0x16cd2d0 | NEXT LBA: 0x8c2750

PREV LBA: 0x88a2390 | HF: 0x000081278 F1: 0x4c1e9683 F2: 0xd3dbfd00 [LOOP: 1 WRITE: 9929 SECTOR: 0 / NUM: 8 / ZERO: 0]
PREV ID Time: 2023-11-28 13:42:37

LOST LBA: 0x16cd2d0 | HF: 0x00000000 F1: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 8 / ZERO: 0]
LOST ID Time: 1900-01-00 00:00:00

NEXT LBA: 0x8c62750 | HF: 0x000081278 F1: 0x4c1e9683 F2: 0xd3dbfd00 [LOOP: 1 WRITE: 9931 SECTOR: 0 / NUM: 8 / ZERO: 0]
NEXT ID Time: 2023-11-28 13:42:37

=====
LBA: 0x88a2390 | HF: 0x000081278 F1: 0x4c1e9683 F2: 0xd3dbfd00 [LOOP: 1 WRITE: 9929 SECTOR: 0 / NUM: 8 / ZERO: 0]
IO Time: 2023-11-28 13:42:37

Buffer addr: 0x27cb000 | Physical addr: 0x2270d000

LBA LIST:
LBA[ 0]: 0x88a2390 0x16cd2d00 0x8c62750 0x07eb7b50 0x09f8dff0 0x01572500 0x118c0990 0x126e3ae0 0x05a44c00 0x00de5080
LBA[10]: 0x0295e398 0x08e1be38 0x0b549e598 0x02059f0 0x14640dc0 0xb02059f0 0x049acfc8 0x04149cc8 0x0692ccf0
LBA[20]: 0x08ff53420 0x17f3a720 0x14f3d1c0 0x01b83c0 0x13394848 0x0bda4f8 0x145b2070 0x08f926f0 0x0c18a590
LBA[30]: 0x14c5c50c0 0x0824c4520 0x0140b4320 0x0573f0 0x09b6b390 0x08e34930 0x0478a100
LBA[40]: 0x119efaf30 0x15d1a118 0x17793390 0x132019e0 0x18948f0 0x082e5b50 0x1865b7d8 0x059b5f10 0x07ec5e50 0x08a701e0
LBA[50]: 0x148abcf20 0x0148a0450 0x0df0020 0x11054940 0x05445a0 0x04540f0 0x1838e50 0x151b530 0x1033fa80 0x0588d740
LBA[60]: 0x115742f0 0x133ff7b0 0x11a2efc0 0x095593a0 0x1390d50 0x0083c890 0x0216e590 0x1109c70 0x08a77918 0x08e0e8f0
LBA[70]: 0x050f9d030 0x0912b0f0 0x157238d0 0x099ed400 0x11070150 0x07e7f930 0x03089988 0x03169950 0x0c065878 0x0842a000
LBA[80]: 0x080183a00 0xc350520 0x020e3d58 0x15d588c0 0x0aae5250 0x02784b30 0x04803c30 0x029a1270 0x03907b78 0x059661d0
LBA[90]: 0x179e0a8c 0xf22f10 0x11776378 0xd7d820 0x05c02358 0x0764b638 0x1892df20 0x03d20f20 0x0ee24ce0 0x07a45590

PRE LBA LIST:
LBA[ 0]: 0x08669530 0x09fbaba0 0x07e42148 0x0eb5a500 0x056d39b0 0x16883e50 0x0862b508 0x147510c0 0x03129bf0 0x167ada80

=====
LBA: 0x16cd2d00 | HF: 0x00000000 F1: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 8 / ZERO: 0]
IO Time: 1900-01-00 00:00:00

Buffer addr: 0x27c5000 | Physical addr: 0x2276a000

LBA LIST:
LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[10]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[20]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[30]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[40]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[50]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[60]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[70]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[80]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[90]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

PRE LBA LIST:
LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

=====
LBA: 0x8c62750 | HF: 0x000081278 F1: 0x4c1e9683 F2: 0xd3dbfd00 [LOOP: 1 WRITE: 9931 SECTOR: 0 / NUM: 8 / ZERO: 0]
IO Time: 2023-11-28 13:42:37

Buffer addr: 0x27cd000 | Physical addr: 0x1fb8d000

LBA LIST:
LBA[ 0]: 0x8c62750 0x07eb7b50 0x09fb0df0 0x01572500 0x118c0990 0x126e3ae0 0x05a44c00 0x00de5080 0x0295e398 0x08e1be98
LBA[10]: 0x05456388 0x02089f0 0x14640dc0 0x14fb150 0x049acfc8 0x04149cc8 0x0692ccf0
LBA[20]: 0x14f3d1c0 0x01b83c0 0x13394848 0x0bda4f8 0x145b2070 0x08f926f0 0x0c18a590
LBA[30]: 0x15d588c0 0x020e3d58 0x0140b4320 0x0573f0 0x09b6b390 0x08e34930 0x0478a100
LBA[40]: 0x11776378 0x0132019e0 0x18948f0 0x082e5b50 0x1865b7d8 0x059b5f10 0x07ec5e50 0x08a701e0
LBA[50]: 0x1033fa80 0x0148a0450 0x0df0020 0x11054940 0x05445a0 0x04540f0 0x1838e50 0x151b530 0x1033fa80 0x0588d740
LBA[60]: 0x133ff7b0 0x11a2efc0 0x095593a0 0x1390d50 0x0083c890 0x0216e590 0x1109c70 0x08a77918 0x08e0e8f0
LBA[70]: 0x050f9d030 0x0912b0f0 0x157238d0 0x099ed400 0x11070150 0x07e7f930 0x03089988 0x03169950 0x0c065878 0x0842a000
LBA[80]: 0x080183a00 0xc350520 0x020e3d58 0x15d588c0 0x0aae5250 0x02784b30 0x04803c30 0x029a1270 0x03907b78 0x059661d0
LBA[90]: 0x179e0a8c 0xf22f10 0x11776378 0xd7d820 0x05c02358 0x0764b638 0x1892df20 0x03d20f20 0x0ee24ce0 0x07a45590

PRE LBA LIST:
LBA[ 0]: 0x88a2390 0x09fbaba0 0x07e42148 0x0eb5a500 0x056d39b0 0x16883e50 0x0862b508 0x147510c0
```

Current Time: 2023-11-28 14:26:56

root@VULPUS ~%

The screenshot shows the GitHub releases page for libnfs. It lists four versions: libnfs-5.0.2 (released on Aug 10, 2022), libnfs-5.0.1 (released on Feb 1, 2022), libnfs-5.0.0 (released on Jan 28, 2022), and libnfs-4.0.0 (released on Feb 13, 2019). Each version has a download link for a zip file.

## 问题原因：libnfs库导致

(1) 使用libnfs-5.0.x库，虚拟机内跑LBA工具测试会出现数据丢失和EIO；

(2) 使用libnfs-4.0.0库，虚拟机内跑LBA工具测试正常；

```
L: 4 #22946 Input: PC Speaker as /devices/platform/pcpu/input/input5
[ OK ] Found device /dev/ttys0.

CentOS Linux 7 (Core)
Kernel: 3.18.0-1166.45.1.el7.x86_64 on x86_64
test -l /dev/null: root
Password: 14_75C011 random: crng init done
root@test-ls: ~# cd /usr/src/
root@test-ls: ~# ./configure --prefix=/usr/local --enable-libc
root@test-ls: ~# make
root@test-ls: ~# make check
root@test-ls: ~# ./lba -t 10 -w 0x00000000 -r 0x00000000 -c 0x00000000 -s 0x00000000 -b 0x00000000 -B 0x00000000 -I 0x00000000 -l 0x00000000 -L 0x00000000 -D 0x00000000 -d 0x00000000 -S 0x00000000 -s 0x00000000 -R 0x00000000 -r 0x00000000 -C 0x00000000 -c 0x00000000 -G 0x00000000 -g 0x00000000 -H 0x00000000 -h 0x00000000 -P 0x00000000 -p 0x00000000 -N 0x00000000 -n 0x00000000 -M 0x00000000 -m 0x00000000 -F 0x00000000 -f 0x00000000 -T 0x00000000 -t 0x00000000 -U 0x00000000 -u 0x00000000 -W 0x00000000 -w 0x00000000 -X 0x00000000 -x 0x00000000 -Y 0x00000000 -y 0x00000000 -Z 0x00000000 -z 0x00000000 -B 0x00000000 -b 0x00000000 -D 0x00000000 -d 0x00000000 -S 0x00000000 -s 0x00000000 -R 0x00000000 -r 0x00000000 -C 0x00000000 -c 0x00000000 -G 0x00000000 -g 0x00000000 -H 0x00000000 -h 0x00000000 -P 0x00000000 -p 0x00000000 -N 0x00000000 -n 0x00000000 -M 0x00000000 -m 0x00000000 -F 0x00000000 -f 0x00000000 -T 0x00000000 -t 0x00000000 -U 0x00000000 -u 0x00000000 -W 0x00000000 -w 0x00000000 -X 0x00000000 -x 0x00000000 -Y 0x00000000 -y 0x00000000 -Z 0x00000000 -z 0x00000000 -B 0x00000000 -b 0x00000000 -D 0x00000000 -d 0x00000000 -S 0x00000000 -s 0x00000000 -R 0x00000000 -r 0x00000000 -C 0x00000000 -c 0x00000000 -G 0x00000000 -g 0x00000000 -H 0x00000000 -h 0x00000000 -P 0x00000000 -p 0x00000000 -N 0x00000000 -n 0x00000000 -M 0x00000000 -m 0x00000000 -F 0x00000000 -f 0x00000000 -T 0x00000000 -t 0x00000000 -U 0x00000000 -u 0x00000000 -W 0x00000000 -w 0x00000000 -X 0x00000000 -x 0x00000000 -Y 0x00000000 -y 0x00000000 -Z 0x00000000 -z 0x00000000 -B 0x00000000 -b 0x00000000 -D 0x00000000 -d 0x00000000 -S 0x00000000 -s 0x00000000 -R 0x00000000 -r 0x00000000 -C 0x00000000 -c 0x00000000 -G 0x00000000 -g 0x00000000 -H 0x00000000 -h 0x00000000 -P 0x00000000 -p 0x00000000 -N 0x00000000 -n 0x00000000 -M 0x00000000 -m 0x00000000 -F 0x00000000 -f 0x00000000 -T 0x00000000 -t 0x00000000 -U 0x00000000 -u 0x00000000 -W 0x00000000 -w 0x00000000 -X 0x00000000 -x 0x00000000 -Y 0x00000000 -y 0x00000000 -Z 0x00000000 -z 0x00000000 -B 0x00000000 -b 0x00000000 -D 0x00000000 -d 0x00000000 -S 0x00000000 -s 0x00000000 -R 0x00000000 -r 0x00000000 -C 0x00000000 -c 0x00000000 -G 0x00000000 -g 0x00000000 -H 0x00000000 -h 0x00000000 -P 0x00000000 -p 0x00000000 -N 0x00000000 -n 0x00000000 -M 0x00000000 -m 0x00000000 -F 0x00000000 -f 0x00000000 -T 0x00000000 -t 0x00000000 -U 0x00000000 -u 0x00000000 -W 0x00000000 -w 0x00000000 -X 0x00000000 -x 0x00000000 -Y 0x00000000 -y 0x00000000 -Z 0x00000000 -z 0x00000000 -B 0x00000000 -b 0x00000000 -D 0x00000000 -d 0x00000000 -S 0x00000000 -s 0x00000000 -R 0x00000000 -r 0x00000000 -C 0x00000000 -c 0x00000000 -G 0x00000000 -g 0x00000000 -H 0x00000000 -h 0x00000000 -P 0x00000000 -p 0x00000000 -N 0x00000000 -n 0x00000000 -M 0x00000000 -m 0x00000000 -F 0x00000000 -f 0x00000000 -T 0x00000000 -t 0x00000000 -U 0x00000000 -u 0x00000000 -W 0x00000000 -w 0x00000000 -X 0x00000000 -x 0x00000000 -Y 0x00000000 -y 0x00000000 -Z 0x00000000 -z 0x00000000 -B 0x00000000 -b 0x00000000 -D 0x00000000 -d 0x00000000 -S 0x00000000 -s 0x00000000 -R 0x00000000 -r 0x00000000 -C 0x00000000 -c 0x00000000 -G 0x00000000 -g 0x00000000 -H 0x00000000 -h 0x00000000 -P 0x00000000 -p 0x00000000 -N 0x00000000 -n 0x00000000 -M 0x00000000 -m 0x00000000 -F 0x00000000 -f 0x00000000 -T 0x00000000 -t 0x00000000 -U 0x00000000 -u 0x00000000 -W 0x00000000 -w 0x00000000 -X 0x00000000 -x 0x00000000 -Y 0x00000000 -y 0x00000000 -Z 0x00000000 -z 0x00000000 -B 0x00000000 -b 0x00000000 -D 0x00000000 -d 0x00000000 -S 0x00000000 -s 0x00000000 -R 0x00000000 -r 0x00000000 -C 0x00000000 -c 0x00000000 -G 0x00000000 -g 0x00000000 -H 0x00000000 -h 0x00000000 -P 0x00000000 -p 0x00000000 -N 0x00000000 -n 0x00000000 -M 0x00000000 -m 0x00000000 -F 0x00000000 -f 0x00000000 -T 0x00000000 -t 0x00000000 -U 0x00000000 -u 0x00000000 -W 0x00000000 -w 0x00000000 -X 0x00000000 -x 0x00000000 -Y 0x00000000 -y 0x00000000 -Z 0x00000000 -z 0x00000000 -B 0x00000000 -b 0x00000000 -D 0x00000000 -d 0x00000000 -S 0x00000000 -s 0x00000000 -R 0x00000000 -r 0x00000000 -C 0x00000000 -c 0x00000000 -G 0x00000000 -g 0x00000000 -H 0x00000000 -h 0x00000000 -P 0x00000000 -p 0x00000000 -N 0x00000000 -n 0x00000000 -M 0x00000000 -m 0x00000000 -F 0x00000000 -f 0x00000000 -T 0x00000000 -t 0x00000000 -U 0x00000000 -u 0x00000000 -W 0x00000000 -w 0x00000000 -X 0x00000000 -x 0x00000000 -Y 0x00000000 -y 0x00000000 -Z 0x00000000 -z 0x00000000 -B 0x00000000 -b 0x00000000 -D 0x00000000 -d 0x00000000 -S 0x00000000 -s 0x00000000 -R 0x00000000 -r 0x00000000 -C 0x00000000 -c 0x00000000 -G 0x00000000 -g 0x00000000 -H 0x00000000 -h 0x00000000 -P 0x00000000 -p 0x00000000 -N 0x00000000 -n 0x00000000 -M 0x00000000 -m 0x00000000 -F 0x00000000 -f 0x00000000 -T 0x00000000 -t 0x00000000 -U 0x00000000 -u 0x00000000 -W 0x00000000 -w 0x00000000 -X 0x00000000 -x 0x00000000 -Y 0x00000000 -y 0x00000000 -Z 0x00000000 -z 0x00000000 -B 0x00000000 -b 0x00000000 -D 0x00000000 -d 0x00000000 -S 0x00000000 -s 0x00000000 -R 0x00000000 -r 0x00000000 -C 0x00000000 -c 0x00000000 -G 0x00000000 -g 0x00000000 -H 0x00000000 -h 0x00000000 -P 0x00000000 -p 0x00000000 -N 0x00000000 -n 0x00000000 -M 0x00000000 -m 0x00000000 -F 0x00000000 -f 0x00000000 -T 0x00000000 -t 0x00000000 -U 0x00000000 -u 0x00000000 -W 0x00000000 -w 0x00000000 -X 0x00000000 -x 0x00000000 -Y 0x00000000 -y 0x00000000 -Z 0x00000000 -z 0x00000000 -B 0x00000000 -b 0x00000000 -D 0x00000000 -d 0x00000000 -S 0x00000000 -s 0x00000000 -R 0x00000000 -r 0x00000000 -C 0x00000000 -c 0x00000000 -G 0x00000000 -g 0x00000000 -H 0x00000000 -h 0x00000000 -P 0x00000000 -p 0x00000000 -N 0x00000000 -n 0x00000000 -M 0x00000000 -m 0x00000000 -F 0x00000000 -f 0x00000000 -T 0x00000000 -t 0x00000000 -U 0x00000000 -u 0x00000000 -W 0x00000000 -w 0x00000000 -X 0x00000000 -x 0x00000000 -Y 0x00000000 -y 0x00000000 -Z 0x00000000 -z 0x00000000 -B 0x00000000 -b 0x00000000 -D 0x00000000 -d 0x00000000 -S 0x00000000 -s 0x00000000 -R 0x00000000 -r 0x00000000 -C 0x00000000 -c 0x00000000 -G 0x00000000 -g 0x00000000 -H 0x00000000 -h 0x00000000 -P 0x00000000 -p 0x00000000 -N 0x00000000 -n 0x00000000 -M 0x00000000 -m 0x00000000 -F 0x00000000 -f 0x00000000 -T 0x00000000 -t 0x00000000 -U 0x00000000 -u 0x00000000 -W 0x00000000 -w 0x00000000 -X 0x00000000 -x 0x00000000 -Y 0x00000000 -y 0x00000000 -Z 0x00000000 -z 0x00000000 -B 0x00000000 -b 0x00000000 -D 0x00000000 -d 0x00000000 -S 0x00000
```

# LBA工具介绍：工具的作用与价值

➤ longhorn存储：对源虚拟机快照克隆，校验目的磁盘发现数据丢失

```
PREV LBA IO Time: 2024-01-18 04:45:47
NEXT LBA: 0x2b19800 | HF: 0x08001270 F1: 0x561d61d1 F2: 0xa455fea2 [LOOP: 51 WRITE: 1842 SECTOR: 0 / NUM: 2048 / ZERO: 104]
NEXT LBA IO Time: 2024-01-17 20:01:05

-----
Current Time: 2024-01-18 07:04:58
WARNING: LBA 0x2119800 - NEXT LBA: 0x4dcc800 flags is different | read[4004]
PREV LBA: 0x2119800 - NEXT LBA: 0x4dcc800 flags is different | read[4004]

PREV LBA: 0x2119800 | HF: 0x08001275 F1: 0x561d61d1 F2: 0xedebf13ac [LOOP: 52 WRITE: 4003 SECTOR: 0 / NUM: 2048 / ZERO: 268]
PREV LBA IO Time: 2024-01-18 04:45:42
NEXT LBA: 0x4dcc800 | HF: 0x08001278 F1: 0x561d61d1 F2: 0x281275e8 [LOOP: 51 WRITE: 634 SECTOR: 0 / NUM: 2048 / ZERO: 434]
NEXT LBA IO Time: 2024-01-17 17:43:29

-----
Current Time: 2024-01-18 07:05:09
WARNING: LBA 0x3d11800 - NEXT LBA: 0x1fb0800 flags is different | read[4012]
PREV LBA: 0x3d11800 - NEXT LBA: 0x1fb0800 flags is different | read[4012]

PREV LBA: 0x3d11800 | HF: 0x08001279 F1: 0x561d61d1 F2: 0x86e9d138 [LOOP: 52 WRITE: 4011 SECTOR: 0 / NUM: 2048 / ZERO: 88]
PREV LBA IO Time: 2024-01-18 04:45:45
NEXT LBA: 0x1fb0800 | HF: 0x08001276 F1: 0x561d61d1 F2: 0x0ac3f680 [LOOP: 51 WRITE: 2013 SECTOR: 0 / NUM: 2048 / ZERO: 16]
NEXT LBA IO Time: 2024-01-17 20:23:02

-----
Current Time: 2024-01-18 07:05:14
WARNING: LBA 0x1d7800 - NEXT LBA: 0x288b000 flags is different | read[3974]
PREV LBA: 0x1d7800 - NEXT LBA: 0x288b000 flags is different | read[3974]

PREV LBA: 0x1d7800 | HF: 0x08001273 F1: 0x561d61d1 F2: 0xd68dd248 [LOOP: 52 WRITE: 3973 SECTOR: 0 / NUM: 2048 / ZERO: 356]
PREV LBA IO Time: 2024-01-18 04:45:47
NEXT LBA: 0x288b000 | HF: 0x08001278 F1: 0x561d61d1 F2: 0x281275e8 [LOOP: 51 WRITE: 3173 SECTOR: 0 / NUM: 2048 / ZERO: 434]
NEXT LBA IO Time: 2024-01-17 22:05:28

-----
Starting write disk: Thread ID | Read MB - Write MB |
KEY: <P> = pause, KEY: <S> = start, KEY: <Q> = quit
Loop 53: .....
Current Time: 2024-01-18 07:05:30
5839, 4030 | 5921, 4068 | 5875, 4064 | 5864, 4126 | 5920, 4087 | 5942, 4085 | 6039, 4144 | 5978, 4136 | 5917, 4079 | 5996, 4135 |

Current Time: 2024-01-18 09:28:10
Thread 9 [tid: 1236]: Starting check disk ...
Thread 1 [tid: 1220]: Starting check disk ...
Thread 5 [tid: 1232]: Starting check disk ...
Thread 4 [tid: 1231]: Starting check disk ...
Thread 6 [tid: 1233]: Starting check disk ...
Thread 8 [tid: 1235]: Starting check disk ...
Thread 2 [tid: 1229]: Starting check disk ...
Thread 0 [tid: 1227]: Starting check disk ...
Thread 3 [tid: 1230]: Starting check disk ...
Thread 7 [tid: 1234]: Starting check disk ...
```

源虚拟机的磁盘，LBA工具已经完第53轮测试并正在进行全盘数据校验，前面52轮测试的数据校验都没有问题。

LBA工具10个线程向源磁盘写入数据，校验克隆后的磁盘数据发现每个线程写入的数据都出现丢失，手动dump校验0号线程写入的数据，如右图：第50轮测试数据，第19个同步direct IO的数据已丢失。

```
Welcome to the YOUPLUS's LBA TESTING SYSTEM
https://github.com/zhangyoujia/

YOUPLUS login: root (automatic login)
Last Login: Wed Jan 17 19:15:08 GMT-8 2024 on tty2
root@YOUPLUS ~var/iso/tools # hd_write_verify_dump -c -0 -T 0 /dev/vda
-----
Device Topology:
Disk: /dev/vda
Logical block size: 512
Physical block size: 512
Minimum I/O size: 512
Optimal I/O size: 0 (0: unknown)
Alignment offset: 0
Disk Size: +2349672960 / 40960M / 40.00G
Sector_Per_Cluster: 2048
Current Time: 2024-01-18 10:17:09
-----
BUG 004: [Thread: 0] DATA LOST | read[20] | filename: /dev/vda
PREV LBA: 0x2422000 | LOST LBA: 0x3156000 | NEXT LBA: 0x14cd000
PREV LBA IO Time: 2024-01-17 08:45:07
PREV LBA: 0x2422000 | HF: 0x08001270 F1: 0x561d61d1 F2: 0x7ba3b97c [LOOP: 50 WRITE: 18 SECTOR: 0 / NUM: 2048 / ZERO: 40]
PREV LBA IO Time: 1900-01-00 00:00:00
LOST LBA: 0x3156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
LOST LBA IO Time: 1900-01-00 00:00:00
NEXT LBA: 0x14cd000 | HF: 0x08001270 F1: 0x561d61d1 F2: 0x7ba3b97c [LOOP: 50 WRITE: 20 SECTOR: 0 / NUM: 2048 / ZERO: 40]
NEXT LBA IO Time: 2024-01-17 08:57:15

-----
LBA: 0x2422000 | HF: 0x08001270 F1: 0x561d61d1 F2: 0x7ba3b97c [LOOP: 50 WRITE: 18 SECTOR: 0 / NUM: 2048 / ZERO: 40]
IO Time: 2024-01-17 08:57:09
Buffer addr: 0x7fd9079e000 | Physical addr: 0x67035000
PRE LBA LIST:
LBA[ 0]: 0x00422000 0x0156000 0x014cd000 0x037f7800 0x03bf1000 0x0192000 0x021e5800 0x012b5000 0x02eb3000 0x00061800
LBA[10]: 0x01ff0000 0x025d5000 0x025c000 0x01cf5800 0x002c800 0x018e9000 0x01956000 0x04050000 0x03764000 0x047b4000
LBA[20]: 0x02940000 0x021fb000 0x001cc000 0x003b800 0x0001b000 0x01ec000 0x023b7000 0x00d58000 0x00192000 0x00ab4000
LBA[30]: 0x00f98000 0x01d42800 0x04b95000 0x0357f000 0x00b63000 0x00133800 0x004c4000 0x0405e000 0x02718000
LBA[40]: 0x02c64800 0x0230f000 0x0195f000 0x02492000 0x00717000 0x016b2000 0x00379000 0x017f2000 0x0450b000
LBA[50]: 0x00556000 0x01059000 0x01b2000 0x04e45000 0x03129000 0x04579000 0x001f7000 0x01b59000 0x04f64000
LBA[60]: 0x02e21a00 0x02274000 0x03f66000 0x00e76000 0x02050000 0x03280000 0x01970000 0x00104000 0x01086000
LBA[70]: 0x04855000 0x02929000 0x0208f000 0x021f2000 0x00023000 0x04404000 0x01ad3000 0x02658000 0x01769000
LBA[80]: 0x02951000 0x02c95000 0x01309000 0x008a4000 0x019ab000 0x029e5000 0x00e48000 0x03763000 0x01129000
LBA[90]: 0x0185c000 0x03d17000 0x03030000 0x0456c000 0x00141000 0x044f7000 0x031e0000 0x00246000 0x00766900

PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
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LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fd9889e000 | Physical addr: 0x7fc8000
PRE LBA LIST:
LBA[ 0]: 0x00159000 0x01af4000 0x016ff000 0x01975000 0x04709000 0x00df2000 0x02e8b000 0x01842000 0x02850000 0x02f2b000
LBA[ 0]: 0x03156000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP
```

# LBA工具介绍：工具的作用与价值

➤ longhorn存储：LBA工具测试三副本存储出现数据丢失(单副本没有问题)

## LBA工具簇间数据校验：

三副本存储裸盘测试数据丢失情况：

1. 十个线程测试，每个线程写了1.9万次左右IO(75%的1K, 25%的512字节)，只有一号线程第18955次IO的1K数据丢失了，数据的LBA偏移地址：0x2ebf8；

2. 使用LBA工具dump读取LBA偏移地址：0x2ebf8的数据为全0；

3. 复现几率高，可以多次测试重现；

4. 原因：**longhorn存储原生缺陷**，虚拟机开机时，通过clone方式构建一个单副本的volume，然后再rebuild成一个三副本的volume；在rebuild的过程中，如果存在非4K对齐写IO，会走入read modify write逻辑，此时由于没有互斥该操作，可能导致数据错误；

5. 修复方案：使用互斥锁保护非4K对齐写IO的read modify write操作；

```
[root@vml ~]# hd_write_verify_dump -c -D -L 0x2ebf8 -S 2 /dev/sdb

Device Topology:
  Disk: /dev/sdb
  Logical block size: 512
  Physical block size: 512
  Minimum I/O size: 512
  Optimal I/O size: 0 (0: unknown)
  Alignment offset: 0
  Disk Size: 209715200 / 200M / 0.20G
  Sector_Per_Cluster: 2
  Current Time: 2024-03-15 15:11:02

=====
LBA: 0x2ebf8 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x195f000 | Physical addr: 0x2e70f1000

LBA LIST:
LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[10]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[20]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[30]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[40]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[50]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[60]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[70]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[80]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[90]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

PRE LBA LIST:
LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
=====
LBA: 0x2ebf9 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x195f200 | Physical addr: 0x2e70f1200

LBA LIST:
LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[10]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[20]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[30]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[40]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[50]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[60]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[70]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[80]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[90]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

PRE LBA LIST:
LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
=====
LBA: 0x17c76 | HF: 0x00021271 F1: 0xa18795fe F2: 0xa1660818 [LOOP: 1 WRITE: 18954 SECTOR: 0 / NUM: 2 / ZERO: 0]
IO Time: 2024-03-15 14:54:16
Buffer addr: 0x205c000 | Physical addr: 0x2e42e1000

LBA LIST:
LBA[ 0]: 0x0005f31c 0x00021271 0x00017c76 0x00003c24 0x00005fea 0x00005ba6 0x0003c14 0x00025dd6 0x00028cee 0x0005acb2
LBA[10]: 0x0003fd6 0x0001fcde 0x00005bae 0x00016e2 0x0004c498 0x0004052c 0x0002b54 0x0003fa
LBA[20]: 0x0005eeef 0x0002126 0x00004eff4 0x0003c720 0x00005e9e 0x00022a46 0x000500a 0x00018148 0x00040d4 0x00015e9a
LBA[30]: 0x0005b5d0 0x0004fb4 0x00029576 0x0003c16 0x00005e9e 0x00041ab0 0x0001bc86 0x00040d76 0x0003c6a4
LBA[40]: 0x0001fd45 0x0004c59e 0x0003738 0x0000807a 0x0004d56 0x0002405a 0x0003d116 0x00051876 0x0005b31c
LBA[50]: 0x0001938d 0x0002e02a 0x0001a7ea 0x0000537c 0x0003e47a 0x00044f7a 0x0002423a 0x000144dc 0x000234b6 0x00036872
LBA[60]: 0x0004656 0x0004ee20 0x0004cc8c 0x0004f47a 0x00052cc 0x000491cc 0x0004223a 0x000144dc 0x000234b6 0x00036872
LBA[70]: 0x00017910 0x00017e5e 0x00054776 0x0001a0ea 0x00008e4 0x000417c 0x0009072a 0x0003d118 0x00012816
LBA[80]: 0x000001fd4 0x00023366 0x00026eee 0x0002dcb6 0x0001244a 0x0004c278 0x0003d3fa 0x0005fc4e 0x00016ce8 0x0001458e
LBA[90]: 0x000239ea 0x0001a0ee 0x00011c78 0x000130ae 0x0002188e 0x00008afe 0x0004cbee 0x000130ee 0x000432be 0x00057bf6

PRE LBA LIST:
LBA[ 0]: 0x0001c0fa 0x00020cfa 0x00008b5e 0x00017e5a 0x0006083c 0x00020cfce 0x0002566e 0x0001be64 0x00054d7e
=====
LBA: 0x2ebf8 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x205b000 | Physical addr: 0x2d69c1000

LBA LIST:
LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[10]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[20]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[30]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[40]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[50]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[60]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[70]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[80]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[90]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

PRE LBA LIST:
LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
=====
LBA: 0x17c76 | HF: 0x00021271 F1: 0xa18795fe F2: 0xa1660818 [LOOP: 1 WRITE: 18956 SECTOR: 0 / NUM: 2 / ZERO: 0]
IO Time: 2024-03-15 14:54:16
Buffer addr: 0x205d000 | Physical addr: 0x2bb0d0000

LBA LIST:
LBA[ 0]: 0x00017c76 0x00036c24 0x00005fea 0x00005ba6 0x0003c14 0x00025dd6 0x00028cee 0x0005acb2 0x0003fd6b 0x0003bdca
LBA[10]: 0x000052fa 0x0001fcde 0x00005bae 0x00016e2 0x0004c498 0x0004052c 0x0002b54 0x0003fa 0x0005bee 0x0002c126
LBA[20]: 0x0004eff4 0x0003e720 0x00005e9e 0x00022a46 0x000500a 0x00018148 0x00040d4 0x00015e9a
LBA[30]: 0x00029576 0x0003c16 0x00063bf2 0x00041ab0 0x0001bc86 0x0000d476 0x0003d6a4 0x0001fd46 0x00045c9e
LBA[40]: 0x00003738 0x0000807a 0x0004c6e 0x0002405a 0x0004366 0x0003d116 0x0005b31c 0x0001936e 0x00042ea0
LBA[50]: 0x0001a7ea 0x0000537c 0x0003e47a 0x0002f16 0x0001d072 0x000266aa 0x00042bea 0x0001fcf2 0x000466ee 0x0004ee20
LBA[60]: 0x00004cc8c 0x0004f47a 0x00052cc 0x000491cc 0x0004223a 0x00036872 0x00017910 0x00017e5e
LBA[70]: 0x000054776 0x00002le6 0x0001a0ea 0x00008e4 0x000417c 0x0000972a 0x0003d118 0x00012816 0x0000fd4c 0x00023366
LBA[80]: 0x000026ee 0x0002dcb6 0x0001244a 0x0004c278 0x0003d3fa 0x0005fc4e 0x00016ce8 0x000239ea 0x000130ee
LBA[90]: 0x00011c78 0x000130ae 0x0002188e 0x00008afe 0x0004cbee 0x000130ee 0x000432be 0x00057bf6 0x0003d92a

PRE LBA LIST:
LBA[ 0]: 0x0002ebf8 0x0005f31c 0x0001c0fa 0x00020cfce 0x00008b5e 0x00017e5a 0x0006083c 0x00020cfce 0x0002566e
=====
```

```
[root@vml ~]# hd_write_verify_dump -c -D -L 0x5f31c -C 0 /dev/sdb

Device Topology:
  Disk: /dev/sdb
  Logical block size: 512
  Physical block size: 512
  Minimum I/O size: 512
  Optimal I/O size: 0 (0: unknown)
  Alignment offset: 0
  Disk Size: 209715200 / 200M / 0.20G
  Sector_Per_Cluster: 2
  Current Time: 2024-03-15 15:17:58

BUG 004: [Thread: 1] DATA LOST | read[3] | filename: /dev/sdb
PREV LBA: 0x5f31c | HF: 0x00021271 F1: 0xa18795fe F2: 0xa1660818 [LOOP: 1 WRITE: 18954 SECTOR: 0 / NUM: 2 / ZERO: 0]
PREV IO Time: 2024-03-15 14:54:16

LOST LBA: 0x2ebf8 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
LOST IO Time: 1900-01-00 00:00:00

NEXT LBA: 0x17c76 | HF: 0x00021271 F1: 0xa18795fe F2: 0xa1660818 [LOOP: 1 WRITE: 18956 SECTOR: 0 / NUM: 2 / ZERO: 0]
NEXT IO Time: 2024-03-15 14:54:16

LBA: 0x5f31c | HF: 0x00021271 F1: 0xa18795fe F2: 0xa1660818 [LOOP: 1 WRITE: 18954 SECTOR: 0 / NUM: 2 / ZERO: 0]
IO Time: 2024-03-15 14:54:16
Buffer addr: 0x205c000 | Physical addr: 0x2e42e1000

LBA LIST:
LBA[ 0]: 0x0005f31c 0x00021271 0x00017c76 0x00003c24 0x00005fea 0x00005ba6 0x0003c14 0x00025dd6 0x00028cee 0x0005acb2
LBA[10]: 0x0003fd6 0x0001fcde 0x00005bae 0x00016e2 0x0004c498 0x0004052c 0x0002b54 0x0003fa
LBA[20]: 0x0005eeef 0x0002126 0x00004eff4 0x0003c720 0x00005e9e 0x00022a46 0x000500a 0x00018148 0x00040d4 0x00015e9a
LBA[30]: 0x0005b5d0 0x0004fb4 0x00029576 0x0003c16 0x00005e9e 0x00041ab0 0x0001bc86 0x00040d76 0x0003c6a4
LBA[40]: 0x0001fd45 0x0004c59e 0x0003738 0x0000807a 0x0004d56 0x0002405a 0x0003d116 0x0005b31c 0x0001936e
LBA[50]: 0x0001938d 0x0002e02a 0x0002e02a 0x0000537c 0x0003e47a 0x00044f7a 0x0002423a 0x00036872 0x00017910 0x00017e5e
LBA[60]: 0x00004656 0x0004ee20 0x0004cc8c 0x0004f47a 0x00052cc 0x000491cc 0x0004223a 0x00036872 0x00017910 0x00017e5e
LBA[70]: 0x000054776 0x00002le6 0x0001a0ea 0x00008e4 0x000417c 0x0000972a 0x0003d118 0x00012816 0x0000fd4c 0x00023366
LBA[80]: 0x000026ee 0x0002dcb6 0x0001244a 0x0004c278 0x0003d3fa 0x0005fc4e 0x00016ce8 0x000239ea 0x000130ee
LBA[90]: 0x00011c78 0x000130ae 0x0002188e 0x00008afe 0x0004cbee 0x000130ee 0x000432be 0x00057bf6 0x0003d92a

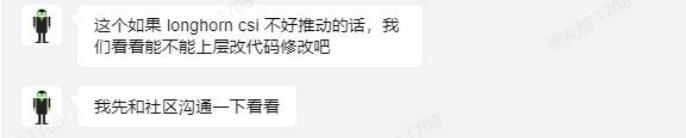
PRE LBA LIST:
LBA[ 0]: 0x0001c0fa 0x00020cfa 0x00008b5e 0x00017e5a 0x0006083c 0x00020cfce 0x0002566e
=====
```

# LBA工具介绍：工具的作用与价值

- K8S容器内运行虚拟机(使用longhorn存储), 关电源时导致数据丢失问题

## 测试出LBA问题的环境:

1. k8s容器内运行虚拟机;



2. 虚拟机使用longhorn存储, 配置: 系统盘 + n个数据盘;

3. 虚拟机运行时, 操作关电源; qemu进程还未退出, k8s容器的控制面实现有问题: 先detach了数据盘;

4. 此时/sys/block/sdX/size为0, 读IO不会失败, 会返回全0数据, 而写IO会失败, 错误码: 28 (如下图)  
ENOSPC 28 No space left on device (如右下图: 使用nbd1磁盘进行模拟)

5. 假设: 在当前虚拟机内, 有某个应用正在从数据盘A中拷贝文件到数据盘B中, 虚拟机关电源时, 可能导致从数据盘A中读取文件的数据为全0, 写到数据盘B中的文件是损坏的;

6. **结论:** 修改longhorn csi控制面的实现, 确保qemu进程未退出之前, 不能detach存储。

```
b'      IO iothread1-1241919 [069] d...1 883723.410675: bpf_trace_printk: rw complete req_addr:0x3c024610 ret:0'
b'      IO iothread1-1241919 [069] d...1 883723.410681: bpf_trace_printk: req complete req_addr:0x3c024610 status:0'
b'      IO iothread3-1241921 [004] d...1 883723.410846: bpf_trace_printk: rw complete req_addr:0x34017150 ret:-28'
b'          qemu-kvm-1241916 [064] d...1 883724.411100: bpf_trace_printk: read req_addr:0x34006910 sector num:0x2ef3600 sector_size:256'
b'      IO iothread3-1241921 [004] d...1 883724.411173: bpf_trace_printk: rw complete req_addr:0x34008d40 ret:-28'
b'      IO iothread3-1241921 [004] d...1 883724.411276: bpf_trace_printk: rw complete req_addr:0x34017150 ret:-28'
b'      IO iothread3-1241921 [004] d...1 883724.411332: bpf_trace_printk: rw complete req_addr:0x34006910 ret:0'
b'      IO iothread3-1241921 [004] d...1 883724.411336: bpf_trace_printk: req complete req_addr:0x34006910 status:0'
b'      IO iothread3-1241921 [004] d...1 883724.411355: bpf_trace_printk: rw complete req_addr:0x34006b10 ret:-28'
b'      IO iothread3-1241921 [004] d...1 883724.411394: bpf_trace_printk: rw complete req_addr:0x34018a80 ret:-28'

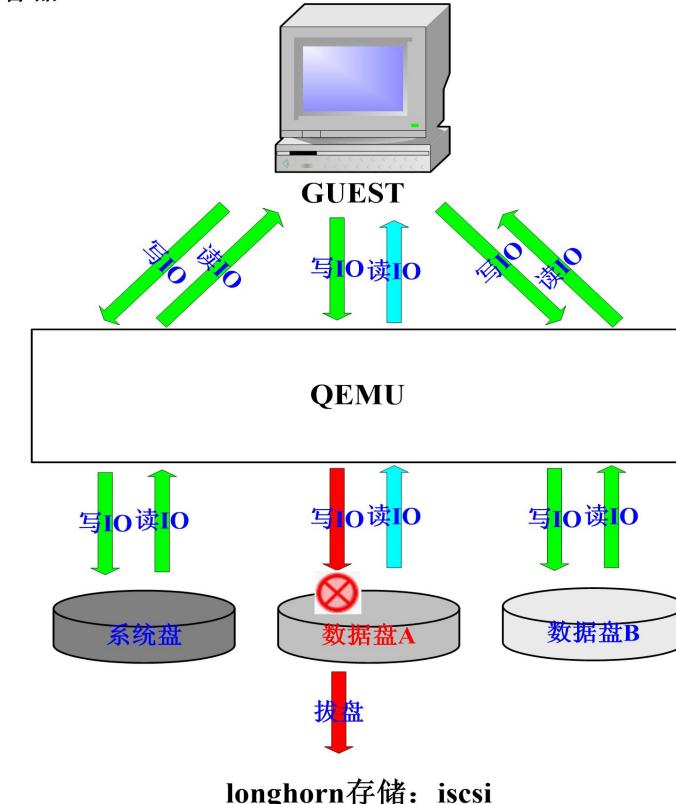
PRE LBA LIST:
LBA[ 0]: 0x05de6d00 0x0564c500 0x06e4ec00 0x098b2800 0x07dba200 0x015c2500 0x0120e400 0x04fc6000 0x0873c100 0x05c3fc00
```

```
b'      DETECT READ ERROR:
b'      LBA: 0x5de6d00 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 STRIPE: 1 LBA: 0x2ef3600 SECTOR: 0 / NUM: 0 / ZERO: 0]
b'      DETECT ERROR ID Time: 1900-01-00 00:00:00
```

```
b'      Buffer addr: 0x7ff49a605000 | Physical addr: 0x5e3d3000
```

```
b'      LBA LIST:
b'      LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
b'      LBA[10]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
b'      LBA[20]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
b'      LBA[30]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
b'      LBA[40]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
```

K8S容器



虚拟机关电源时, qemu进程还未退出, 数据盘先被detach了, 导致LBA问题。

```
[root@compute467 ~]# cat /sys/block/nbd1/size
0
[root@compute467 ~]#
[root@compute467 ~]# hexdump -C -n 512 /dev/nbd1
[root@compute467 ~]#
[root@compute467 ~]# echo $?
0
[root@compute467 ~]#
[root@compute467 ~]# dd if=/dev/zero of=/dev/nbd1 bs=512 count=1
dd: 写入 '/dev/nbd1' 出错: 设备上没有空间
记录了1+0 的读入
记录了0+0 的写出
0字节已复制, 0.000214475 s, 0.0 kB/s
[root@compute467 ~]#
[root@compute467 ~]# echo $?
1
[root@compute467 ~]#
```

# LBA工具介绍：工具的作用与价值

- qemu: qcow2代码存在原生缺陷可能导致数据丢失问题

## 测试复现问题：

1. 虚拟磁盘使用raw格式镜像，虚拟机内跑LBA工具测试过程中，kill -9 pid杀qemu进程(模拟虚拟机关机电源---部分关闭电源的实现案，当关闭电源超时后会kill杀qemu进程)，**未出现LBA问题(数据丢失)**。
2. 虚拟磁盘使用qcow2格式镜像(`preallocation=metadata/full分配模式`)，虚拟机内跑LBA工具测试过程中，kill -9 pid杀qemu进程(模拟虚拟机关机电源---部分关闭电源的实现方案，当关闭电源超时后会kill杀qemu进程)，**未出现LBA问题(数据丢失)**。
3. 虚拟磁盘使用qcow2格式镜像(`preallocation=off分配模式`)，虚拟机内跑LBA工具测试过程中，kill -9 pid杀qemu进程(模拟虚拟机关机电源---部分关闭电源的实现方案，当关闭电源超时后会kill杀qemu进程)，**出现LBA问题(数据丢失)**。

## 问题原因：

qemu的qcow2代码存在原生缺陷，`preallocation=off分配模式`qcow2格式镜像并且已随机写入部分数据后，当存在如下情况：

1. qcow2镜像中的三个簇，第一簇对应的L2表项已经创建分配，第二簇对应的L2表项未创建分配，第三簇对应的L2表项已经创建分配；
2. 先后向这三簇写入数据，第一簇直接覆盖写数据(不会更新L2表项)；第二簇先在qcow2 cache中创建L2表项，然后写数据；第三簇直接覆盖写数据(不会更新L2表项)；
3. kill -9 pid杀qemu进程时，第二簇在qcow2 cache中创建L2表项还未被刷新到存储中，导致中间IO的数据丢失。
4. **qemu所有版本都存在这个问题**：测试了qemu-7.0和最新版本qemu-8.2，都可以复现问题。

# LBA工具介绍：工具的作用与价值

- qemu: qcow2代码存在原生缺陷可能导致数据丢失问题patch

```
[root@localhost ~]# hd_write_verify_dump -c -D -T 1 /dev/vdb
Device Topology:
Disk: /dev/vdb
Logical block size: 512
Physical block size: 512
Minimum I/O size: 512
Optimal I/O size: 0 (0: unknown)
Alignment offset: 0
Disk Size: 53687091200 / 51200M / 50.00G
Sector_Per_Cluster: 1024
Current Time: 2024-03-06 10:35:55

=====
BUG 004: [Thread: 1] DATA LOST | read[466] | filename: ./dev/vdb
FREV LBA: 0xb77000 | LOST LBA: 0x324000 | NEXT LBA: 0x3e61000

PREV LBA: 0xb77000 | HF: 0x04001271 F1: 0x9a7c98f7 F2: 0x77bdeaa0 [LLOOP: 1 WRITE: 466 SECTOR: 0 / NUM: 1024 / ZERO: 228]
PREV IO Time: 2024-03-06 10:32:18

LOST LBA: 0x324000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LLOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
LOST IO Time: 1900-01-00 00:00:00

NEXT IO LBA: 0x3e61000 | HF: 0x04001271 F1: 0x9a7c98f7 F2: 0x77bdeaa0 [LLOOP: 1 WRITE: 466 SECTOR: 0 / NUM: 1024 / ZERO: 228]
NEXT IO Time: 2024-03-06 10:32:18

=====
LBA: 0xb77000 | HF: 0x04001271 F1: 0x9a7c98f7 F2: 0x77bdeaa0 [LLOOP: 1 WRITE: 466 SECTOR: 0 / NUM: 1024 / ZERO: 228]
IO Time: 2024-03-06 10:32:18
Buffer addr: 0x7fe4b9ec000 | Physical addr: 0x160bfcc000

LBA LIST:
LBA[ 0]: 0xcb77000 0x0324000 0x00823800 0x03eb000 0x03f1f000 0x04ab600 0x03d61000 0x022c8000 0x03d5000 0x03e69800
LBA[10]: 0x05234800 0x03574800 0x040cd00 0x0cd7d00 0x012e000 0x03ed600 0x052f0c00 0x01575000 0x01c4000 0x02146000
LBA[20]: 0x05d61000 0x0388d000 0x04669800 0x04e1b000 0x05cc6000 0x0325a000 0x04cb7000 0x04ac800 0x05a0800 0x0228a000
LBA[30]: 0x05c7e000 0x05d5a000 0x03ef4a00 0x022d8000 0x0244b000 0x04d94000 0x05e05800 0x0045e000 0x05c73c00 0x02fb8800
LBA[40]: 0x02b31000 0x03a5c800 0x022d8000 0x05dbb800 0x03f3f000 0x060f800 0x04a8f000 0x02b49000 0x03f1d800 0x05787400
LBA[50]: 0x041a0400 0x04000000 0x045f1000 0x052a5000 0x02217000 0x02220000 0x02120000 0x04266000 0x0014f000 0x042d1000 0x00c80400
LBA[60]: 0x01ec5700 0x01568c00 0x013e3400 0x03b6000 0x03dd6000 0x03ac7000 0x00320400 0x04743800 0x036d000 0x02425000
LBA[70]: 0x03d0c000 0x04a3b400 0x0569e000 0x0200800 0x00734400 0x05d52000 0x05a78000 0x0447a400 0x01f60c00 0x043ab800
LBA[80]: 0x04061000 0x04000000 0x045f1000 0x052a5000 0x02217000 0x02220000 0x02120000 0x04266000 0x0014f000 0x042d1000 0x00c80400
LBA[90]: 0x01ec5700 0x01568c00 0x013e3400 0x03b6000 0x03dd6000 0x03ac7000 0x00320400 0x04743800 0x036d000 0x02425000
LBA[100]: 0x03d0c000 0x04a3b400 0x0569e000 0x0200800 0x00734400 0x05d52000 0x05a78000 0x0447a400 0x01f60c00 0x043ab800

PRE LBA LIST:
LBA[ 0]: 0x00410000 0x02e8b000 0x043f4000 0x06230000 0x00312000 0x05316800 0x01c88c00 0x01af6400 0x015e5800 0x04f8c800

=====
LBA: 0x324000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LLOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
IO Time: 1900-01-00 00:00:00
Buffer addr: 0x7fe4b9ec000 | Physical addr: 0x124f97000

LBA LIST:
LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[10]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[20]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[30]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[40]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[50]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[60]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[70]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[80]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[90]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[100]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

PRE LBA LIST:
LBA[ 0]: 0x004a6b000 0x03f1f000 0x03eeb000 0x00823800 0x00324000 0x00b77000 0x00410800 0x02e8b000 0x043f4000 0x06230000

=====
LBA: 0x3e61000 | HF: 0x04001271 F1: 0x9a7c98f7 F2: 0x77bdeaa0 [LLOOP: 1 WRITE: 466 SECTOR: 0 / NUM: 1024 / ZERO: 228]
IO Time: 2024-03-06 10:32:18
Buffer addr: 0x7fe4b9ec000 | Physical addr: 0x123dbcccc0

LBA LIST:
LBA[ 0]: 0x03e61000 0x022c8000 0x03ed8000 0x006fe9800 0x05234800 0x03574800 0x040cd00 0x00d7d000 0x0012e000 0x003ed000
LBA[10]: 0x052f0c00 0x01570000 0x02146000 0x05d61000 0x0388d000 0x003eb000 0x04e1b000 0x05cc6000 0x0325a000 0x04cb7000 0x04ac800
LBA[20]: 0x04cb7000 0x04a4b800 0x055ad000 0x03f7e000 0x05d52000 0x03ef4a00 0x022d8000 0x0044b800 0x04d94000 0x05e05800 0x0045e000
LBA[30]: 0x04d94000 0x04000000 0x045f1000 0x052a5000 0x02217000 0x02220000 0x02120000 0x04266000 0x0014f000 0x042d1000 0x00c80400
LBA[40]: 0x0014f000 0x00000000 0x045f1000 0x052a5000 0x02217000 0x02220000 0x02120000 0x04266000 0x0014f000 0x042d1000 0x00c80400
LBA[50]: 0x0014f000 0x00000000 0x045f1000 0x052a5000 0x02217000 0x02220000 0x02120000 0x04266000 0x0014f000 0x042d1000 0x00c80400
LBA[60]: 0x0014f000 0x00000000 0x045f1000 0x052a5000 0x02217000 0x02220000 0x02120000 0x04266000 0x0014f000 0x042d1000 0x00c80400
LBA[70]: 0x0014f000 0x00000000 0x045f1000 0x052a5000 0x02217000 0x02220000 0x02120000 0x04266000 0x0014f000 0x042d1000 0x00c80400
LBA[80]: 0x0014f000 0x00000000 0x045f1000 0x052a5000 0x02217000 0x02220000 0x02120000 0x04266000 0x0014f000 0x042d1000 0x00c80400
LBA[90]: 0x0014f000 0x00000000 0x045f1000 0x052a5000 0x02217000 0x02220000 0x02120000 0x04266000 0x0014f000 0x042d1000 0x00c80400
LBA[100]: 0x0014f000 0x00000000 0x045f1000 0x052a5000 0x02217000 0x02220000 0x02120000 0x04266000 0x0014f000 0x042d1000 0x00c80400

PRE LBA LIST:
LBA[ 0]: 0x004a6b000 0x03f1f000 0x03eeb000 0x00823800 0x00324000 0x00b77000 0x00410800 0x02e8b000 0x043f4000 0x06230000

=====
Current Time: 2024-03-06 10:35:57
```

## LBA工具簇间数据校验： 第461-465次IO数据丢失

```
2599 static coroutine_fn int qcow2_co_pwritev_part(
2600     BlockDriverState *bs, int64_t offset, int64_t bytes,
2601     QEMUIOVector *qiov, size_t qiov_offset, BdrvRequestFlags flags)
2602 {
2603     BDRVQcow2State *s = bs->opaque;
2604     int offset_in_cluster;
2605     int ret;
2606     unsigned int cur_bytes; /* number of sectors in current iteration */
2607     uint64_t host_offset;
2608     QCow2Meta *l2meta = NULL;
2609     AioTaskPool *aio = NULL;
2610     bool flush = false;
2611
2612     trace_qcow2_writev_start_req(qemu_coroutine_self(), offset, bytes);
2613
2614     while (bytes != 0 && aio_task_pool_status(aio) == 0) {
2615
2616         l2meta = NULL;
2617
2618         trace_qcow2_writev_start_part(qemu_coroutine_self());
2619         offset_in_cluster = offset_into_cluster(s, offset);
2620         cur_bytes = MIN(bytes, INT_MAX);
2621         if (bs->encrypted) {
2622             cur_bytes = MIN(cur_bytes, QCOW_MAX_CRYPT_CLUSTERS * s->cluster_size
2623                         - offset_in_cluster);
2624         }
2625
2626         qemu_co_mutex_lock(&s->lock);
2627
2628         ret = qcow2_alloc_host_offset(bs, offset, &cur_bytes,
2629                                      &host_offset, &l2meta);
2630         if (ret < 0) {
2631             goto out_locked;
2632         }
2633
2634         if (l2meta /* && running in qemu */) {
2635             flush = true;
2636         }
2637
2638         ret = qcow2_pre_write_overlap_check(bs, 0, host_offset,
2639                                             cur_bytes, true);
2640         if (ret < 0) {
2641             goto out_locked;
2642         }
2643
2644         qemu_co_mutex_unlock(&s->lock);
2645
2646         if (!aio && cur_bytes != bytes) {
2647             aio = aio_task_pool_new(QCOW2_MAX_WORKERS);
2648         }
2649         ret = qcow2_add_task(bs, aio, qcow2_co_pwritev_task_entry, 0,
2650                             host_offset, offset,
2651                             cur_bytes, qiov, qiov_offset, l2meta);
2652         l2meta = NULL; /* l2meta is consumed by qcow2_co_pwritev_task() */
2653         if (ret < 0) {
2654             goto fail_nometa;
2655         }
2656
2657         bytes -= cur_bytes;
2658         offset += cur_bytes;
2659         qiov_offset += cur_bytes;
2660         trace_qcow2_writev_done_part(qemu_coroutine_self(), cur_bytes);
2661
2662         ret = 0;
2663
2664         qemu_co_mutex_lock(&s->lock);
2665
2666         //刷新l2表元数据
2667         if (flush) {
2668             ret = qcow2_cache_flush(bs, s->l2_table_cache);
2669         }
2670
2671         out_locked:
2672         qcow2_handle_l2meta(bs, &l2meta, false);
2673
2674         qemu_co_mutex_unlock(&s->lock);
2675
2676         fail_nometa:
2677         if (aio) {
2678             aio_task_pool_wait_all(aio);
2679             if (ret == 0) {
2680                 ret = aio_task_pool_status(aio);
2681             }
2682             g_free(aio);
2683         }
2684
2685         trace_qcow2_writev_done_req(qemu_coroutine_self(), ret);
2686
2687         return ret;
2688 }
```

# LBA工具介绍：工具的作用与价值

➤ 自研存储研发过程中，测试出很多数据一致性问题(部分典型问题，总结wiki如下)

## ▼ 【疑难问题排查】

- 【自研存储】虚拟机内跑LBA工具测试出存储IO问题
- 【自研存储】虚拟机内跑LBA工具测试出存储出错问题
- 【自研存储】超整合节点重启后回滚快照虚拟机故障
- 【自研存储-全闪】业务中连续替换data-pool的nvme磁盘4次虚拟机数据不一致
- 【自研存储-全闪】虚拟机跑LBA工具测试出存储数据不一致性问题
- 【自研存储-全闪】虚拟机跑LBA工具测试出数据不一致问题2--数据丢失
- 【自研存储-全闪】虚拟机跑LBA工具测试出数据不一致问题--数据丢失
- 【自研存储-混闪】三节点之一kill存储引擎虚拟机跑LBA工具测试出数据不一致
- 【自研存储-混闪】依次替换booster池中的nvme盘两次虚机出现数据读写不一致
- 【自研存储-混闪】修改IO及ULT超时阈值后虚机跑LBA工具出现数据不一致
- 【自研存储-混闪】反复拔插数据盘虚拟机跑LBA工具测试出数据不一致问题
- 【自研存储-混闪】存储异常导致虚拟机文件系统损坏
- 【自研存储-混闪】环境亚健康重构结束后虚拟机磁盘出现数据丢失
- 【自研存储-混闪】虚拟机跑LBA工具主机拔插磁盘测试出数据不一致性问题
- 【自研存储-混闪】虚拟机跑LBA工具测试出单磁盘场景LBA问题
- 【自研存储-混闪】虚拟机跑LBA工具测试出多磁盘场景LBA问题
- 【自研存储-混闪】虚拟机跑LBA工具测试出多磁盘场景LBA问题--数据错位
- 【自研存储-混闪】虚拟机跑LBA工具测试出存储数据不一致性问题
- 【自研存储-混闪】虚拟机跑LBA工具测试出数据不一致问题--两个字节错误
- 【自研存储-混闪】虚拟机跑LBA工具测试出现数据丢失
- 【自研存储-混闪】连续两次删除booster中nvme磁盘虚机内出现数据不一致
- 【自研存储-混闪】连续扩盘连续删盘虚拟机跑出LBA问题

■ 存储部门和测试部门每个人都应该熟练掌握LBA工具的使用，加强推广普及LBA工具及自动化系统测试验证存储稳定性，缩短开发存储产品稳定性达到可正式发布标准的研发周期、降低研发成本。

## LBA工具介绍：数据不一致问题，案例一

- 【自研存储-混闪】虚拟机跑LBA工具测试出数据不一致问题--两个字节错误

Current Time: 2023-04-05 10:56:50  
BUG 007(1): [Thread: 0] VERIFY SECTOR(S) DIFFER: 4 | read[120358]  
LBA: 0x1f2e480 | thread\_num: 10, bitmap: 1 0 0 0 0 0 0 0 0 0

CORRECT LBA[0]: 0x1f2e480 | HF: 0x00801270 F1: 0x7fa81dc9 F2: 0xc58591e4 [LOOP: 3 WRITE: 120358 STRIPE: 0 LBA: 0xf97240 SECTOR: 0 / NUM: 128 / ZERO: 42]  
CORRECT IO Time: 2023-04-04 12:19:30

Buffer addr: 0x7f098003c000 | Physical addr: 0x228c83000

LBA LIST:  
LBA[ 0]: 0x01f2e480 0x08f31980 0x02496780 0x08629280 0x048e7580 0x07932500 0x07f6f700 0x072f5880 0x00dd5380 0x05765400  
LBA[10]: 0x05243a00 0x05d01400 0x02955d00 0x021f6f80 0x0643a580 0x03e7d480 0x089df400 0x09f99200 0x08a8bd80 0x01157680  
LBA[20]: 0x064d6f80 0x038fa00 0x048f5480 0x07db5300 0x09fdff00 0x08696e00 0x08df4380 0x078d5500 0x08207380 0x019e5a80  
LBA[30]: 0x038dcc00 0x0095ef00 0x06a9ec00 0x0366b880 0x00e7b500 0x042bf600 0x01328e80 0x04b0fc00 0x058cccd00 0x0100ed80  
LBA[40]: 0x025c5500 0x05e84480 0x0456e580 0x013bf80 0x0298f000 0x0126f300 0x04e37980 0x00f45f00 0x07525780 0x08c1b280  
LBA[50]: 0x05142280 0x00ac5b80 0x06163f80 0x01265e80 0x047df280 0x07984c80 0x00f2b200 0x08a5bb00 0x06875d00 0x01da3f80  
LBA[60]: 0x065a3200 0x06645f80 0x0454b880 0x0639ab80 0x07a32b00 0x02e7fb80 0x073e7280 0x049d2e00 0x0082ef80 0x07ea3280  
LBA[70]: 0x03ffdff80 0x09b31f00 0x00531b80 0x04219f80 0x04e1db80 0x078d5500 0x09a15d00 0x06f47c00 0x06938780 0x0056be80  
LBA[80]: 0x09194d00 0x07d5d580 0x0588f300 0x081c4f00 0x02002580 0x0380f800 0x07d5d680 0x07d25e80 0x08c59500 0x08153980  
LBA[90]: 0x05f3e580 0x005eae80 0x0656a780 0x00b74580 0x08a44d80 0x04dca800 0x0006fc00 0x010a4a80 0x0408af80 0x09235200

PRE LBA LIST:  
LBA[ 0]: 0x09218e80 0x08d70980 0x040cda80 0x05c92480 0x07ac2b80 0x044c4980 0x06b30d80 0x07938f80 0x01697380 0x07a7af00

ERROR LBA[8]: 0x1f2e488 | HF: 0x00801270 F1: 0x7fa81dc9 F2: 0xc58591e4 [LOOP: 3 WRITE: 120358 STRIPE: 0 LBA: 0xf97248 SECTOR: 12 / NUM: 128 / ZERO: 42]  
INCUMSTANTIO Time: 2023-04-04 12:19:30

Buffer addr: 0x7f898003d000 | Physical addr: 0x21f324000

LBA LIST:  
LBA[ 0]: 0x01f2e480 0x08f31980 0x02496780 0x08629280 0x048e7580 0x07932500 0x07f6f700 0x072f5880 0x00dd5380 0x05765400  
LBA[10]: 0x05243a00 0x05d01400 0x02955d00 0x021f6f80 0x0643a580 0x03e7d480 0x089df400 0x09f99200 0x08a8bd80 0x01157680  
LBA[20]: 0x064d6f80 0x038fa00 0x048f5480 0x07db5300 0x09fdff00 0x08696e00 0x08df4380 0x078d5500 0x08207380 0x019e5a80  
LBA[30]: 0x038dcc00 0x0095ef00 0x06a9ec00 0x0366b880 0x00e7b500 0x042bf600 0x01328e80 0x04b0fc00 0x058cccd00 0x0100ed80  
LBA[40]: 0x025c5500 0x05e84480 0x0456e580 0x013bf80 0x0298f000 0x0126f300 0x04e37980 0x00f45f00 0x07525780 0x08c1b280  
LBA[50]: 0x05142280 0x00ac5b80 0x06163f80 0x01265e80 0x047df280 0x07984c80 0x00f2b200 0x08a5bb00 0x06875d00 0x01da3f80  
LBA[60]: 0x065a3200 0x06645f80 0x0454b880 0x0639ab80 0x07a32b00 0x02e7fb80 0x073e7280 0x049d2e00 0x0082ef80 0x07ea3280  
LBA[70]: 0x03ffdff80 0x09b31f00 0x00531b80 0x04219f80 0x04e1db80 0x078d5500 0x09a15d00 0x06f47c00 0x06938780 0x0056be80  
LBA[80]: 0x09194d00 0x07d5d580 0x0588f300 0x081c4f00 0x02002580 0x0380f800 0x07d5d680 0x07d25e80 0x08c59500 0x08153980  
LBA[90]: 0x05f3e580 0x005eae80 0x0656a780 0x00b74580 0x08a44d80 0x04dca800 0x0006fc00 0x010a4a80 0x0408af80 0x09235200

PRE LBA LIST:  
LBA[ 0]: 0x09218e80 0x08d70980 0x040cda80 0x05c92480 0x07ac2b80 0x044c4980 0x06b30d80 0x07938f80 0x01697380 0x07a7af00

CORRECT LBA[12]: 0x1f2e48c | HF: 0x00801270 F1: 0x7fa81dc9 F2: 0xc58591e4 [LOOP: 3 WRITE: 120358 STRIPE: 0 LBA: 0xf9724c SECTOR: 12 / NUM: 128 / ZERO: 42]  
CORRECT IO Time: 2023-04-04 12:19:30

Buffer addr: 0x7f898003d800 | Physical addr: 0x21f324800

# LBA工具介绍：数据不一致问题，案例一

## ➤ 【自研存储-混闪】虚拟机跑LBA工具测试出数据不一致问题--两个字节错误

问题原因：

客户端io使用了相同的buffer导致数据在内存中不一致，之所以采用了相同的buffer是因为o log offset为0导致一个io中的两个recxmap到相同的地址

验证思路：

写入64k数据并且记录每个512字节的crc，批量读取64数据内的多段数据，查看数据crc是否满足要求

验证过程记录：

修改前：

```
wr idx 119 csum 8027518714553792079
wr idx 120 csum 17495080994129261748
wr idx 121 csum 10950643281404104464
wr idx 122 csum 18262799847820884056
wr idx 123 csum 3981115071714742922
wr idx 124 csum 2340204067906706629
wr idx 125 csum 11354231219956398386
wr idx 126 csum 10813301452522952677
wr idx 127 csum 13355868685102970665
rd idx 0 csum 5856497656288625140
unexcepted err ori crc 335982869464060228 new crc 5856497656288625140
rd idx 9 csum 5856497656288625140
unexcepted err ori crc 10228107122013071008 new crc 5856497656288625140
rd idx 20 csum 5856497656288625140
unexcepted err ori crc 69069208052814211 new crc 5856497656288625140
rd idx 30 csum 5856497656288625140
```

修改后：

```
wr idx 119 csum 8027518714553792079
wr idx 120 csum 17495080994129261748
wr idx 121 csum 10950643281404104464
wr idx 122 csum 18262799847820884056
wr idx 123 csum 3981115071714742922
wr idx 124 csum 2340204067906706629
wr idx 125 csum 11354231219956398386
wr idx 126 csum 10813301452522952677
wr idx 127 csum 13355868685102970665
rd idx 0 csum 335982869464060228
rd idx 9 csum 10228107122013071008
rd idx 20 csum 69069208052814211
rd idx 30 csum 5856497656288625140
```

# LBA工具介绍：数据不一致问题，案例二

- 【自研存储-混闪】虚拟机跑LBA工具测试出多磁盘场景LBA问题--数据错位  
第一次见到这种数据不一致出错的情形：数据错位一个字节！

```
LBA: 0x2c1c082 | HF: 0x00001279 F1: 0x010742B3 F2: 0xe177ddc0 LLOOP: 5 WRITE: 16138 STRIPE: 1 LBA: 0x160e002 SECTOR: 2 × NUM: 128 × ZERO
IO Time: 2023-04-03 17:12:32

Buffer addr: 0x22ba400 | Physical addr: 0x42457b400

LBA LIST:
LBA[ 0]: 0x02c1c080 0x0664d600 0x06903980 0x0830e280 0x0281c600 0x010df880 0x04164c80 0x06b7b000 0x046e6780 0x00e18300
LBA[10]: 0x092f1500 0x0122b600 0x0513a000 0x07ae8180 0x03e21e00 0x06800200 0x0007c100 0x07c60100 0x041d4000 0x06fe4000
LBA[20]: 0x09909980 0x07cd2200 0x09e57580 0x092eed00 0x021ce980 0x0327fd00 0x035a4900 0x09a79f80 0x022a5880 0x071df900
LBA[30]: 0x06c40c80 0x07b20480 0x07dc0280 0x0655f980 0x07017d00 0x07d67400 0x047d1e00 0x01bd900 0x09d52b00 0x02f5a000
LBA[40]: 0x0091d680 0x04710800 0x01436600 0x03976080 0x004cb880 0x037e8880 0x00fc4000 0x08b7d000 0x016d4880 0x030a1880
LBA[50]: 0x075e5800 0x042c0080 0x029aa000 0x0703b000 0x04bbe800 0x0935c080 0x05269b80 0x034f3500 0x0270ad00 0x02cef500
LBA[60]: 0x061e6a00 0x07911500 0x07594e00 0x089adb00 0x05a59780 0x0292c80 0x013da400 0x01a16a80 0x03ecac80 0x07c7e100
LBA[70]: 0x043e3600 0x09a2b800 0x08777600 0x0894c200 0x01946000 0x0855ac00 0x06851080 0x00f1e080 0x05ee8e00 0x05e7b900
LBA[80]: 0x01925b80 0x0285e580 0x07d8b800 0x06b68500 0x018a6100 0x06426800 0x09709800 0x00616800 0x05a0c000 0x0873b380
LBA[90]: 0x00ba0680 0x08251300 0x048de300 0x078f9a00 0x050cd900 0x077a9200 0x08681b00 0x05d01c00 0x06d74080 0x066ecc80

PRE LBA LIST:
LBA[ 0]: 0x07cd6000 0x01b74a00 0x01b55900 0x075df080 0x06ff4080 0x095f8800 0x00647800 0x06462c80 0x09ca6800 0x0219e400
```

有个数据结构强转了一下，转换出来的值相同或者相差1个字节，导致分配到了相同的buffer来存放数据，两次不同的row IO都使用该buffer放数据的话，会被覆盖掉，要非常巧合才能出现，比较偶现。

17:33  
啥原因呀？有没有什么必现的场景  
我看目前20台虚机就两台出这个问题

```
LBA: 0x2c1c003 | HF: 0x83000012 F1: 0x00010742 F2: 0x00e177dd LLOOP: 4261412864 WRITE: 830000143 STRIPE: 1 LBA: 0x160e003 SECTOR: 30976 × NUM: 0 × ZERO: 16777216
01
IO Time: 385877868-2063597569-50331648 50331648:285212672:201326592

Buffer addr: 0x22ba600 | Physical addr: 0x42457b600

LBA LIST:
LBA[ 0]: 0x0002c1c0 0x000656486 0x00069039 0x000830e2 0x000281c6 0x00010f8 0x0004154c 0x0006b7b0 0x00046e67 0x0000e183
LBA[10]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[20]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[30]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[40]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[50]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[60]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[70]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[80]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[90]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

PRE LBA LIST:
LBA[ 0]: 0x00007cd600 0x00001b74a 0x00001b559 0x000075d10 0x00006ff40 0x000095f88 0x000006478 0x00006162c 0x00009ca68 0x000219e1

=====
Current Time: 2023-04-04 09:48:01
```

# LBA工具介绍：数据不一致问题，案例三

【自研存储-全闪】虚拟机跑LBA工具测试出数据不一致问题--数据丢失

```
BUG 004: [Thread: 51 DATA LOST | read[288]
PREV LBA: 0x359ec00 | LOST LBA: 0x20c5c00 | NEXT LBA: 0x1d3c800
PREV LBA: 0x359ec00 | HF: 0x04001275 F1: 0xa62d2928 F2: 0xab2ebd00 [LOOP: 5 WRITE: 286 SECTOR: 0 / NUM: 1024 / ZERO: 208]
PREV IO Time: 2023-05-13 11:20:53
LOST LBA: 0x20c5c00 | HF: 0x04001272 F1: 0xa62d2928 F2: 0x1d66938a [LOOP: 4 WRITE: 8030 SECTOR: 0 / NUM: 1024 / ZERO: 142]
LOST IO Time: 2023-05-13 11:22:55
NEXT LBA: 0x1d3c800 | HF: 0x04001275 F1: 0xa62d2928 F2: 0xab2ebd00 [LOOP: 5 WRITE: 288 SECTOR: 0 / NUM: 1024 / ZERO: 208]
NEXT IO Time: 2023-05-13 11:20:54
```

```
LBA: 0x359ec00 | HF: 0x04001275 F1: 0xa62d2928 F2: 0xab2ebd00 [LOOP: 5 WRITE: 286 SECTOR: 0 / NUM: 1024 / ZERO: 208]
IO Time: 2023-05-13 11:20:53
```

```
Buffer addr: 0x7f6faadd5000 | Physical addr: 0x422516000
```

```
LBA LIST:
LBA[ 0]: 0x0359ec00 0x020c5c00 0x01d3c800 0x032a8c00 0x00fa8800 0x0043a800 0x042c5c00 0x02d9e400 0x03de2c00 0x03ab1000
LBA[ 1]: 0x0139b400 0x01fb0400 0x03020800 0x03b00400 0x03020800 0x03b00400 0x00a48c00 0x03108400 0x0498db00 0x01685400
LBA[ 20]: 0x00225000 0x03af2400 0x04f8a000 0x041fb000 0x02e1c900 0x03bd1c00 0x001a1000 0x00045c00 0x0e033e400 0x0336f000
LBA[ 30]: 0x02873400 0x030f1c00 0x02aec800 0x01864400 0x03410000 0x03b9c00 0x044d4000 0x02507c00 0x01bd0000 0x00ae4400
LBA[ 40]: 0x03395e000 0x015d8400 0x03232000 0x02a80000 0x03520800 0x0398a000 0x0029e000 0x0442a000 0x00240800
LBA[ 50]: 0x00500000 0x0139c400 0x02f5e000 0x039b1000 0x01557c00 0x02055800 0x00775800 0x0282c000 0x00e0cc00 0x03128c00
LBA[ 60]: 0x03a3c400 0x047f6400 0x04040400 0x000bc800 0x03ddc800 0x0385f000 0x01c4a800 0x03dac00 0x00163000
LBA[ 70]: 0x0496d000 0x04c1c800 0x03518000 0x03577800 0x021c1400 0x01573800 0x03d08800 0x00fb8a800 0x04925000 0x0104e800
LBA[ 80]: 0x028cc000 0x01e32c00 0x0455e000 0x03a0cc00 0x019a9400 0x02f0c000 0x01026000 0x000bf000 0x03ac1000 0x03c5b800
LBA[ 90]: 0x02b02800 0x02aee400 0x00cce800 0x00d56000 0x0011c000 0x03ac4400 0x01137000 0x0332f000 0x04f5f000 0x02f61000
```

```
PRE LBA LIST:
LBA[ 0]: 0x023f1c00 0x01fb0400 0x00277800 0x04b48000 0x01281000 0x0332d800 0x00c4d800 0x00534400 0x01964400
```

```
LBA: 0x20c5c00 | HF: 0x04001272 F1: 0xa62d2928 F2: 0x1d66938a [LOOP: 4 WRITE: 8030 SECTOR: 0 / NUM: 1024 / ZERO: 142]
IO Time: 2023-05-13 11:12:55
```

```
Buffer addr: 0x7f6faae57000 | Physical addr: 0x41f880000
```

```
LBA LIST:
LBA[ 0]: 0x020c5c00 0x01ccb400 0x0266cc00 0x040cb400 0x00995400 0x011e3800 0x019fbcc0 0x004e800 0x00857c00 0x013sec00
LBA[ 1]: 0x00d95800 0x017f6800 0x02b7dc00 0x0134bc00 0x011fd800 0x0237dc00 0x009ec00 0x00954000 0x01605400 0x02250000 0x03af2400
LBA[ 20]: 0x043dc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000
LBA[ 30]: 0x043dc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000
LBA[ 40]: 0x043dc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000
LBA[ 50]: 0x043dc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000
LBA[ 60]: 0x043dc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000
LBA[ 70]: 0x043dc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000
LBA[ 80]: 0x043dc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000
LBA[ 90]: 0x043dc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000 0x011fc000
```

```
PRE LBA LIST:
LBA[ 0]: 0x023f1c00 0x01fb0400 0x00277800 0x04b48000 0x01281000 0x0332d800 0x00c4d800 0x00534400 0x01964400
```

数据不一致问题：数据丢失 (10)



还没具体写原因，目前结论是，下电前的部分io对于上层写入成功，对于底层还在元数据在部分节点树上未提交，上电后判断数据树的状态有问题，导致未提交的节点将数据丢失

Welcome to the YOOLPLUS's Lba TEST SYSTEM  
https://github.com/zhangyoujia

```
(none) login: root (automatic login)
echo never > /sys/kernel/mm/transparent_hugepage/enabled
hd_write_verify -c -D -R -S 3 1024 -U all -T 10 -L 102400 -P split -I ./dev/uda
device TestDisk
Disk: ./dev/uda | Thread: 10 | Total Sectors: 83886080 | Total Clusters: 81920 | Sectors of Cluster: 1024 | DIRECT IO & NO Flush | Verify: 5 | Notify: 0
Current Time: 2023-05-13 11:57:40
Thread 8 (tid: 6631): Starting check disk ...
Thread 9 (tid: 6641): Starting check disk ...
Thread 0 (tid: 6751): Starting check disk ...
Thread 3 (tid: 6701): Starting check disk ...
Thread 2 (tid: 6771): Starting check disk ...
Thread 6 (tid: 6671): Starting check disk ...
Thread 7 (tid: 6791): Starting check disk ...
Thread 5 (tid: 6601): Starting check disk ...
Thread 1 (tid: 6761): Starting check disk ...
Thread 9 (tid: 6841): Starting check disk ...
Current Time: 2023-05-13 11:57:55
PRE LBA: 0x359ec00 | HF: 0x04001275 F1: 0xa62d2928 F2: 0xab2ebd00 [LOOP: 5 WRITE: 286 SECTOR: 0 / NUM: 1024 / ZERO: 208]
PRE LBA IO Time: 2023-05-13 11:20:53
NEXT LBA: 0x20c5c00 | HF: 0x04001272 F1: 0xa62d2928 F2: 0x1d66938a [LOOP: 4 WRITE: 8030 SECTOR: 0 / NUM: 1024 / ZERO: 142]
NEXT LBA IO Time: 2023-05-13 11:12:55
```

```
Current Time: 2023-05-13 11:57:55
PRE LBA: 0x359ec00 | HF: 0x04001275 F1: 0xa62d2928 F2: 0x1d66938a [LOOP: 5 WRITE: 286 SECTOR: 0 / NUM: 1024 / ZERO: 208]
PRE LBA IO Time: 2023-05-13 11:20:53
Buffer addr: 0x7f2c814f000 | Physical addr: 0x41fc2000
LBA LIST:
LBA[ 0]: 0x0359ec00 0x0139b400 0x013dc000 0x0043a800 0x0043a800 0x042c500 0x02d9e400 0x03de2c00 0x03ab1000
LBA[ 1]: 0x0139b400 0x013dc000 0x0043a800 0x0043a800 0x042c500 0x02d9e400 0x03de2c00 0x03ab1000
LBA[ 20]: 0x00273400 0x017f6800 0x0237dc00 0x009ec00 0x009ec00 0x042c500 0x02d9e400 0x03de2c00 0x03ab1000
LBA[ 30]: 0x02379000 0x0172c000 0x0458db00 0x03232000 0x02a00000 0x05208000 0x039a0000 0x009ec000 0x042c5000
LBA[ 40]: 0x03239000 0x0172c000 0x0458db00 0x03232000 0x02a00000 0x05208000 0x039a0000 0x009ec000 0x042c5000
LBA[ 50]: 0x03239000 0x0172c000 0x0458db00 0x03232000 0x02a00000 0x05208000 0x039a0000 0x009ec000 0x042c5000
LBA[ 60]: 0x03239000 0x0172c000 0x0458db00 0x03232000 0x02a00000 0x05208000 0x039a0000 0x009ec000 0x042c5000
LBA[ 70]: 0x03239000 0x0172c000 0x0458db00 0x03232000 0x02a00000 0x05208000 0x039a0000 0x009ec000 0x042c5000
LBA[ 80]: 0x03239000 0x0172c000 0x0458db00 0x03232000 0x02a00000 0x05208000 0x039a0000 0x009ec000 0x042c5000
LBA[ 90]: 0x03239000 0x0172c000 0x0458db00 0x03232000 0x02a00000 0x05208000 0x039a0000 0x009ec000 0x042c5000
```

```
PRE LBA LIST:
LBA[ 0]: 0x023f1c00 0x01fb0400 0x00277800 0x04b48000 0x01281000 0x0332d800 0x00c4d800 0x00534400 0x01964400
LOST LBA: 0x20c5c00 | HF: 0x04001272 F1: 0xa62d2928 F2: 0x1d66938a [LOOP: 4 WRITE: 8030 SECTOR: 0 / NUM: 1024 / ZERO: 142]
LOST LBA IO Time: 2023-05-13 11:12:55
Buffer addr: 0x7f2c3000000 | Physical addr: 0x4214a300
```

```
LBA LIST:
LBA[ 0]: 0x020c5c00 0x0139b400 0x013dc000 0x0043a800 0x0043a800 0x042c500 0x02d9e400 0x03de2c00 0x03ab1000
LBA[ 1]: 0x0139b400 0x013dc000 0x0043a800 0x0043a800 0x042c500 0x02d9e400 0x03de2c00 0x03ab1000
LBA[ 20]: 0x00273400 0x017f6800 0x0237dc00 0x009ec00 0x009ec00 0x042c500 0x02d9e400 0x03de2c00 0x03ab1000
LBA[ 30]: 0x02379000 0x0172c000 0x0458db00 0x03232000 0x02a00000 0x05208000 0x039a0000 0x009ec000 0x042c5000
LBA[ 40]: 0x03239000 0x0172c000 0x0458db00 0x03232000 0x02a00000 0x05208000 0x039a0000 0x009ec000 0x042c5000
LBA[ 50]: 0x03239000 0x0172c000 0x0458db00 0x03232000 0x02a00000 0x05208000 0x039a0000 0x009ec000 0x042c5000
LBA[ 60]: 0x03239000 0x0172c000 0x0458db00 0x03232000 0x02a00000 0x05208000 0x039a0000 0x009ec000 0x042c5000
LBA[ 70]: 0x03239000 0x0172c000 0x0458db00 0x03232000 0x02a00000 0x05208000 0x039a0000 0x009ec000 0x042c5000
LBA[ 80]: 0x03239000 0x0172c000 0x0458db00 0x03232000 0x02a00000 0x05208000 0x039a0000 0x009ec000 0x042c5000
LBA[ 90]: 0x03239000 0x0172c000 0x0458db00 0x03232000 0x02a00000 0x05208000 0x039a0000 0x009ec000 0x042c5000
```

```
PRE LBA LIST:
LBA[ 0]: 0x023f1c00 0x01fb0400 0x00277800 0x04b48000 0x01281000 0x0332d800 0x00c4d800 0x00534400 0x01964400
NEXT LBA: 0x1d3c800 | HF: 0x04001275 F1: 0xa62d2928 F2: 0x1d66938a [LOOP: 5 WRITE: 288 SECTOR: 0 / NUM: 1024 / ZERO: 208]
NEXT LBA IO Time: 2023-05-13 11:20:54
Buffer addr: 0x7f2c814f000 | Physical addr: 0x422aa000
```

```
LBA LIST:
LBA[ 0]: 0x0139b400 0x013dc000 0x0043a800 0x00fa8800 0x0043a800 0x042c500 0x02d9e400 0x03de2c00 0x03ab1000
LBA[ 1]: 0x0139b400 0x013dc000 0x0043a800 0x00fa8800 0x0043a800 0x042c500 0x02d9e400 0x03de2c00 0x03ab1000
LBA[ 20]: 0x00273400 0x017f6800 0x0237dc00 0x009ec00 0x009ec00 0x042c500 0x02d9e400 0x03de2c00 0x03ab1000
LBA[ 30]: 0x02379000 0x0172c000 0x0458db00 0x03232000 0x02a00000 0x05208000 0x039a0000 0x009ec000 0x042c5000
LBA[ 40]: 0x03239000 0x0172c000 0x0458db00 0x03232000 0x02a00000 0x05208000 0x039a0000 0x009ec000 0x042c5000
LBA[ 50]: 0x03239000 0x0172c000 0x0458db00 0x03232000 0x02a00000 0x05208000 0x039a0000 0x009ec000 0x042c5000
LBA[ 60]: 0x03239000 0x0172c000 0x0458db00 0x03232000 0x02a00000 0x05208000 0x039a0000 0x009ec000 0x042c5000
LBA[ 70]: 0x03239000 0x0172c000 0x0458db00 0x03232000 0x02a00000 0x05208000 0x039a0000 0x009ec000 0x042c5000
LBA[ 80]: 0x03239000 0x0172c000 0x0458db00 0x03232000 0x02a00000 0x05208000 0x039a0000 0x009ec000 0x042c5000
LBA[ 90]: 0x03239000 0x0172c000 0x0458db00 0x03232000 0x02a00000 0x05208000 0x039a0000 0x009ec000 0x042c5000
```

```
PRE LBA LIST:
LBA[ 0]: 0x020c5c00 0x0359ec00 0x0231c00 0x01fb0400 0x00277800 0x04b48000 0x01281000 0x0332d800 0x00c4d800 0x00534400
Current Time: 2023-05-13 11:57:55
pause_and_exit_work: Press KEY: <Q> to exit!
```

# LBA工具介绍：数据不一致问题，案例四

## 【自研存储-全闪】虚拟机跑LBA工具测试出数据不一致问题2--数据丢失

```
[root@node81 ~]# daos obj dkey-query -p testA -c c8e405fc-0f84-4d9c-b3b1-ea42a073b052 -i 939282005873393974.0 --dkey 1 --poolmap
```

```
/var/log/storage/pool_buf/4eae947-2adb-4cde-9ac4-a7b27148b533_18_0
```

Dkey Layout: grp\_nr: 1 grp\_size: 4

idx: 5 shardid: 4 rank: 3 tgt: 10 rebuild: 0 hyper: 0

idx: 4 shardid: 3 rank: 1 tgt: 1 rebuild: 0 hyper: 0

idx: 6 shardid: 5 rank: 5 tgt: 7 rebuild: 0 hyper: 0

idx: 4294967295 shardid: 4294967295 rank: 4294967295 tgt: 4294967295 rebuild: 1 hyper: 0

```
[root@node81 ~]# daos obj dkey-query -p testA -c c8e405fc-0f84-4d9c-b3b1-ea42a073b052 -i 939282005873393974.0 --dkey 1 --poolmap
```

```
/var/log/storage/pool_buf/4eae947-2adb-4cde-9ac4-a7b27148b533_19_0
```

Dkey Layout: grp\_nr: 1 grp\_size: 3

idx: 4 shardid: 4 rank: 3 tgt: 10 rebuild: 0 hyper: 0

idx: 3 shardid: 3 rank: 2 tgt: 2 rebuild: 0 hyper: 0

idx: 5 shardid: 5 rank: 7 tgt: 7 rebuild: 0 hyper: 0

```
node81 INFO 2023/05/25 20:07:19 [gid:137] daos_engine:1 Cluster map 4eae947 version 19 reclaim 1 disable 0
```

```
root[0] v0 UP_IN 0
```

protect domain[2] v1 UP\_IN 0

```
rack[3] v1 UP_IN 0
```

node[6] v1 UP\_IN 0

rank[1] v1 UP\_IN 0

target[0][1] v1 UP\_IN (fseq=11 out=14 up=6 upin=8 flags=1)

target[1][2] v1 UP\_IN (fseq=1 out=1 up=1 upin=1 flags=0)

rank[2] v1 UP\_IN 0

target[2][1] v1 UP\_IN (fseq=10 out=12 up=18 upin=19 flags=0)

target[3][2] v1 UP\_IN (fseq=1 out=1 up=1 upin=1 flags=0)

node[10] v1 UP\_IN 0

rank[4] v1 UP\_IN 0

target[4][1] v1 UP\_IN (fseq=1 out=1 up=1 upin=1 flags=0)

```
node81 INFO 2023/05/25 20:07:19 [gid:137] daos_engine:1
```



已有基本结论：jump算法导致的数据重构丢失，明天我找攀哥确认，环境先继续帮忙保留，明天确认后，我会通知环境释放

### 【问题影响】

故障target后数据不一致。

### 【问题根因】

再允许不同group间允许重复，如果group中重复的target UP后，计算合并layout的时候只取值一次，导致选出的layout有问题。

### 【修改方案】

不同的group间允许多次选择，相同的group中不允许重复。

Welcome to the YOUPlus's LBA TESTING SYSTEM

<https://github.com/zhangyoujia/>

```
YOUPlus Login root (automatic login)
root:~$ login: root: 20 16:50:41 GMT+0 2023 on ttys0
0:0 NO_MENUS RESTRICTED
root@YOUPlus:/var/iso/tools# lsblk
NAME MAJ:MIN RM SIZE RO TYPE MOUNTPOINT
sda 1:0 1 8M 0 rom /var/iso
vda 2:0 0 20G 0 disk
root@YOUPlus:/var/iso/tools# hd_writ_verify_dump -c -D -T 2 /dev/vda
Device Topology:
Disk: /dev/vda
Logical block size: 512
Physical block size: 512
Minimum I/O size: 512
Optimal I/O size: 0 (io unknown)
Alignment offset: 0
Disk Size: 21474836480 / 20480M / 20.00G
Sector_Per_Cluster: 2048
Current Time: 2023-05-30 17:36:01
=====
WARNING: [Thread: 2] WRITE SECTORS INCONSISTENT | read[146] | filename: /dev/vda
CORRECT LBA[0]: 0x1b2000 | HF: 0x08001272 F1: 0x639bdb3c F2: 0xaeecd94c [LOOP: 2 WRITE: 146 SECTOR: 0 / NUM: 2048 / ZERO: 72]
CORRECT IO Time: 2023-05-30 15:19:31
ERROR LBA[0]: 0x1b2008 | HF: 0x08001272 F1: 0x639bdb3c F2: 0xaeecd94c [LOOP: 1 WRITE: 566 SECTOR: 8 / NUM: 2048 / ZERO: 664]
INCONSISTENT IO Time: 2023-05-30 15:19:35
CORRECT LBA[0]: 0x1b2000 | HF: 0x08001272 F1: 0x639bdb3c F2: 0xaeecd94c [LOOP: 2 WRITE: 146 SECTOR: 0 / NUM: 2048 / ZERO: 72]
CORRECT IO Time: 2023-05-30 15:19:31
=====
BUG 007[1] LAST IO: [Thread: 2] WRITE SECTOR[0] DIFFER: 0 | read[146] | filename: /dev/vda
hd_writ_verify_dump -c -D -L 0x00178000 disk/file
hd_writ_verify_dump -c -D -L 0x00180000 disk/file
CORRECT LBA[0]: 0x1b2000 | HF: 0x08001272 F1: 0x639bdb3c F2: 0xaeecd94c [LOOP: 2 WRITE: 146 SECTOR: 0 / NUM: 2048 / ZERO: 72]
CORRECT IO Time: 2023-05-30 15:19:31
ERROR LBA[0]: 0x1b2008 | HF: 0x08001272 F1: 0x639bdb3c F2: 0xaeecd94c [LOOP: 1 WRITE: 566 SECTOR: 8 / NUM: 2048 / ZERO: 664]
INCONSISTENT IO Time: 2023-05-30 15:19:35
CORRECT LBA[0]: 0x1b2010 | HF: 0x08001272 F1: 0x639bdb3c F2: 0xaeecd94c [LOOP: 2 WRITE: 146 SECTOR: 16 / NUM: 2048 / ZERO: 72]
CORRECT IO Time: 2023-05-30 15:19:31
=====
LBA: 0x1b2007 | HF: 0x08001272 F1: 0x639bdb3c F2: 0xaeecd94c [LOOP: 2 WRITE: 146 SECTOR: 7 / NUM: 2048 / ZERO: 72]
IO Time: 2023-05-30 15:19:31
Buffer addr: 0x7fb04136e00 | Physical addr: 0x422cate00
LBA LIST:
LBA[ 0]: 0x001b2000 0x01528000 0x01a00000 0x021b8000 0x022c8000 0x03c7800 0x01a5000 0x01bcb000 0x00b34800
LBA[ 1]: 0x00352000 0x02508000 0x01a00000 0x01b70000 0x00532000 0x0203d000 0x004d2000 0x01b1000 0x00b34800
LBA[ 2]: 0x0174f000 0x00440000 0x002d3000 0x00b2800 0x004e2000 0x01b2000 0x00635000 0x01c95000 0x01d42000 0x00b64000
LBA[ 3]: 0x021ac000 0x00e00000 0x00dd4000 0x00223000 0x00dc0000 0x01824000 0x027e2800 0x001d5000 0x01540000 0x01982000
LBA[ 4]: 0x001b5800 0x01d65000 0x02010400 0x00156800 0x017c800 0x02165000 0x01565000 0x01d37000 0x01628000
LBA[ 5]: 0x001b5800 0x01d65000 0x02010400 0x00156800 0x017c800 0x02165000 0x01565000 0x01d37000 0x01628000
LBA[ 6]: 0x00571800 0x00820000 0x00e04800 0x01a1000 0x0105d000 0x00432000 0x00202300 0x00555000 0x00580000 0x0330800
LBA[ 7]: 0x01cf7000 0x00520000 0x01b31000 0x0105d000 0x00432000 0x00202300 0x00555000 0x00580000 0x0330800
LBA[ 8]: 0x00426000 0x01426000 0x01090000 0x027d0800 0x01203000 0x002f5800 0x027e6000 0x00763000 0x01b6c000 0x01d42000
LBA[ 9]: 0x019b6000 0x0027e000 0x0223a000 0x01b0000 0x01010000 0x024a0000 0x018e4000 0x022cc000 0x02416000
PRE LBA LIST:
LBA[ 0]: 0x00317800 0x01552800 0x025d6000 0x0026c000 0x0031c000 0x006aa000 0x009a0000 0x0148c800 0x0134c800 0x00c58000
=====
LBA: 0x1b2007 | HF: 0x08001272 F1: 0x639bdb3c F2: 0xaeecd94c [LOOP: 1 WRITE: 566 SECTOR: 8 / NUM: 2048 / ZERO: 664]
IO Time: 2023-05-30 15:19:35
Buffer addr: 0x7fb04137000 | Physical addr: 0x425a1300
LBA LIST:
LBA[ 0]: 0x001b2000 0x01528000 0x00790000 0x01c20000 0x0101e000 0x02016000 0x03018000 0x0091565000 0x005e5000
LBA[ 1]: 0x00052000 0x01655000 0x01b00000 0x01b70000 0x00581000 0x00882000 0x004d2000 0x02401000 0x013b0000 0x01984000
LBA[ 2]: 0x01918000 0x00741000 0x000454000 0x00808000 0x004e4000 0x027c0000 0x00001800 0x02218000 0x00801800 0x01b40000
LBA[ 3]: 0x01458000 0x001d5000 0x01010000 0x01277000 0x00256800 0x00030000 0x0151d000 0x01811000 0x0054f000
LBA[ 4]: 0x00145800 0x001d5000 0x01010000 0x01277000 0x00256800 0x00030000 0x0151d000 0x01811000 0x0054f000
LBA[ 5]: 0x00145800 0x001d5000 0x01010000 0x01277000 0x00256800 0x00030000 0x0151d000 0x01811000 0x0054f000
LBA[ 6]: 0x00059000 0x001d5000 0x01010000 0x01277000 0x00256800 0x00030000 0x0151d000 0x01811000 0x0054f000
LBA[ 7]: 0x001d5000 0x001142000 0x000456000 0x0101e000 0x00156800 0x005f51000 0x004b0000 0x005e6000
LBA[ 8]: 0x00059000 0x001d5000 0x01010000 0x01277000 0x00256800 0x00030000 0x0151d000 0x01811000 0x0054f000
LBA[ 9]: 0x001d5000 0x001d5000 0x01010000 0x01277000 0x00256800 0x00030000 0x0151d000 0x01811000 0x0054f000
PRE LBA LIST:
LBA[ 0]: 0x00317800 0x01552800 0x025d6000 0x0026c000 0x0031c000 0x006aa000 0x009a0000 0x0148c800 0x0134c800 0x00c58000
=====
LBA: 0x1b2010 | HF: 0x08001272 F1: 0x639bdb3c F2: 0xaeecd94c [LOOP: 2 WRITE: 146 SECTOR: 16 / NUM: 2048 / ZERO: 72]
IO Time: 2023-05-30 15:19:31
Buffer addr: 0x7fb04138000 | Physical addr: 0x42369100
LBA LIST:
LBA[ 0]: 0x001b2000 0x01515000 0x01a00000 0x021b8000 0x01483800 0x025c800 0x03c7800 0x01a5000 0x01bcb000 0x00b34800
LBA[ 1]: 0x00352000 0x02508000 0x01a00000 0x01b70000 0x00532000 0x0203d000 0x004d2000 0x01b1000 0x00b34800
LBA[ 2]: 0x0174f000 0x00440000 0x002d3000 0x00b2800 0x004e2000 0x01b2000 0x00635000 0x01c95000 0x01d42000 0x00b64000
LBA[ 3]: 0x021ac000 0x00e00000 0x00dd4000 0x00223000 0x00dc0000 0x01824000 0x027e2800 0x001d5000 0x01540000 0x01982000
LBA[ 4]: 0x001b5800 0x01d65000 0x02010400 0x00156800 0x017c800 0x02165000 0x01565000 0x01d37000 0x01628000
LBA[ 5]: 0x001b5800 0x01d65000 0x02010400 0x00156800 0x017c800 0x02165000 0x01565000 0x01d37000 0x01628000
LBA[ 6]: 0x00571800 0x00820000 0x00e04800 0x01a1000 0x0105d000 0x00432000 0x00202300 0x00555000 0x00580000 0x0330800
LBA[ 7]: 0x01cf7000 0x00520000 0x01b31000 0x0105d000 0x00432000 0x00202300 0x00555000 0x00580000 0x0330800
LBA[ 8]: 0x00426000 0x01426000 0x01090000 0x027d0800 0x01203000 0x002f5800 0x027e6000 0x00763000 0x01b6c000 0x01d42000
LBA[ 9]: 0x019b6000 0x0027e000 0x0223a000 0x01b0000 0x01010000 0x024a0000 0x018e4000 0x022cc000 0x02416000
PRE LBA LIST:
LBA[ 0]: 0x00317800 0x01552800 0x025d6000 0x0026c000 0x0031c000 0x006aa000 0x009a0000 0x0148c800 0x0134c800 0x00c58000
=====
current Time: 2023-05-30 17:36:02
root@YOUPlus:/var/iso/tools#
```



# LBA工具介绍：数据不一致问题，案例六

## 【自研存储-混闪】连续扩盘连续删盘虚拟机跑出LBA问题

The screenshot shows a hex editor interface with two panes. The left pane displays a sequence of bytes, primarily in red, indicating errors. The right pane is a terminal window showing log output from a storage tool. Key log entries include:

- Current Time: 2023-07-26 15:50:21
- LBA: 0x2bb240 | thread\_num: 10, bitmap: 0 1 0 0 0 0 0 0
- LAST CORRECT WRITE:
- LBA: 0x18300 | HF: 0x00081272 F1: 0x63aac4e6 F2: 0x2d5e04f8 [LOOP: 1 WRITE: 6731 SECTOR: 0 / NUM: 0 / ZERO: 0]
- LAST WRITE ID Time: 2023-07-26 15:50:21
- Buffer addr: 0x7f7fb4145000 | Physical addr: 0x347e000
- LBA LIST:
- Detect Read Error:
- LBA: 0x2bb240 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
- Detect Error ID Time: 1900-01-00 00:00:00
- Buffer addr: 0x7f7fb4149000 | Physical addr: 0x5da82000
- LBA LIST:

2号线程，随机数据校验：读取前面已经成功写入并落盘的数据来进行校验，发现数据错误--全0数据。

2023-09-06 17:19:52

【问题原因】`iter next`误将二级指针判断为一级，导致`dtx`被误认为`abort`，重构拉取数据时，无法拉取到被`abort`（实际重试是成功，只是中间有`abort`）的数据

【修改方案】`iter next`需要识别指针状态，并且在`insert`插入使用`reuse`时，需要初始化`evt_node_entry_at_re`

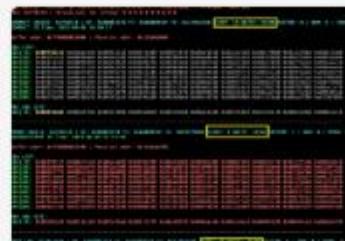
# LBA工具介绍：上海XXX公司使用LBA工具

➤ 虚拟机中跑LBA工具的小IO测试，簇内校验发现有一扇区数据丢失

@YOUPLUS 不好意思打搅一下，试用 LBA 工具的过程中发现一个问题，LBA 工具测试的结果会受上一次测试的影响吗？从报出的 BUG 来看，LOOP 10 读到了 LOOP 9 的数据：



不会受上一次测试的影响，这就是测试出了数据不一致问题：有数据丢失了



6号线程，第10轮测试，簇内校验，第35208个IO中的第1扇区的数据丢失了。



134174 这个簇的数据貌似被 134175 覆盖了

构造数据的时候会去读盘么？



这次的问题就比上次的问题严重了，上次是丢失了数据，这次的数据完全被写到了不应该的位置了。

会不会是 LBA 工具写串了

134174 和 134175 两个 IO 簇的数据是一样的

不用怀疑LBA工具了，还是排查一下存储方向的原因吧，估计用fio/vdbench等工具也能测试出这个问题。

fio 没跑出来，所以有这个疑问 😞

YOUPLUS：不用怀疑LBA工具了，还是排查一下存储方向的原因吧，估计用fio/vdbench等工具也能...

你用的是什么存储啊？要不你先在一个本地存储(ext4/xfs)上跑同样的虚拟机测试对比一下就知道了。

这两个IO的时间就不太正常

我这边应该是存储层面的问题

正在看存储日志

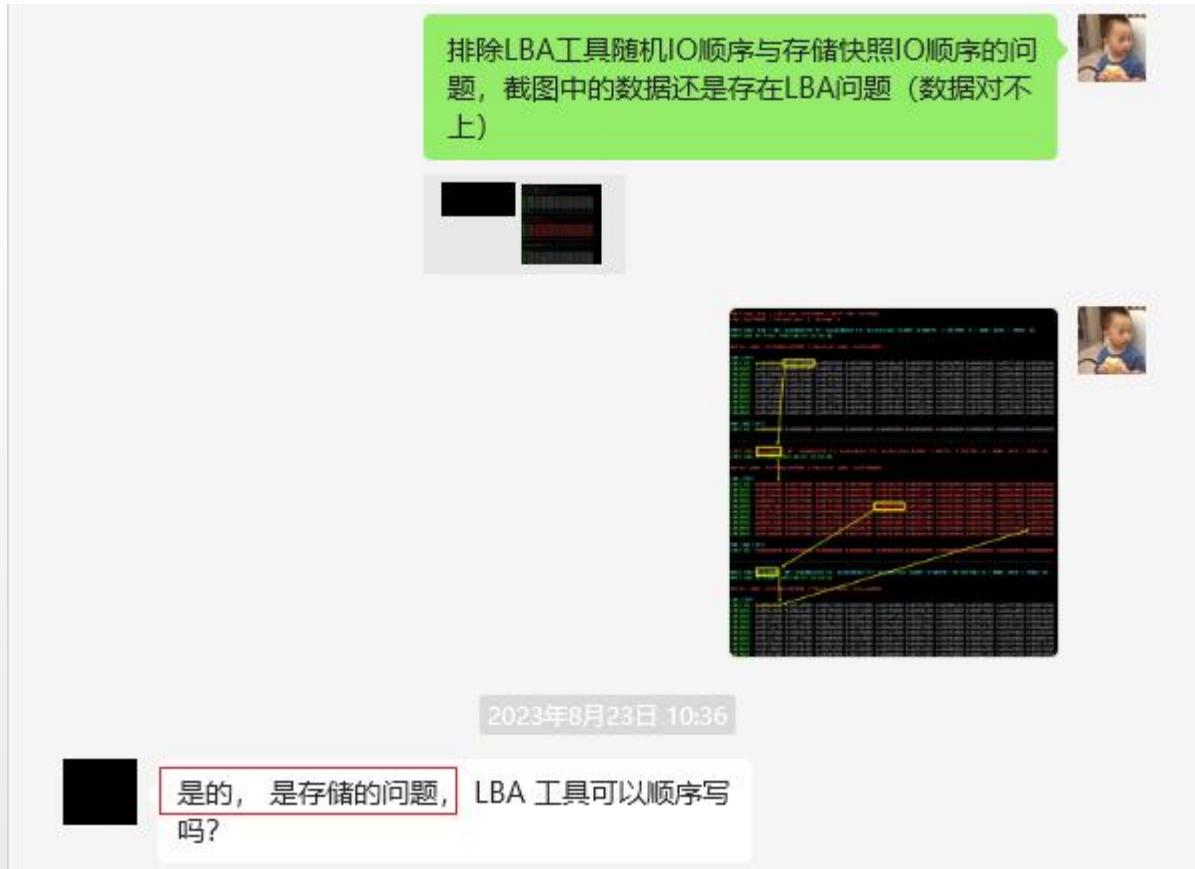


所以LBA工具比fio/vdbench的verify功能强大多了，轻易就测试出来了LBA问题，但fio工具却测试不出来。



# LBA工具介绍：北京XXX公司使用LBA工具

- 对全闪NVMeOF存储卷打快照，LBA工具测试出快照中的数据不一致



## 另外：

- 北京XXX公司、XXX软件公司等在使用LBA工具；
- 目前已有四十多个公司在使用LBA工具及自动化测试系统；
- 与openGuass社区总工确定合作意向；也有国外使用者；
- Intel SPDK上海团队可能在试用LBA工具，也可能没有，没有收到反馈；

# LBA工具介绍：工具的作用与价值

➤ qemu-2.5版本热迁移代码原生BUG：排查、修复此问题代价较大 -- 两个资深的研发花了三周左右时间

1. 2020年2月份(新冠疫情爆发期间), 多台虚拟机跑LBA自动化测试系统并进行热迁移, 偶现内存热迁移数据不一致问题;
2. 批量虚拟机跑热迁移(加大主机节点负载), 增加复现概率;
3. 排查手段: LBA工具 + 详细的调试日志 + mprotect抓取篡改内存现场;

```
03-04 15:44:17
[2020-03-04]
一、当前的情况:
1、早上热迁移winpe和linux虚拟机各出现一次lba, 调试日志明确记录了这次内存数据被正确发送到目的端并保存, 但是guest运行后读对应位置内存时, 数据却是错误的。
2、分析了guest的内存, 是1M buff中间一个4K内存页损坏, 而前后的内存页数据是正确的, 与调试日志对得上。
3、目前初步怀疑是目的端虚拟机启动阶段, 某个流程把guest内存页4K数据破坏掉, 关键阶段的时间线如下, 在02:18:00.364045到02:18:09.273347这段时间, 内存被破坏。
2020-03-04 02:18:00.364045 目的端qemu接收到对应内存页并保存, 调试日志显示此内存页数据是正确的
2020-03-04 02:18:00.464607 内存迁移全部完成
2020-03-04 02:18:09.203232 热迁移完成, 目的端虚拟机开始运行
2020-03-04 02:18:09.273347 测试工具检测数据错误, 报告出现lba
```

## 二、下一步计划

- 1、在目的端虚拟机启动前的几个阶段, 分别将guest内存文件保存下来, 这样可以进一步判断内存页数据是在哪个阶段被破坏。
- 2、添加调试代码, 调用mprotect接口将guest物理内存对应的qemu虚拟地址空间设为只读, 如果有流程破坏内存, 就可以被抓到。

```
03-04 18:15:11
有一种场景需要注意:
1、现在测试都是使用共享内存, ksm模块不会进行内存回收;
2、如果使用普通内存, ksm是会时进行相同页内存回收的(特别是全0页), 需要在这种场景下跑LBA工具进行热迁移测试, 会不会也存在LBA的问题?
```

## 三、结论:

- 1、lba工具测试虚拟机热迁移, 发现内存数据不一致;
- 2、在qemu的热迁移源端和目的端的代码中加详细的调试日志, 确认所有内存数据被正确发送到目的端并保存, 但是目的端guest运行后读对应位置内存时, LBA工具却发现有些内存数据是错误的;
- 3、在qemu的热迁移目的端的代码中调用mprotect接口将guest物理内存对应的qemu虚拟地址空间设为只读, 在目的端虚拟机运行之前, 部分内存数据被篡改并主动触发断言出core;
- 4、qemu热迁移原生bug, 内存热迁移每轮迭代没有对解压缩线程做同步等待, 如果解压缩线程执行速度很慢, 在内存热迁移已经整体完成后, 解压缩线程还在向guest写入旧数据, 导致guest内存损坏。

```
Using host libthread_db library "/lib/x86_64-linux-gnu/libthread_db.so.1".
Core was generated by `/usr/bin/kvm -id 227587371880 -chardev socket,id=qmp,path=/var/run/qemu-server/'.
Program terminated with signal SIGSEGV, Segmentation fault.
#0 0x00007f5ee420ee70 in inflate_fast () from /lib/x86_64-linux-gnu/libz.so.1
[Current thread is 1 (Thread 0x7f5e503fe700 (LWP 12496))]
```

```
(gdb) bt
#0 0x00007f5ee420ee70 in inflate_fast () from /lib/x86_64-linux-gnu/libz.so.1
#1 0x00007f5ee421116e in inflate () from /lib/x86_64-linux-gnu/libz.so.1
#2 0x00007f5ee42150b1 in uncompress2 () from /lib/x86_64-linux-gnu/libz.so.1
#3 0x00007f5ee4215193 in uncompress () from /lib/x86_64-linux-gnu/libz.so.1
#4 0x0000561b5b0b3058 in do_data_decompress (opaque=0x561b5d1453f0) at /home/test/qemu-2.5.1/migration/ram.c:2341
#5 0x00007f5eddcc8bb50 in start_thread () from /lib/x86_64-linux-gnu/libpthread.so.0
#6 0x00007f5edd9d5a7d in clone () from /lib/x86_64-linux-gnu/libc.so.6
#7 0x0000000000000000 in ?? ()
```

# LBA工具介绍：工具的作用与价值

- 簇IO随机拆分功能也测试发现了qemu-2.0.1版本virtio-blk磁盘IO合并功能存在原生bug

```
static int multiwrite_merge(BlockDriverState *bs, BlockRequest *reqs,
...    int num_reqs, MultiwriteCB *mcb)
{
    ... int i, outidx;

    ... // Sort requests by start sector
    ... qsort(reqs, num_reqs, sizeof(*reqs), &multiwrite_req_compare);

    ... // Check if adjacent requests touch the same clusters. If so, combine them,
    ... // filling up gaps with zero sectors.
    ... outidx = 0;
    ... for (i = 1; i < num_reqs; i++) {
        ... int merge = 0;
        ... int64_t oldreq_last = reqs[outidx].sector + reqs[outidx].nb_sectors;

        ... // Handle exactly sequential writes and overlapping writes.
        ... if (reqs[i].sector <= oldreq_last) {
            ... merge = 1;
            ...
            ...
            ... if (reqs[outidx].qiov->niov + reqs[i].qiov->niov + 1 > IOV_MAX) {
                ... merge = 0;
                ...
                ...
                ... if (merge) {
                    ... size_t size;
                    ... QEMUIOVector *qiov = g_malloc0(sizeof(*qiov));
                    ... qemu_iovec_init(qiov,
                    ...     reqs[outidx].qiov->niov + reqs[i].qiov->niov + 1);
                    ...
                    ... // Add the first request to the merged one. If the requests are
                    ... // overlapping, drop the last sectors of the first request.
                    ... size = (reqs[i].sector - reqs[outidx].sector) << 9;
                    ... qemu_iovec_concat(qiov, reqs[outidx].qiov, 0, size);
                    ...
                    ... // We should need to add any zeros between the two requests
                    ... assert(reqs[i].sector <= oldreq_last);
                    ...
                    ... // Add the second request
                    ... qemu_iovec_concat(qiov, reqs[i].qiov, 0, reqs[i].qiov->size);
                    ...
                    ... reqs[outidx].nb_sectors = qiov->size >> 9;
                    ... reqs[outidx].qiov = qiov;
                    ...
                    ... mcb->callbacks[i].free_qiov = reqs[outidx].qiov;
                } else {
                    ... outidx++;
                    ... reqs[outidx].sector = reqs[i].sector;
                    ... reqs[outidx].nb_sectors = reqs[i].nb_sectors;
                    ... reqs[outidx].qiov = reqs[i].qiov;
                }
            }
        }
        ...
        ... return outidx + 1;
    }
}
```

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05 存储稳定性测试与数据一致性校验  
自动化测试系统演示

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06 展望

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# LBA工具实现原理

## ➤ 磁盘、簇、扇区、全局bitmap(内存)

磁盘



簇

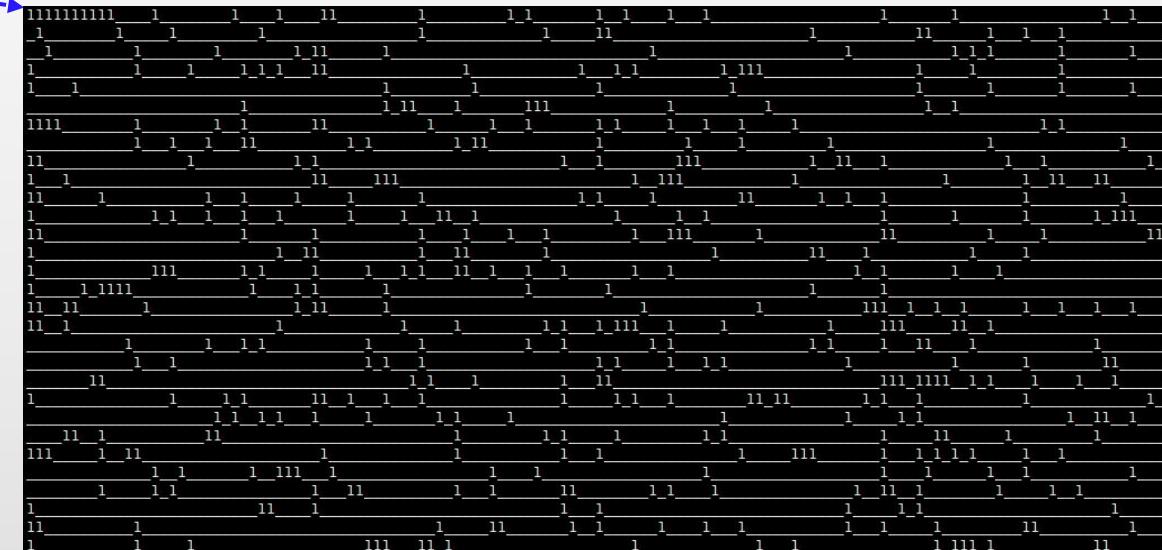
测试/校验固定起始簇



扇区



全局bitmap(内存) bitmapt.txt



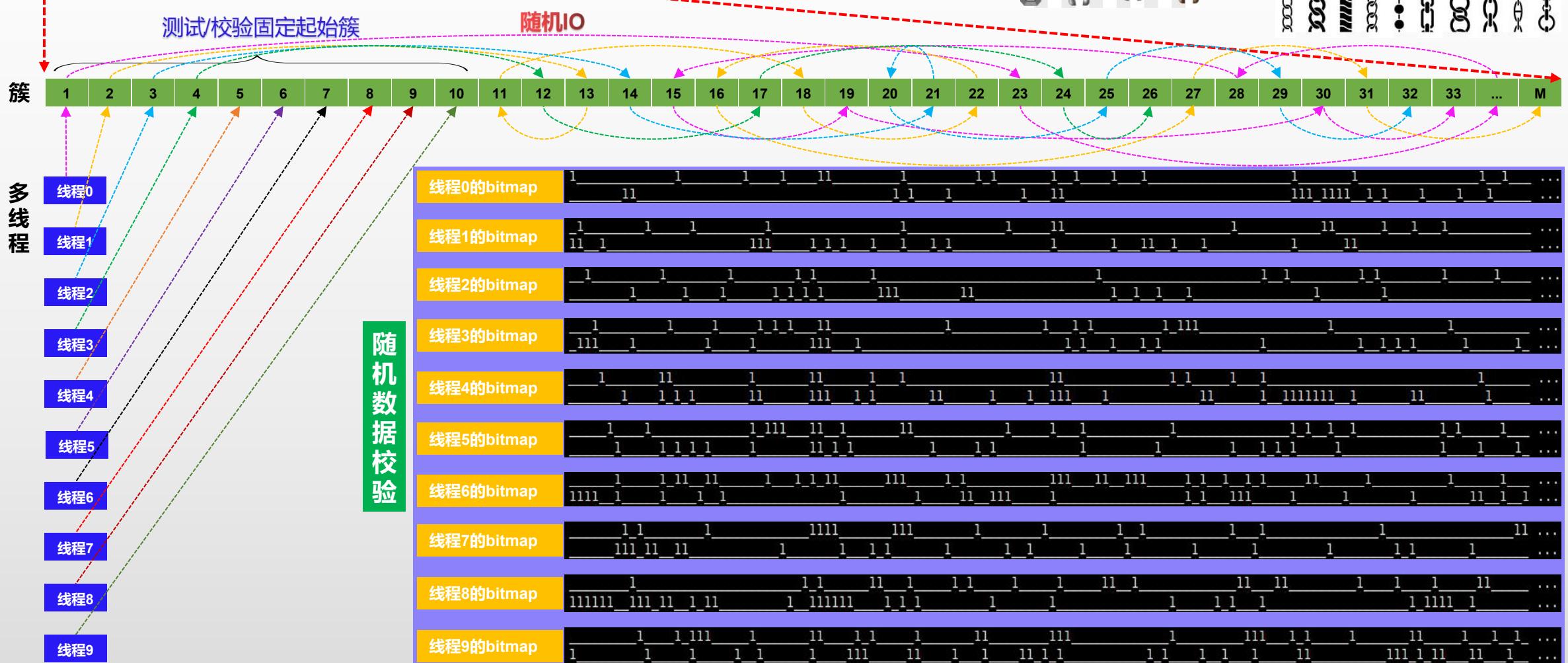
1. 每个磁盘/文件被划分为M个IO数据簇;
2. 每个IO数据簇包含N个扇区;
3. IO数据簇N个扇区中的数据: 每个扇区除index字段表示簇中的扇区序号外, 其它数据均相同

4. LBA工具测试磁盘/文件时, 为每个磁盘/文件分配全局bitmap内存, 并置为全0;
5. 每个IO数据簇不会被重复分配, 分配新IO数据簇时, 随机分配bitmap未被置1的对应数据簇;
6. 每个已分配的IO数据簇对应的bitmap被置位为1;

# LBA工具实现原理

# 链条

#### ➤ 多线程、随机线程(高级功能)



# LBA工具实现原理：数据结构

➤ 强双向链表、数组、队列混合体：5个数组、2个链表、2个队列

DATA LAYOUT:

```
=====
offsetof HF:          0   [4   bytes]
offsetof MAGIC:       4   [4   bytes]
offsetof PRE_LBA[10]: 8   [40  bytes]
offsetof LBA_LIST[100]:48  [400 bytes]
offsetof TIME:        448 [56  bytes]
offsetof RANDOM:      504 [4   bytes]
offsetof NUM:         508 [2   bytes]
offsetof INDEX:       510 [2   bytes]
=====
```

[LOOP: 1 WRITE: 101 SECTOR: 0 / NUM: 1024 / ZERO: 322]

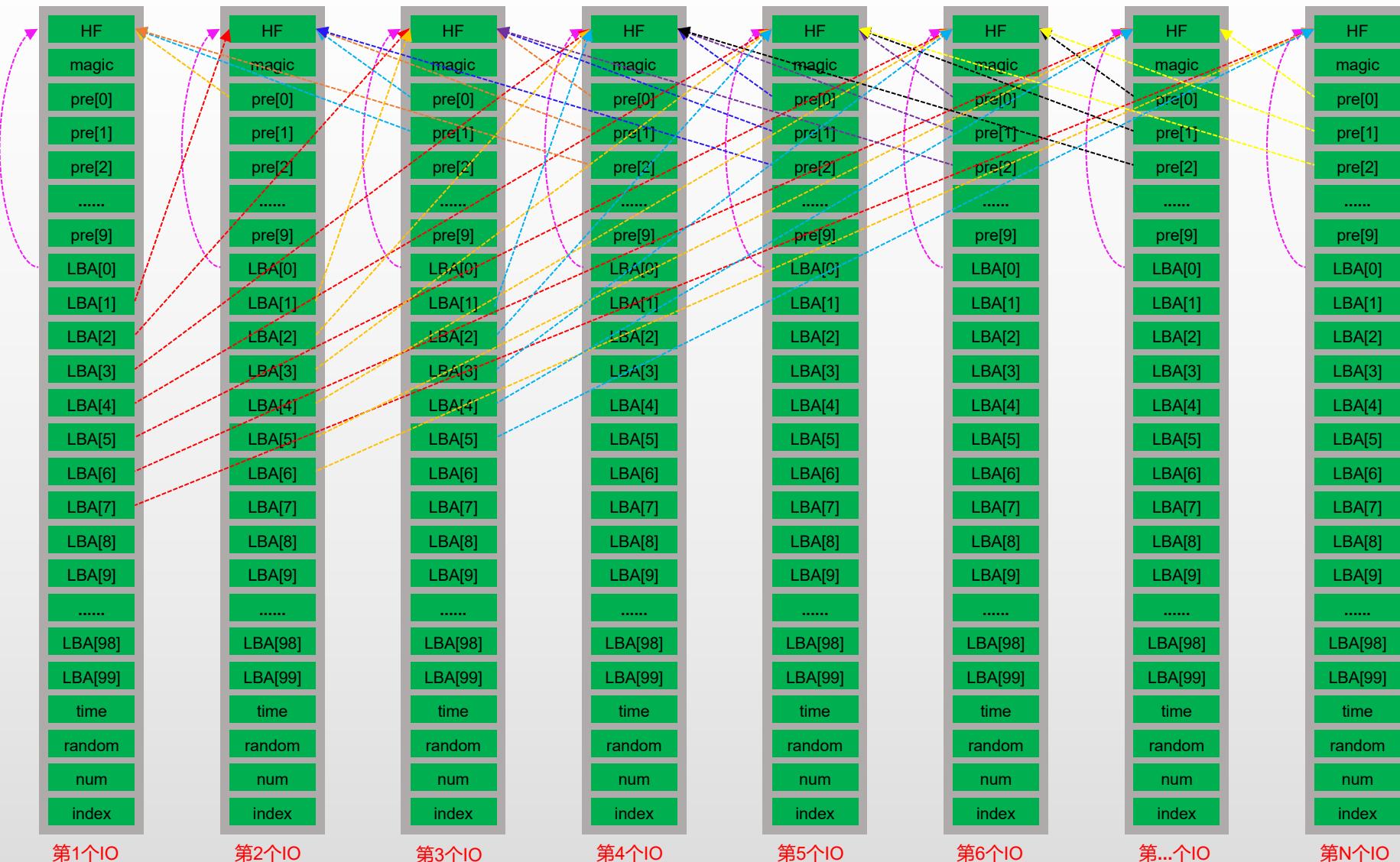
1. 数组1：一个IO数据簇包括N(1024)个扇区，如右图和上图
2. 数组2：包括M+1(702)个扇区的非零数据
3. 数组3：包括N-M-1(322)个扇区的全零数据
4. 数组4：每个扇区中的PRE\_LBA[10]，如上图
5. 数组5：每个扇区中的LBA\_LIST[100]，如上图
6. 队列1：每个扇区中的PRE\_LBA[10]，如下一页
7. 队列2：每个扇区中的LBA\_LIST[100]，如下一页
8. 链表1：PRE\_LBA[10]前向链表，如下一页
9. 链表2：LBA\_LIST[100]后向链表，如下一页



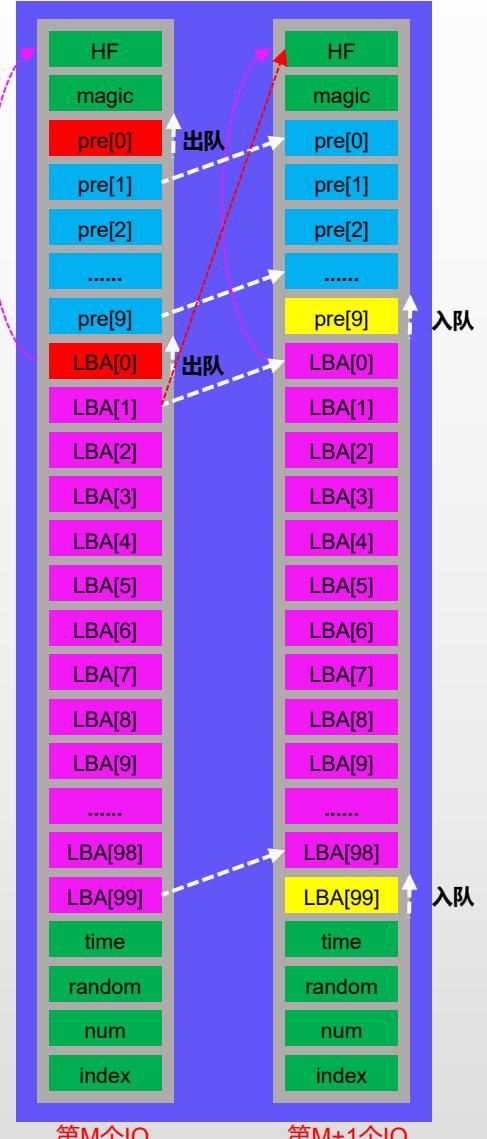
# LBA工具实现原理：无状态

## ► 强双向链表、队列

强双向链表：每个节点，第一个lba指针指向自己，99个lba指针指向后向节点，10个pre指针指向前向节点



队列：相邻的IO簇



# LBA工具实现原理

链条

## ➤ 强双向链表、队列、数组 (为什么要设计成强双向链表的形式?)

强双向链表也可以理解为是网状，每个数据与附近的数据之间形成强相关的关系，只要数据出错了（哪怕是数据只出错一个字节）

LBA工具很容易知道出错数据的偏移位置和大小、时间等信息，例如：渔民的渔网破了一个洞，渔民很容易知道渔网上破洞的位置和大小。

LBA: 0x0   HF: 0x04001270 F1: 0x0892947a F2: 0xcb47c88 [LOOP: 1 WRITE: 1 SECTOR: 0 / NUM: 1024 / ZERO: 322]	I0 Time: 2023-07-12 15:36:04
Buffer addr: 0x12e0000   Physical addr: 0x58277a00000	
LBA LIST: 第1个IO 第2个IO 第3个IO 第4个IO 第5个IO 第6个IO 第7个IO 第8个IO 第9个IO 第10个IO	
LBA[ 0]: 0x00000000 0x007ed000 0x00112800 0x00652000 0x00161000 0x0037b800 0x00460000 0x00489800 0x00159000 0x0016e800	
LBA[10]: 0x00755000 0x004f9c00 0x002aec00 0x0063a400 0x00653800 0x00051000 0x00333400 0x007cf800 0x00433000 0x00554000	
LBA[20]: 0x007fe800 0x00247000 0x0077c800 0x002e0000 0x002d4c00 0x0027f000 0x0002b800 0x0021c400 0x0015c000 0x00600000	
LBA[30]: 0x0032bc00 0x0022bc00 0x00463400 0x006fe000 0x007cd400 0x0047b000 0x005a6800 0x00727000 0x0063d800 0x0028e800	
LBA[40]: 0x000a8800 0x006bb800 0x00127000 0x001b3400 0x00020000 0x002a9800 0x00522000 0x00365000 0x000e4000 0x00204400	
LBA[50]: 0x001bd000 0x001e3800 0x007c7000 0x002b3c00 0x004b8400 0x001cb800 0x00611c00 0x002edc00 0x00377800 0x00174800	
LBA[60]: 0x005be800 0x00053c00 0x00095000 0x00461000 0x00511000 0x00708000 0x002f3000 0x00740800 0x007d1000 0x002e2000	
LBA[70]: 0x00307400 0x005a9000 0x00481800 0x0041cc00 0x004eb800 0x003fa800 0x00782400 0x007c2400 0x00228800 0x004e2c00	
LBA[80]: 0x0067d300 0x0011dc00 0x00436400 0x00420000 0x00650400 0x00684400 0x00767c00 0x006f2000 0x00186400 0x002bd400	
LBA[90]: 0x004d2800 0x007a4c00 0x00284000 0x0073f000 0x00720000 0x006f9c00 0x004d9000 0x0008b400 0x005dc800 0x0070a800	
PRE LBA LIST:	
LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000	

LBA: 0x7ed000   HF: 0x04001270 F1: 0x0892947a F2: 0xcb47c88 [LOOP: 1 WRITE: 2 SECTOR: 0 / NUM: 1024 / ZERO: 322]	I0 Time: 2023-07-12 15:36:04
Buffer addr: 0xfffff86170000   Physical addr: 0x500911c0000	
LBA LIST: 第2个IO 第3个IO 第4个IO 第5个IO 第6个IO 第7个IO 第8个IO 第9个IO 第10个IO 第11个IO	
LBA[ 0]: 0x007ed000 0x00112800 0x00652000 0x00161000 0x0037b800 0x00460000 0x00489800 0x00159000 0x0016e800 0x00755000	
LBA[10]: 0x004f9c00 0x002aec00 0x0063a400 0x00653800 0x00051000 0x00333400 0x007cf800 0x00433000 0x00554000 0x007fe800	
LBA[20]: 0x00247000 0x0077c800 0x002e0000 0x002d4c00 0x0027f000 0x0002b800 0x0021c400 0x0015c000 0x00600000 0x0032bc00	
LBA[30]: 0x0022bc00 0x00463400 0x006fe000 0x007cd400 0x0047b000 0x005a6800 0x00727000 0x0063d800 0x0028e800 0x000a8800	
LBA[40]: 0x006bb800 0x00127000 0x001b3400 0x00020000 0x002a9800 0x00522000 0x00365000 0x000e4000 0x00204400 0x001bd000	
LBA[50]: 0x001e3800 0x007c7000 0x002b3c00 0x004b8400 0x001cb800 0x00611c00 0x002edc00 0x00377800 0x00174800 0x005be800	
LBA[60]: 0x00053c00 0x00095000 0x00461000 0x00511000 0x00708000 0x002f3000 0x00740800 0x007d1000 0x002e2000 0x000a8800	
LBA[70]: 0x005a9000 0x00481800 0x0041cc00 0x004eb800 0x003fa800 0x00782400 0x007c2400 0x00228800 0x004e2c00 0x0067d300	
LBA[80]: 0x0011dc00 0x00436400 0x00420000 0x00650400 0x00684400 0x00767c00 0x006f2000 0x00186400 0x002bd400 0x0004d2800	
LBA[90]: 0x007a4c00 0x00284000 0x0073f000 0x00720000 0x006f9c00 0x004d9000 0x0008b400 0x005dc800 0x0070a800 0x0005be800	
PRE LBA LIST:	
LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000	
第1个IO	

dump第1个IO和第2个IO的数据

LBA: 0x112800   HF: 0x04001270 F1: 0x0892947a F2: 0xcb47c88 [LOOP: 1 WRITE: 3 SECTOR: 0 / NUM: 1024 / ZERO: 322]	I0 Time: 2023-07-12 15:36:04
Buffer addr: 0xfffff95640000   Physical addr: 0x5814e6b0000	
LBA LIST: 第3个IO 第4个IO 第5个IO 第6个IO 第7个IO 第8个IO 第9个IO 第10个IO 第11个IO 第12个IO	
LBA[ 0]: 0x00112800 0x00652000 0x00161000 0x0037b800 0x00460000 0x00489800 0x00159000 0x0016e800 0x00755000 0x004f9c00	
LBA[10]: 0x002aec00 0x0063a400 0x00653800 0x00051000 0x00333400 0x007cf800 0x00433000 0x00554000 0x007fe800 0x00247000	
LBA[20]: 0x0077c800 0x002e0000 0x002d4c00 0x0027f000 0x0002b800 0x0021c400 0x0015c000 0x00600000 0x0032bc00 0x0002b0400	
LBA[30]: 0x00463400 0x006fe000 0x007cd400 0x0047b000 0x005a6800 0x00727000 0x0063d800 0x0028e800 0x000a8800 0x00095000	
LBA[40]: 0x001b3400 0x00020000 0x002a9800 0x00522000 0x00365000 0x000e4000 0x00204400 0x001bd000 0x00217400 0x00041cc00	
LBA[50]: 0x00611c00 0x002edc00 0x00377800 0x00174800 0x005be800 0x00053c00 0x00095000 0x00461000 0x00511000 0x00708000	
LBA[60]: 0x002f3000 0x0002b3c00 0x004eb800 0x003fa800 0x00782400 0x007c2400 0x00228800 0x004e2c00 0x0067d300 0x0004d9000	
LBA[70]: 0x0010a400 0x00041cc00 0x00217400 0x0007d400 0x00661000 0x00180000 0x00656400 0x00780800 0x0006c600 0x00094400 0x006a0000 0x001c5800	
LBA[80]: 0x0004d2800 0x00042000 0x00650400 0x00684400 0x00767c00 0x006f2000 0x00186400 0x002bd400 0x0004d2800 0x0004d2800 0x0004d2800	
LBA[90]: 0x0070a800 0x0005dc800 0x0008b400 0x0005dc800 0x00070a800 0x0005dc800 0x0005dc800 0x0005dc800 0x0005dc800 0x0005dc800 0x0005dc800	
PRE LBA LIST:	
LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000	
第2个IO	
第1个IO	

dump第3个IO的数据

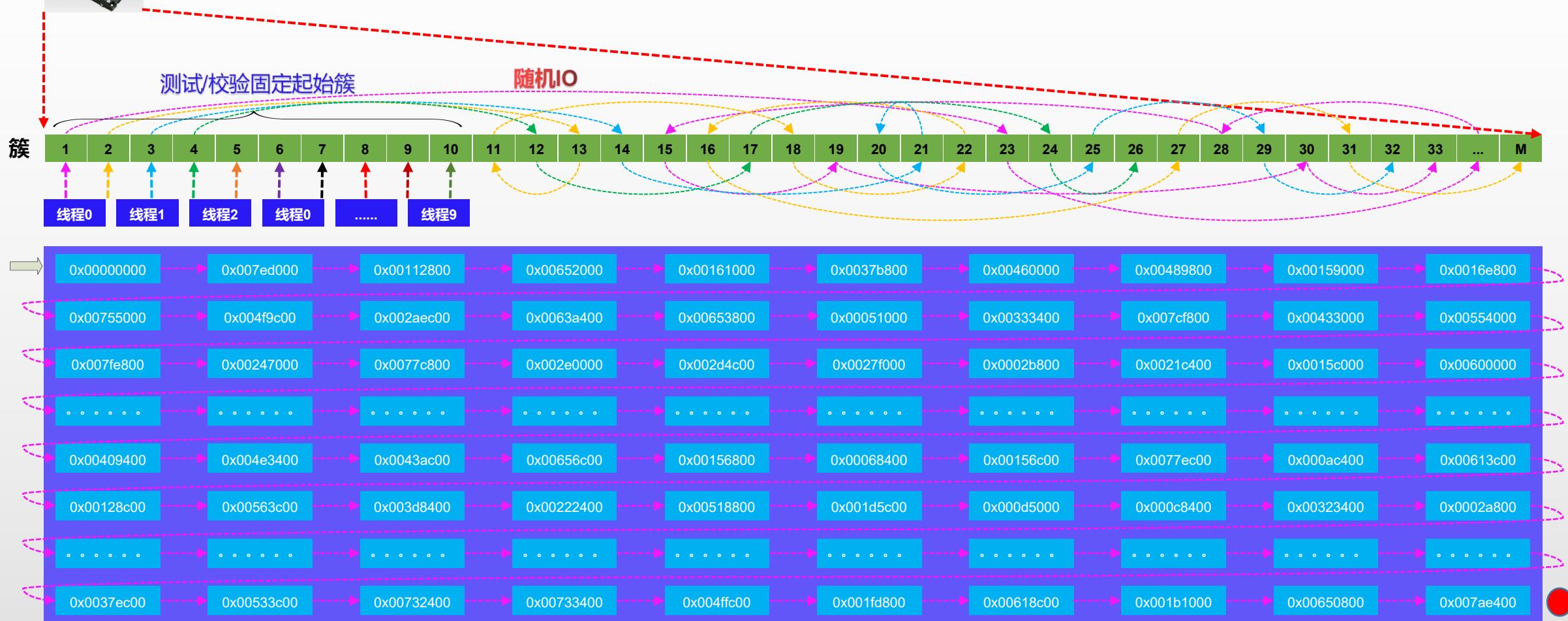
LBA: 0x204800   HF: 0x04001270 F1: 0x0892947a F2: 0xcb47c88 [LOOP: 1 WRITE: 101 SECTOR: 0 / NUM: 1024 / ZERO: 322]	I0 Time: 2023-07-12 15:36:13
Buffer addr: 0xfffffaf2d0000   Physical addr: 0x58398310000	
LBA LIST: 第101个IO 第102个IO 第103个IO 第104个IO 第105个IO 第106个IO 第107个IO 第108个IO 第109个IO 第110个IO	
LBA[ 0]: 0x00204800 0x006bf800 0x0076d400 0x001d7800 0x00390000 0x000f8000 0x004aac00 0x00422400 0x0010a400 0x0029e800	
LBA[10]: 0x002a6c00 0x00312400 0x0032d000 0x0015fc00 0x00565400 0x000e1c00 0x000ec400 0x00716000 0x004e1c00 0x002b0400	
LBA[20]: 0x000f3c00 0x0026a800 0x006fb000 0x0061b000 0x00301c00 0x004ee000 0x0010a800 0x0070e000 0x0015b000 0x006fe400	
LBA[30]: 0x00393000 0x0013a400 0x001l400 0x0016f400 0x0055cac00 0x0038a400 0x000de000 0x005a0400 0x004b0800	
LBA[40]: 0x00376400 0x00488800 0x00570000 0x00040000 0x001cc400 0x006f8400 0x00360000 0x0024c00 0x002fb800 0x00778400	
LBA[50]: 0x006d8000 0x0044e400 0x00641000 0x00268800 0x0070b000 0x0003c000 0x004f6400 0x006fdcc0 0x00791800 0x005f6400	
LBA[60]: 0x00217400 0x0007d400 0x00661000 0x00180000 0x00656400 0x00780800 0x0006c600 0x00094400 0x006a0000 0x001c5800	
LBA[70]: 0x00538400 0x00228c00 0x00731400 0x00096c00 0x001f8c00 0x006c3400 0x00252c00 0x00046400 0x006c3c00 0x0036b000	
LBA[80]: 0x0004c2000 0x00141000 0x00087c00 0x0017f800 0x00554400 0x007b5400 0x007e7000 0x00517c00 0x002af800 0x0006fa000	
LBA[90]: 0x007e0000 0x003d6000 0x006cf000 0x0043b800 0x001ef000 0x0006800 0x0076e000 0x0014a800 0x0017a800 0x00451800	
PRE LBA LIST:	
LBA[ 0]: 0x0070a800 0x005dc800 0x0008b400 0x004d9000 0x006f9c00 0x00720000 0x0073f000 0x00284000 0x007a4c00 0x004d2800	
第100个IO	
第99个IO	
第98个IO	
第97个IO	
第96个IO	
第95个IO	
第94个IO	
第93个IO	
第92个IO	
第91个IO	

dump第101个IO的数据

# LBA工具实现原理：数据校验

- 全盘数据校验 (**checktime & runtime**: 线程数据校验、簇间数据校验、簇内数据校验)

磁盘

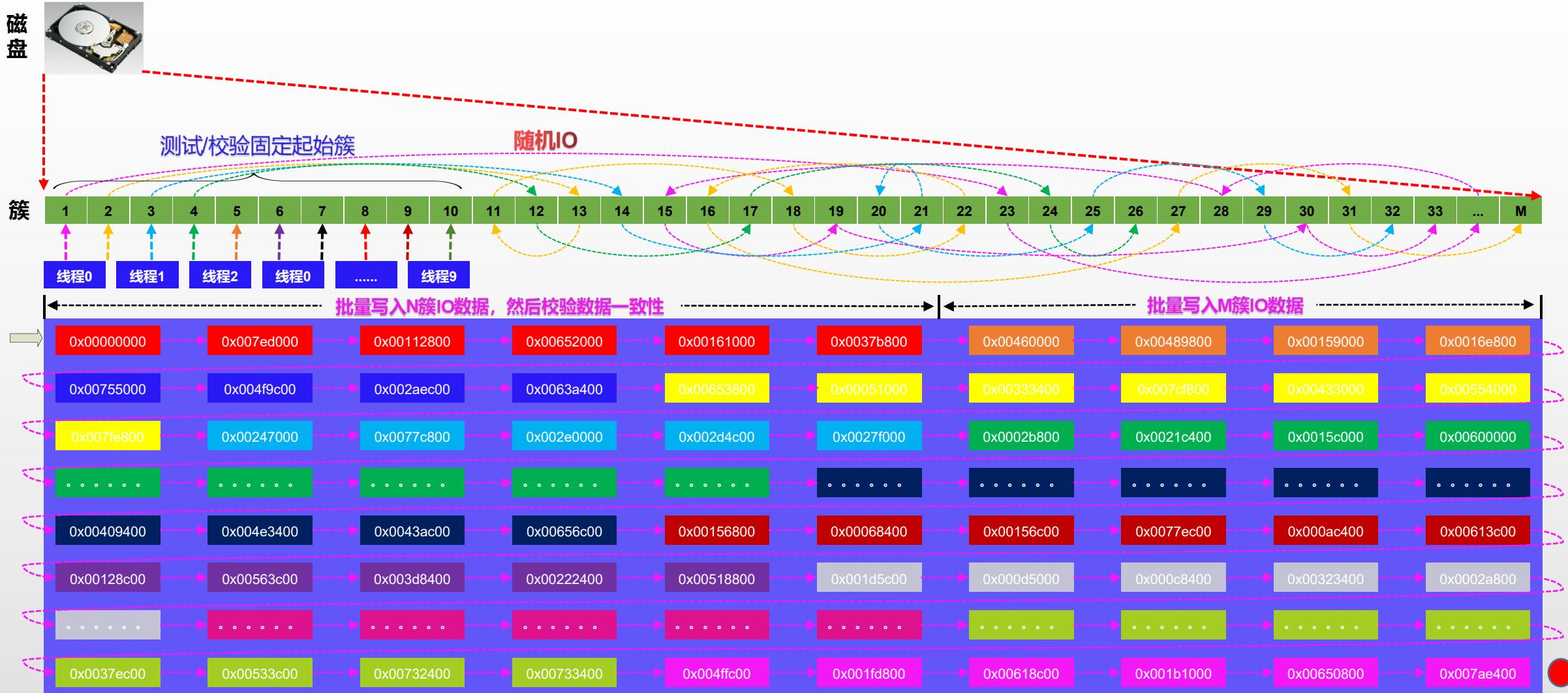


1. runtime的全盘数据校验，即：10个线程向磁盘写入IO数据簇，当磁盘中的数据写满后，10个线程随即对全盘的所有写入数据进行一次完整校验(簇间数据校验、簇内数据校验)；
2. checktime的全盘数据校验，三个重要命令：**hd\_write\_verify -c -D -T 1 disk/file**   **hd\_write\_verify -c -D -T 10 disk/file**   **hd\_write\_verify\_dump -c -D -T 0-9 disk/file**
3. 每次对磁盘写入数据测试完一轮后，可以进行三种数据校验：全盘数据校验、批量数据校验、随机数据校验，即：强双向链表、数组、队列混合体数据出现脱钩断链、鸡蛋的裂缝，都会被检测出来。如前面列举的案例：数据错位一个字节，或者出错两个字节，LBA工具都能校验发现。

# LBA工具实现原理：数据校验

- 批量数据校验 (**runtime**: 线程数据校验、簇间数据校验、簇内数据校验)

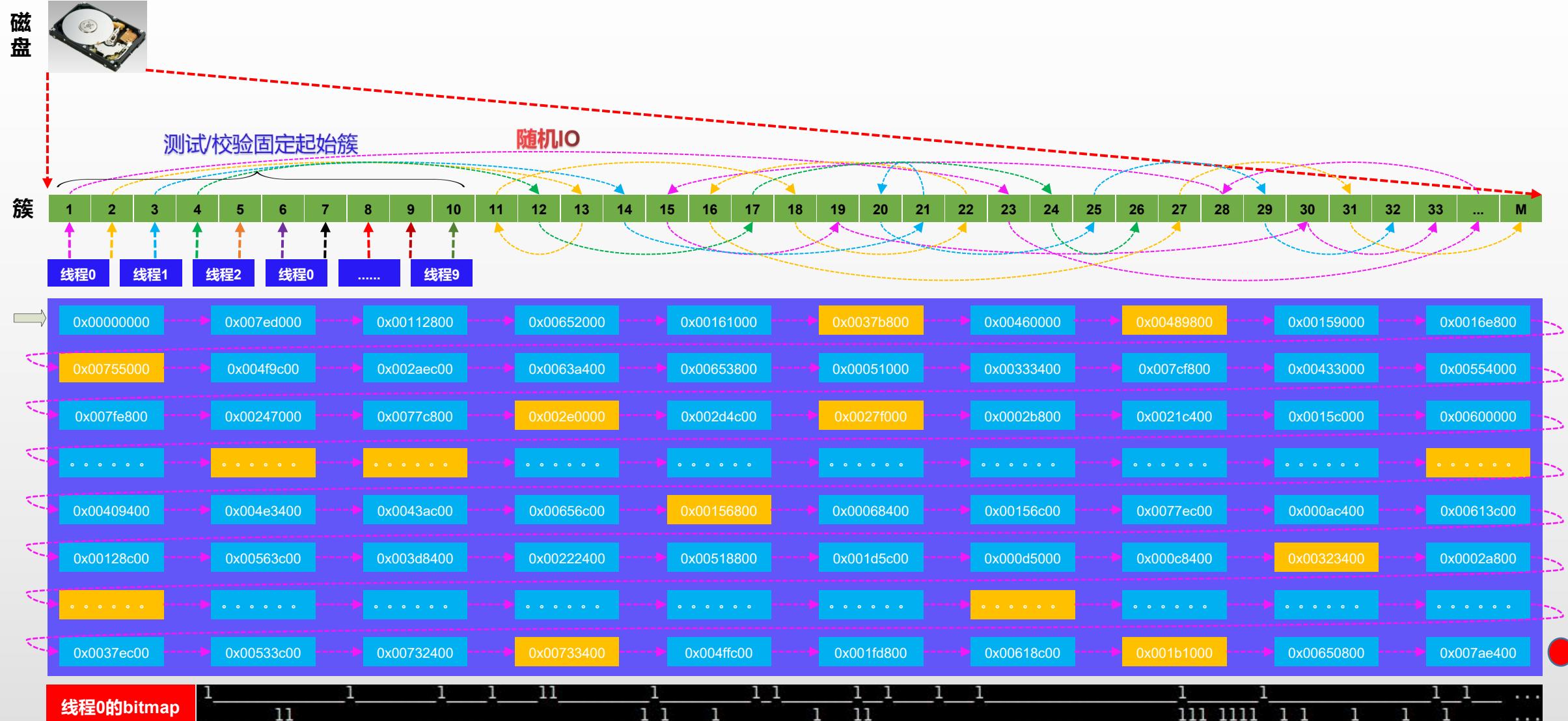
磁盘



1. 批量数据校验属于**runtime**的数据校验，即：一边写入测试数据，一边校验前面写入数据的一致性；
2. 10个线程，每个线程分批向磁盘写入数据，每批写入磁盘的IO数据簇个数是随机的：**i, j, k, m, n, l, x, y, z, .....**；
3. 在写下一批IO数据簇之前，先校验上一批数据的一致性：簇间数据校验和簇内数据校验，当一个线程的所有数据写完成后，即这个线程的线程数据校验也完成了

# LBA工具实现原理：数据校验

- 随机数据校验 (**runtime**: 簇间数据校验、簇内数据校验)

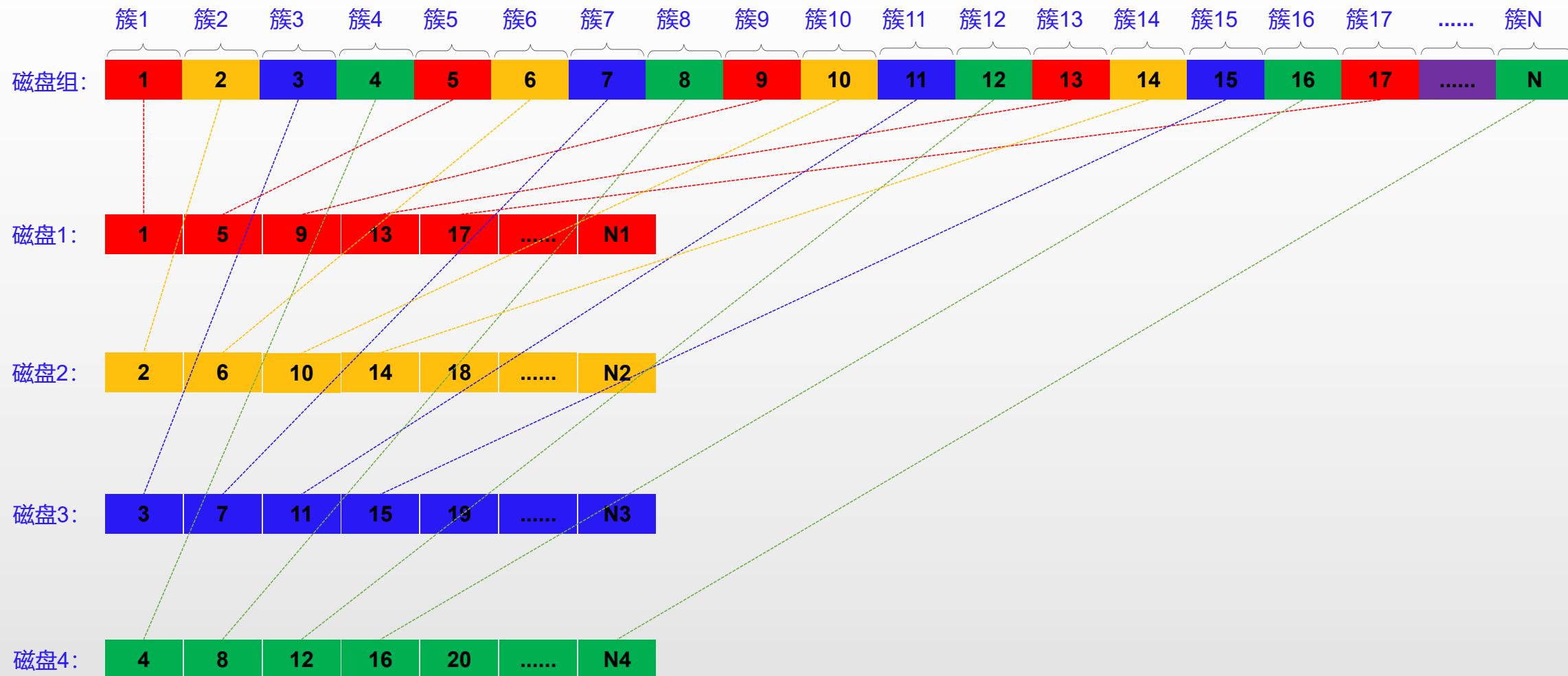


1. 每个线程写入磁盘中的IO数据簇，当每个IO数据簇被分配时，对应的线程bitmap被置位为1；

2. 每个线程定期随机查找被置位为1的线程bitmap，读取对应IO簇的数据进行校验；

# LBA工具实现原理：磁盘组数据一致性(一致性备份、快照等)

➤ 条带策略: round-robin (高级功能) --- 最多支持同时测试64个磁盘/文件



```
[root@localhost lba]# hd_write_verify -c -D -S 1024 -V all -T 10 -P robin --stripe lba1.raw --stripe lba2.raw --stripe lba3.raw --stripe lba4.raw
File Information:
  File: lba1.raw
  Size: 1073741824
  Blocks: 0
  IO Block: 65536
  Device: 2051
  Inode: 1677992490
  Links: 1
  File Size: 1073741824 / 1024M / 1.00G
```

```
File Information:
  File: lba2.raw
  Size: 1073741824
  Blocks: 0
  IO Block: 65536
  Device: 2051
  Inode: 1677992491
  Links: 1
  File Size: 1073741824 / 1024M / 1.00G
```

```
File Information:
  File: lba3.raw
  Size: 1073741824
  Blocks: 0
  IO Block: 65536
  Device: 2051
  Inode: 1677992492
  Links: 1
  File Size: 1073741824 / 1024M / 1.00G
```

```
File Information:
  File: lba4.raw
  Size: 1073741824
  Blocks: 0
  IO Block: 65536
  Device: 2051
  Inode: 1677992493
  Links: 1
  File Size: 1073741824 / 1024M / 1.00G
```

```
File: stripe | Thread: 10 | Total Sectors: 33554432 | Total Clusters: 8192 | Sectors of Cluster: 1024 | DIRECT IO & NO Flush | Verify: 5 | Notify: 0
```

```
Current Time: 2023-06-12 20:12:30
Thread 5 [tid: 1496736]: Starting check file ...
Thread 9 [tid: 1496740]: Starting check file ...
Thread 6 [tid: 1496737]: Starting check file ...
Thread 8 [tid: 1496739]: Starting check file ...
Thread 0 [tid: 1496731]: Starting check file ...
Thread 3 [tid: 1496734]: Starting check file ...
Thread 7 [tid: 1496738]: Starting check file ...
Thread 4 [tid: 1496735]: Starting check file ...
Thread 2 [tid: 1496733]: Starting check file ...
Thread 1 [tid: 1496732]: Starting check file ...
```

```
Starting write file: Thread ID | Read MB - Write MB |
KEY: <P> = pause, KEY: <S> = start, KEY: <Q> = quit
```

```
Loop 1: .
Current Time: 2023-06-12 20:12:30
68, 101 | 89, 109 | 68, 100 | 92, 111 | 59, 106 | 62, 113 | 90, 117 | 89, 109 | 86, 107 | 84, 106 |
Pause
Start
122, 133 | 140, 150 | 125, 137 | 137, 147 | 122, 140 | 133, 141 | 125, 149 | 119, 144 | 139, 143 | 129, 136 |
Quit
```

```
Current Time: 2023-06-12 20:13:02
```

```
[root@localhost lba]#
```

```
hd_write_verify_dump -c -D -T 0 -I lba1.raw -I lba2.raw -I lba3.raw -I lba4.raw
```

```
File Information:
  File: lba1.raw
  Size: 1073741824
  Blocks: 1994752
  IO Block: 2048
  Device: 2064
  Inode: 163831
  Links: 1
  File Size: 1073741824 / 1024M / 1.00G
```

```
File Information:
  File: lba2.raw
  Size: 1073741824
  Blocks: 1739360
  IO Block: 4096
  Device: 2064
  Inode: 166369
  Links: 1
  File Size: 1073741824 / 1024M / 1.00G
```

```
File Information:
  File: lba3.raw
  Size: 1073741824
  Blocks: 1763328
  IO Block: 4096
  Device: 2064
  Inode: 167051
  Links: 1
  File Size: 1073741824 / 1024M / 1.00G
```

```
File Information:
  File: lba4.raw
  Size: 1073741824
  Blocks: 1392640
  IO Block: 2048
  Device: 2064
  Inode: 172036
  Links: 1
  File Size: 1073741824 / 1024M / 1.00G
  Sector_Per_Cluster: 1024
```

```
Current Time: 2024-03-21 10:39:52
```

```
=====
BUG 007[1] LAST IO: [Thread: 0] VERIFY_SECTOR(755) DIFFER: 1 | read[419] | filename: lba4.raw
hd_write_verify_dump -c -D -I 0x0002h400 disk/file
hd_write_verify_dump -c -D -I 0x00379h400 disk/file
```

```
CORRECT LBA[0]: 0x731c080 | HF: 0x04001270 F1: 0x641f6aec F2: 0x6f4ee3c0 [LOOP: 1 WRITE: 419 ROBIN-STRIPE: 3 LBA: 0x1cc400 SECTOR: 8 / NUM: 1024 / ZERO: 0]
```

```
CORRECT IO TIME: 2022-12-20 16:41:24
```

```
ERROR LBA[755]: 0x731e[3] | HF: 0x04001270 F1: 0x641f6aec F2: 0x6f4ee3c0 [LOOP: 1 WRITE: 419 ROBIN-STRIPE: 3 LBA: 0x1cc6f3 SECTOR: 755 / NUM: 1024 / ZERO: 0]
```

```
INCONSISTENT IO TIME: 2022-12-20 16:41:24
```

```
CORRECT LBA[756]: 0x731e[4] | HF: 0x04001270 F1: 0x641f6aec F2: 0x6f4ee3c0 [LOOP: 1 WRITE: 419 ROBIN-STRIPE: 3 LBA: 0x1cc6f4 SECTOR: 756 / NUM: 1024 / ZERO: 0]
```

```
CORRECT IO TIME: 2022-12-20 16:41:24
```

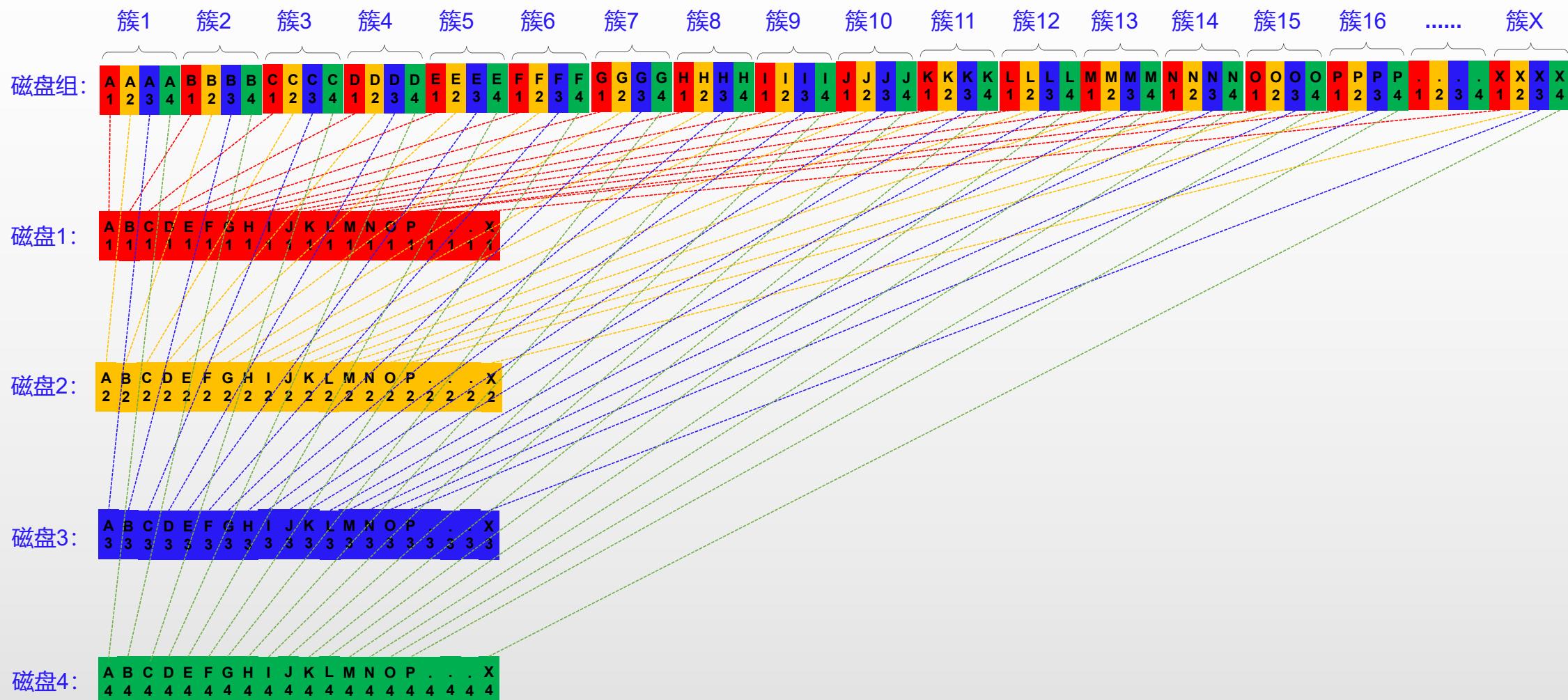
```
=====
LBA: 0x731ef2 | HF: 0x04001270 F1: 0x641f6aec F2: 0x6f4ee3c0 [LOOP: 1 WRITE: 419 ROBIN-STRIPE: 3 LBA: 0x1cc6f2 SECTOR: 754 / NUM: 1024 / ZERO: 0]
IO TIME: 2022-12-20 16:41:24
```

```
Buffer addr: 0x7fd09788400 | Physical addr: 0x5df745000
```

```
LBA LIST:
LBA[ 0]: 0x00731c08 0x00079h400 0x0096e800 0x00954300 0x00595000 0x005fc00 0x001ab400 0x00405c00 0x00975d000 0x00007c00
LBA[1]: 0x0031f400 0x00112900 0x0025e800 0x000283400 0x00151400 0x003f1200 0x00174000 0x00944c00 0x00585c00
LBA[2]: 0x004f4400 0x00194000 0x0025e800 0x000283400 0x00151400 0x003f1200 0x00174000 0x00944c00 0x00585c00
LBA[3]: 0x00194400 0x002ce00 0x00131800 0x0006f000 0x00760000 0x003d400 0x0050d400 0x00493400 0x0004a800 0x00510c00
LBA[4]: 0x003abc00 0x00064c00 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[5]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[6]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[7]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[8]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[9]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[10]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[11]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[12]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[13]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[14]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[15]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[16]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[17]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[18]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[19]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[20]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[21]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[22]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[23]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[24]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[25]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[26]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[27]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[28]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[29]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[30]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[31]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[32]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[33]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[34]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[35]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[36]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[37]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[38]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[39]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[40]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[41]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[42]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[43]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[44]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[45]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[46]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[47]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[48]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[49]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[50]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[51]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[52]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[53]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[54]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[55]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[56]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[57]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[58]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[59]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[60]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[61]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[62]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[63]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[64]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[65]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[66]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[67]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[68]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
LBA[69]: 0x00254000 0x00194000 0x0021d400 0x00902e00 0x0093e200 0x00181400 0x0093d000 0x0011a400 0x0094ad00 0x00717c00
```

# LBA工具实现原理：磁盘组数据一致性(一致性备份、快照等)

➤ 条带策略：cluster-split (高级功能) --- 最多支持同时测试64个磁盘/文件





# LBA工具实现原理：fio和vdbench的verify功能实现原理

## ➤ fio数据校验原理 ([https://blog.csdn.net/weixin\\_52944590/article/details/137870811](https://blog.csdn.net/weixin_52944590/article/details/137870811))

**数据校验的工作流程：**用-verify=str来选择校验算法：md5/crc16/crc32/crc32c/crc32c-intel/crc64/crc7/sha256/sha512/sha1等；开启校验功能，需要配置do\_verify参数：如果是写，do\_verify=1表示写完再读校验，但会占用大量内存，因为fio会把每个数据块的校验数据保存在内存里；而do\_verify=0时只写校验数据，不做读校验。

另外：verify=meta时，fio会在数据块内写入时间戳、逻辑地址等，同时可以通过verify\_pattern参数指定写入数据pattern。

```
struct verify_header {  
    uint16_t magic;  
    uint16_t verify_type;  
    uint32_t len;  
    uint64_t rand_seed;  
    uint64_t offset;  
    uint32_t time_sec;  
    uint32_t time_nsec;  
    uint16_t thread;  
    uint16_t numberio;  
    uint32_t crc32;  
};
```

## ➤ vdbench数据校验原理 (<https://blog.csdn.net/zangjiaoshou/article/details/122063819>)

**数据校验的工作流程：**每一个在存储系统中的第一次写操作记录在一个表中，假定写操作的块大小是1M，那么这个块大小中的每512字节中包含的两项---八个字节的逻辑字节地址(LBA)和一个字节的数据校验key值(标记是第几次写，范围为0-125，00代表创建写，01代表第一次覆盖写，以此类推，当到达126后折返00，重新来一轮)会被记录，这个过程为生成校验日志；第二次重新运行脚本(使用参数-jr或者-v)则根据第一次记录的日志进行数据校验。

./vdbench -f parmfile -jn

-jn：支持数据校验，可以验证数据一致性，并支持crash和reboot时的数据校验。

# LBA工具实现原理

- 簇IO对齐、簇IO随机拆分：测试存储栈IO合并(高级功能)
- LBA bitmap：区分runtime与checktime (高级功能)

```
BUG 002[4]: [Thread: 7] VERIFY_ZERO_SECTOR[1020] DIFFER: 1 | CORRECT_LBA[0]: 0xb50800
LBA: 0xb50bfc | thread_num: 10, bitmap: 0 0 0 0 0 0 0 1 0 0

LAST CORRECT WRITE:
LBA: 0x484000 | HF: 0x04001277 F1: 0x1ab5ec90 F2: 0x1a8453bd [LOOP: 1 WRITE: 86 SECTOR:
LAST WRITE IO Time: 2023-06-12 17:12:01

Current Time: 2023-06-13 10:03:57
BUG 004: [Thread: 5] DATA LOST | read[2]: 65536 | filename: /dev/vda
PREV_LBA: 0x4a5100 | LOST_LBA: 0x35480 | NEXT_LBA: 0x1c93780
LBA: 0x35480 | thread_num: 10, bitmap: 0 0 0 0 0 0 0 0 0 0
```

- 数据回写(负载保持)，参数：--writeback (高级功能)

应用于虚拟机热迁移场景

```
hd_write_verify -c -D -K -R 33 -w on -S 1024 -V once -
Device Topology:
Disk: /dev/loop1
Logical block size: 512
Physical block size: 512
Minimum I/O size: 512
Optimal I/O size: 0 (0: unknown)
Alignment offset: 0
Disk Size: 3387949056 / 3231M / 3.16G
```

```
399: void virtio_blk_submit_multireq(BlockBackend *blk, MultiReqBuffer *mrb)
400: {
401:     int i = 0, start = 0, num_reqs = 0, niov = 0, nb_sectors = 0;
402:     int max_xfer_len = 0;
403:     int64_t sector_num = 0;
404:
405:     if (mrb->num_reqs == 1) {
406:         submit_requests(blk, mrb, 0, 1, -1);
407:         mrb->num_reqs = 0;
408:         return;
409:     }
410:
411:     max_xfer_len = blk_get_max_transfer_length(mrb->reqs[0]->dev->blk);
412:     max_xfer_len = MIN_NON_ZERO(max_xfer_len, BDRV_REQUEST_MAX_SECTORS);
413:
414:     qsort(mrb->reqs, mrb->num_reqs, sizeof(*mrb->reqs),
415:           &multireq_compare);
416:
417:     for (i = 0; i < mrb->num_reqs; i++) {
418:         VirtIOBlockReq *req = mrb->reqs[i];
419:         if (num_reqs > 0) {
420:             bool merge = true;
421:
422:             /* merge would exceed maximum number of IOVs */
423:             if (niov + req->qiov.niov > IOV_MAX) {
424:                 merge = false;
425:             }
426:
427:             /* merge would exceed maximum transfer length of backend device */
428:             if (req->qiov.size / BDRV_SECTOR_SIZE + nb_sectors > max_xfer_len) {
429:                 merge = false;
430:             }
431:
432:             /* requests are not sequential */
433:             if (sector_num + nb_sectors != req->sector_num) {
434:                 merge = false;
435:             }
436:
437:             if (!merge) {
438:                 submit_requests(blk, mrb, start, num_reqs, niov);
439:                 num_reqs = 0;
440:             }
441:
442:         if (num_reqs == 0) {
443:             sector_num = req->sector_num;
444:             nb_sectors = niov = 0;
445:             start = i;
446:         }
447:
448:         nb_sectors += req->qiov.size / BDRV_SECTOR_SIZE;
449:         niov += req->qiov.niov;
450:         num_reqs++;
451:     }
452:
453:     submit_requests(blk, mrb, start, num_reqs, niov);
454:     mrb->num_reqs = 0;
455: }
```

# LBA工具实现原理

- 支持4K磁盘(簇IO随机拆分功能仍然生效)

```
Welcome to the YOUPPLUS's LBA TESTING SYSTEM
https://github.com/zhangyoujia/
YOUPPLUS login: root (automatic login)
Last login: Wed Aug 30 00:26:50 GMT-8 2023 on ttys0
echo never > /sys/kernel/mm/transparent_hugepage/enabled
hd_write_verify -c -D -K -R 33 -w on -S 2048 -V all -T 10 -L 102400 -P robin -I /dev/vda -I /dev/vdb
Device Topology:
Disk: /dev/vda
Logical block size: 512
Physical block size: 512
Minimum I/O size: 4096
Optimal I/O size: 0 (0: unknown)
Alignment offset: 0
Disk Size: 10737418240 / 10240M / 10.00G

Device Topology:
Disk: /dev/vdb
Logical block size: 512
Physical block size: 512
Minimum I/O size: 4096
Optimal I/O size: 0 (0: unknown)
Alignment offset: 0
Disk Size: 10737418240 / 10240M / 10.00G

Disk: stripe | Thread: 10 | Total Sectors: 83886080 | Total Clusters: 2048
Current Time: 2023-08-30 23:59:01
Thread 5 [tid: 1036]: Starting check disk ...
Thread 7 [tid: 1038]: Starting check disk ...
Thread 8 [tid: 1039]: Starting check disk ...
Thread 6 [tid: 1037]: Starting check disk ...
Thread 3 [tid: 1034]: Starting check disk ...
Thread 2 [tid: 1033]: Starting check disk ...
Thread 9 [tid: 1040]: Starting check disk ...
Thread 0 [tid: 1031]: Starting check disk ...
Thread 4 [tid: 1035]: Starting check disk ...
Thread 1 [tid: 1032]: Starting check disk ...

Starting write disk: Thread ID | Read MB - Write MB |
KEY: <P> = pause, KEY: <S> = start, KEY: <Q> = quit
Loop 1: .
Current Time: 2023-08-30 23:59:01
261, 274 | 265, 276 | 257, 279 | 246, 289 | 253, 283 | 271, 281 | 280, 286

Welcome to the YOUPPLUS's LBA TESTING SYSTEM
https://github.com/zhangyoujia/
YOUPPLUS login: root (automatic login)
Last login: Wed Aug 30 15:12:29 GMT-8 2023 on ttys0
echo never > /sys/kernel/mm/transparent_hugepage/enabled
hd_write_verify -c -D -K -R 33 -w on -S 2048 -V all -T 10 -L 102400 -P robin -I /dev/vda -I /dev/vdb
Device Topology:
Disk: /dev/vda
Logical block size: 4096
Physical block size: 4096
Minimum I/O size: 4096
Optimal I/O size: 0 (0: unknown)
Alignment offset: 0
Disk Size: 10737418240 / 10240M / 10.00G

Device Topology:
Disk: /dev/vdb
Logical block size: 4096
Physical block size: 4096
Minimum I/O size: 4096
Optimal I/O size: 0 (0: unknown)
Alignment offset: 0
Disk Size: 10737418240 / 10240M / 10.00G

Disk: stripe | Thread: 10 | Total Sectors: 83886080 | Total Clusters: 20480 | Sectors of Cluster: 2048 | DIRECT IO & NO Flush | Verify: 6 | Notify: 0
Current Time: 2023-08-30 18:27:25
Thread 2 [tid: 1026]: Starting check disk ...
Thread 4 [tid: 1028]: Starting check disk ...
Thread 8 [tid: 1032]: Starting check disk ...
Thread 5 [tid: 1029]: Starting check disk ...
Thread 0 [tid: 1024]: Starting check disk ...
Thread 7 [tid: 1031]: Starting check disk ...
Thread 1 [tid: 1025]: Starting check disk ...
Thread 9 [tid: 1033]: Starting check disk ...
Thread 3 [tid: 1027]: Starting check disk ...
Thread 6 [tid: 1030]: Starting check disk ...

Starting write disk: Thread ID | Read MB - Write MB |
KEY: <P> = pause, KEY: <S> = start, KEY: <Q> = quit
Loop 1: .
Current Time: 2023-08-30 18:27:26
448, 401 | 488, 426 | 455, 405 | 440, 409 | 447, 402 | 465, 411 | 431, 418 | 472, 415 | 433, 417 | 473, 417 | _
```

# LBA工具实现原理

## ➤ 全0数据测试，参数：--zero-ratio 和 --zero-sectors (高级功能)

1. 虚拟机热迁移测试：全0数据内存页迁移
2. 虚拟机热迁移测试：全0数据IO簇迁移
3. qcow2镜像L2表项：CLUSTER\_ZERO\_PLAIN和CLUSTER\_ZERO\_ALLOC特性测试
4. 稀疏文件的(远程)拷贝测试：cp / scp / rsync / socat等

```
1200: static int save_zero_page_to_file(RAMState *rs, QEMUFfile *file,
1201:                                     RAMBlock *block, ram_addr_t offset)
1202: {
1203:     uint8_t *p = block->host + offset;
1204:     int len = 0;
1205:
1206:     if (buffer_is_zero(p, TARGET_PAGE_SIZE)) {
1207:         len += save_page_header(rs, file, block, offset | RAM_SAVE_FLAG_ZERO);
1208:         qemu_put_byte(file, 0);
1209:         len += 1;
1210:         ram_release_page(block->idstr, offset);
1211:     }
1212:     return len;
1213: }
131: static void blk_send(QEMUFfile *f, BlkMigBlock *blk)
132: {
133:     int len;
134:     uint64_t flags = BLK_MIG_FLAG_DEVICE_BLOCK;
135:
136:     if (block_mig_state.zero_blocks &&
137:         buffer_is_zero(blk->buf, BLK_MIG_BLOCK_SIZE)) {
138:         flags |= BLK_MIG_FLAG_ZERO_BLOCK;
139:     }
140: }
```

```
420: static bool
421: extent_copy (int src_fd, int dest_fd, char
422:                 size_t hole_size, off_t src_
423:                 enum Sparse_type sparse_mode
424:                 char const *src_name, char c
425:                 bool *require_normal_copy)
426: {
427:     struct extent_scan scan;
428:     off_t last_ext_start = 0;
429:     off_t last_ext_len = 0;
430:
431:     /* Keep track of the output position.
432:      We may need this at the end, for a final
433:      off_t dest_pos = 0;
434:
435:     extent_scan_init (src_fd, &scan);
436:
437:     *require_normal_copy = false;
438:     bool wrote_hole_at_eof = true;
439:
440:     do
441:     {
442:         if (!extent_scan_read (&scan))
443:             if (!ok)
444:                 break;
445:     } while (last_ext_start != last_ext_len);
```

```
l2 table[8186], data offset: 0x6c650000 [0x800000006c650000: COPIED] | vdisk offset: 0xdffa0000
l2 table[8187], data offset: 0x6c660000 [0x800000006c660000: COPIED] | vdisk offset: 0xdffbb0000
l2 table[8188], data offset: 0x6c700000 [0x800000006c670000: ZERO] | vdisk offset: 0xdffcc0000
l2 table[8189], data offset: 0x6c680000 [0x800000006c680000: ZERO] | vdisk offset: 0xdffdd0000
l2 table[8190], data offset: 0x6c690000 [0x800000006c690000: ZERO] | vdisk offset: 0xdffee0000
l2 table[8191], data offset: 0x6c6a0000 [0x800000006c6a0000: ZERO] | vdisk offset: 0xdffff0000
l2 Entry: unaligned: 0, invalid: 0, used: 4132, zero alloc: 21, zero_plain: 76 unused: 3963
-----
l1 table[ 7], l2 offset: 0xdf0000 [0x8000000000df0000: COPIED]
l2 table[ 0], data offset: 0xf4b0000 [0x8000000000f4b000: COPIED] | vdisk offset: 0xe0000000
l2 table[ 1], data offset: 0xf4c0000 [0x8000000000f4c000: COPIED] | vdisk offset: 0xe0010000
l2 table[ 2], data offset: 0xf4d0000 [0x8000000000f4d000: COPIED] | vdisk offset: 0xe0020000
l2 table[ 3], data offset: 0xf4e0000 [0x8000000000f4e000: COPIED] | vdisk offset: 0xe0030000
l2 table[ 4], data offset: 0xf4f0000 [0x8000000000f4f000: COPIED] | vdisk offset: 0xe0040000
l2 table[ 5], data offset: 0xf500000 [0x8000000000f50000: COPIED] | vdisk offset: 0xe0050000
l2 table[ 6], data offset: 0xf510000 [0x8000000000f51000: COPIED] | vdisk offset: 0xe0060000
l2 table[ 7], data offset: 0xf520000 [0x8000000000f52000: COPIED] | vdisk offset: 0xe0070000
l2 table[ 8], data offset: 0xf530000 [0x8000000000f53000: COPIED] | vdisk offset: 0xe0080000
l2 table[ 9], data offset: 0xf540000 [0x8000000000f54000: COPIED] | vdisk offset: 0xe0090000
l2 table[10], data offset: 0xf550000 [0x8000000000f55000: COPIED] | vdisk offset: 0xe00a0000
l2 table[11], data offset: 0xf560000 [0x8000000000f56000: COPIED] | vdisk offset: 0xe00b0000
l2 table[12], data offset: 0xf570000 [0x8000000000f57000: COPIED] | vdisk offset: 0xe00c0000
l2 table[13], data offset: 0xf580000 [0x8000000000f58000: COPIED] | vdisk offset: 0xe00d0000
l2 table[14], data offset: 0x0 [0x1: ZERO] | vdisk offset: 0xe00e0000
l2 table[15], data offset: 0x0 [0x1: ZERO] | vdisk offset: 0xe00f0000
l2 table[96], data offset: 0x2520000 [0x8000000002520000: COPIED] | vdisk offset: 0xe0600000
l2 table[97], data offset: 0x2530000 [0x8000000002530000: COPIED] | vdisk offset: 0xe0610000
```

## ➤ 块设备指令/文件系统特性测试，参数：--write-zeroes 和 --discard (高级功能)

指令：

```
68: #define WRITE_SAME          0x41
69: #define UNMAP                0x42
70:
71: /* I/O commands */
72: enum nvme_opcode {
73:     nvme_cmd_flush           = 0x00,
74:     nvme_cmd_write            = 0x01,
75:     nvme_cmd_read             = 0x02,
76:     nvme_cmd_write_uncor     = 0x04,
77:     nvme_cmd_compare          = 0x05,
78:     nvme_cmd_write_zeroes    = 0x08,
79:     nvme_cmd_dsm              = 0x09,
80:     nvme_cmd_verify           = 0x0c,
81:     nvme_cmd_resv_register   = 0x0d,
82:     nvme_cmd_resv_report     = 0x0e,
83:     nvme_cmd_resv_acquire    = 0x11,
84:     nvme_cmd_resv_release    = 0x15,
85:     nvme_cmd_zone_mgmt_send  = 0x79,
86:     nvme_cmd_zone_mgmt_recv  = 0x7a,
87:     nvme_cmd_zone_append     = 0x7d,
88: };
89:
90: (1) mkfs.ext4 /dev/sdb          # cat /etc/fstab
91: (2) mount -o discard /dev/sdb /mnt/test/  UUID=3453g54-6628-2346-8123435f /home xfs defaults,discard 0 0
92: (3) fstrim -a
```

```
440: u16 nvmet_bdev_parse_io_cmd(struct nvmet_req *req)
441: {
442:     struct nvme_command *cmd = req->cmd;
443:
444:     switch (cmd->common.opcode) {
445:     case nvme_cmd_read:
446:     case nvme_cmd_write:
447:         req->execute = nvmet_bdev_execute_rw;
448:         if (req->sq->ctrl->pi_support && nvmet_ns_has_pi(req->nns))
449:             req->metadata_len = nvmet_rw_metadata_len(req);
450:         return 0;
451:     case nvme_cmd_flush:
452:         req->execute = nvmet_bdev_execute_flush;
453:         return 0;
454:     case nvme_cmd_dsm:
455:         req->execute = nvmet_bdev_execute_dsm;
456:         return 0;
457:     case nvme_cmd_write_zeroes:
458:         req->execute = nvmet_bdev_execute_write_zeroes;
459:         return 0;
460:     default:
461:         return nvmet_report_invalid_opcode(req);
462:     }
463: }
```

# LBA工具实现原理

- IO重试，参数：--io-retry (高级功能) 实例：微软iscsi target测试出数据不一致
- 存储整体trim，参数：--trim-all (高级功能)
- 识别文件存储的文件系统类型
- bsrangle指定簇IO随机拆分范围 (适配4K盘)

IO簇大小，例如：1MB  
bsrange指定IO拆分范围：1K-4K

[root@linux lba]# ./hd\_write\_verify -c -D -S 1024 [-A on -B 1-8] -V all -T 10 /root/lba/lba.raw

File Information:  
FS type: xfs  
File: /root/lba/lba.raw  
Size: 4294967296  
Blocks: 0  
IO Block: 65536  
Device: 2066  
Inode: 1291848975  
Links: 1  
File Size: 4294967296 / 4096M / 4.00G

File: /root/lba/lba.raw | Thread: 10 | Total Sectors: 8388608 | Total Clusters: 8192 | Sectors of Cluster: 1024 | DIRECT IO & NO Flush | Policy: robin | Verify: 6

Current Time: 2024-05-13 09:43:17  
Thread 9 [tid: 1586757]: Starting check file ...  
Thread 4 [tid: 1586752]: Starting check file ...  
Thread 8 [tid: 1586756]: Starting check file ...  
Thread 1 [tid: 1586749]: Starting check file ...  
Thread 2 [tid: 1586750]: Starting check file ...  
Thread 6 [tid: 1586754]: Starting check file ...  
Thread 3 [tid: 1586751]: Starting check file ...  
Thread 7 [tid: 1586755]: Starting check file ...  
Thread 5 [tid: 1586753]: Starting check file ...  
Thread 0 [tid: 1586748]: Starting check file ...

Starting write file: Thread ID | Read MB - Write MB |  
KEY: <P> = pause, KEY: <S> = start, KEY: <Q> = quit

Loop 1:  
Current Time: 2024-05-13 09:43:18

269, 230 | 304, 253 | 235, 207 | 236, 208 | 240, 210 | 283, 239 | 293, 252 | 228, 202 | 317, 262 | 232, 205 | □

[root@linux lba]# stat lba.raw  
File: lba.raw  
Size: 11811160064 Blocks: 22765488 IO Block: 65536 regular file  
Device: 812h/2066d Inode: 1291848976 Links: 1  
Access: (0644/-rw-r--r--)Uid: ( 0/ root) Gid: ( 0/ root)  
Access: 2024-04-29 23:29:39.369332820 -0400  
Modify: 2024-04-29 23:29:39.359332820 -0400  
Change: 2024-04-29 23:29:39.359332820 -0400  
Birth: 2024-04-29 23:20:46.549332820 -0400  
  
[root@linux lba]# stat lba.raw  
File: lba.raw  
Size: 11811160064 Blocks: 3136 IO Block: 65536 regular file  
Device: 812h/2066d Inode: 1291848976 Links: 1  
Access: (0644/-rw-r--r--)Uid: ( 0/ root) Gid: ( 0/ root)  
Access: 2024-04-29 23:29:39.369332820 -0400  
Modify: 2024-04-29 23:35:46.009332820 -0400  
Change: 2024-04-29 23:35:46.009332820 -0400  
Birth: 2024-04-29 23:20:46.549332820 -0400

(gdb) set args -c -D -t on -S 1024 -V loop -T 3 /root/lba/lba.raw  
Breakpoint 1 at 0x404000 file hd\_write\_verify.c line 254.  
(gdb) r  
Run as program: [root@lba:~] /root/lba/lba/lba.raw  
[Thread debugging using libthread\_db library "/lib64/libthread\_db.so.1"].  
Using host libthread\_db library "/lib64/libthread\_db.so.1".

File Information:  
FS type: xfs  
File: /root/lba/lba.raw  
Size: 11811160064 Blocks: 22765488 IO Block: 65536 regular file  
Device: 812h/2066d Inode: 1291848976 Links: 1  
Access: (0644/-rw-r--r--)Uid: ( 0/ root) Gid: ( 0/ root)  
Access: 2024-04-29 23:21:51  
Modify: 2024-04-29 23:21:51  
Change: 2024-04-29 23:21:51  
Birth: 2024-04-29 23:21:51

Current Time: 2024-04-29 23:21:51  
New Thread 0xfffff70bf120 (LWP 140653)  
New Thread 0xfffff75fa120 (LWP 140653)  
Thread 0 [tid: 140653]: Starting check file ...  
Thread 1 [tid: 140653]: Starting check file ...  
Thread 2 [tid: 140652]: Starting check file ...  
Thread 3 [tid: 140652]: Starting check file ...  
Thread 4 [tid: 140652]: Starting check file ...  
Thread 5 [tid: 140652]: Starting check file ...  
Thread 6 [tid: 140652]: Starting check file ...  
Thread 7 [tid: 140652]: Starting check file ...  
Thread 8 [tid: 140652]: Starting check file ...  
Thread 9 [tid: 140652]: Starting check file ...

Starting write file: Thread ID | Read MB - Write MB |  
KEY: <P> = pause, KEY: <S> = start, KEY: <Q> = quit

Loop 1:  
Current Time: 2024-04-29 23:22:00  
0, 329 | 0, 323 | 0, 320 | 0, 322 |

Current Time: 2024-04-29 23:22:19  
Thread 0 [tid: 140650]: Starting check file ...  
Thread 1 [tid: 140650]: Starting check file ...  
Thread 2 [tid: 140650]: Starting check file ...

Current Time: 2024-04-29 23:22:33  
WARNING: [Thread: 1] VERIFY DIFFER FLAGS | filename: /root/lba/lba.raw  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(422)  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(422)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0xfeffff00 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)

Current Time: 2024-04-29 23:22:37  
WARNING: [Thread: 0] VERIFY DIFFER FLAGS | filename: /root/lba/lba.raw  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)

Current Time: 2024-04-29 23:22:57  
WARNING: [Thread: 0] VERIFY DIFFER FLAGS | filename: /root/lba/lba.raw  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)

Current Time: 2024-04-29 23:22:57  
WARNING: [Thread: 0] VERIFY DIFFER FLAGS | filename: /root/lba/lba.raw  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)

Current Time: 2024-04-29 23:22:57  
WARNING: [Thread: 0] VERIFY DIFFER FLAGS | filename: /root/lba/lba.raw  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)

Current Time: 2024-04-29 23:22:57  
WARNING: [Thread: 0] VERIFY DIFFER FLAGS | filename: /root/lba/lba.raw  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)

Current Time: 2024-04-29 23:22:57  
WARNING: [Thread: 0] VERIFY DIFFER FLAGS | filename: /root/lba/lba.raw  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)

Current Time: 2024-04-29 23:22:57  
WARNING: [Thread: 0] VERIFY DIFFER FLAGS | filename: /root/lba/lba.raw  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)  
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Current Time: 2024-04-29 23:22:57  
WARNING: [Thread: 0] VERIFY DIFFER FLAGS | filename: /root/lba/lba.raw  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)

Current Time: 2024-04-29 23:22:57  
WARNING: [Thread: 0] VERIFY DIFFER FLAGS | filename: /root/lba/lba.raw  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
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NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)

Current Time: 2024-04-29 23:22:57  
WARNING: [Thread: 0] VERIFY DIFFER FLAGS | filename: /root/lba/lba.raw  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)

Current Time: 2024-04-29 23:22:57  
WARNING: [Thread: 0] VERIFY DIFFER FLAGS | filename: /root/lba/lba.raw  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)

Current Time: 2024-04-29 23:22:57  
WARNING: [Thread: 0] VERIFY DIFFER FLAGS | filename: /root/lba/lba.raw  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)

Current Time: 2024-04-29 23:22:57  
WARNING: [Thread: 0] VERIFY DIFFER FLAGS | filename: /root/lba/lba.raw  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)  
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Current Time: 2024-04-29 23:22:57  
WARNING: [Thread: 0] VERIFY DIFFER FLAGS | filename: /root/lba/lba.raw  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)  
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Current Time: 2024-04-29 23:22:57  
WARNING: [Thread: 0] VERIFY DIFFER FLAGS | filename: /root/lba/lba.raw  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)  
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Current Time: 2024-04-29 23:22:57  
WARNING: [Thread: 0] VERIFY DIFFER FLAGS | filename: /root/lba/lba.raw  
PREV LBA: 0x51400 - NEXT LBA: 0x51406 Flags is different | read(424)  
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NEXT LBA: 0x51400000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 Flags is different | read(424)

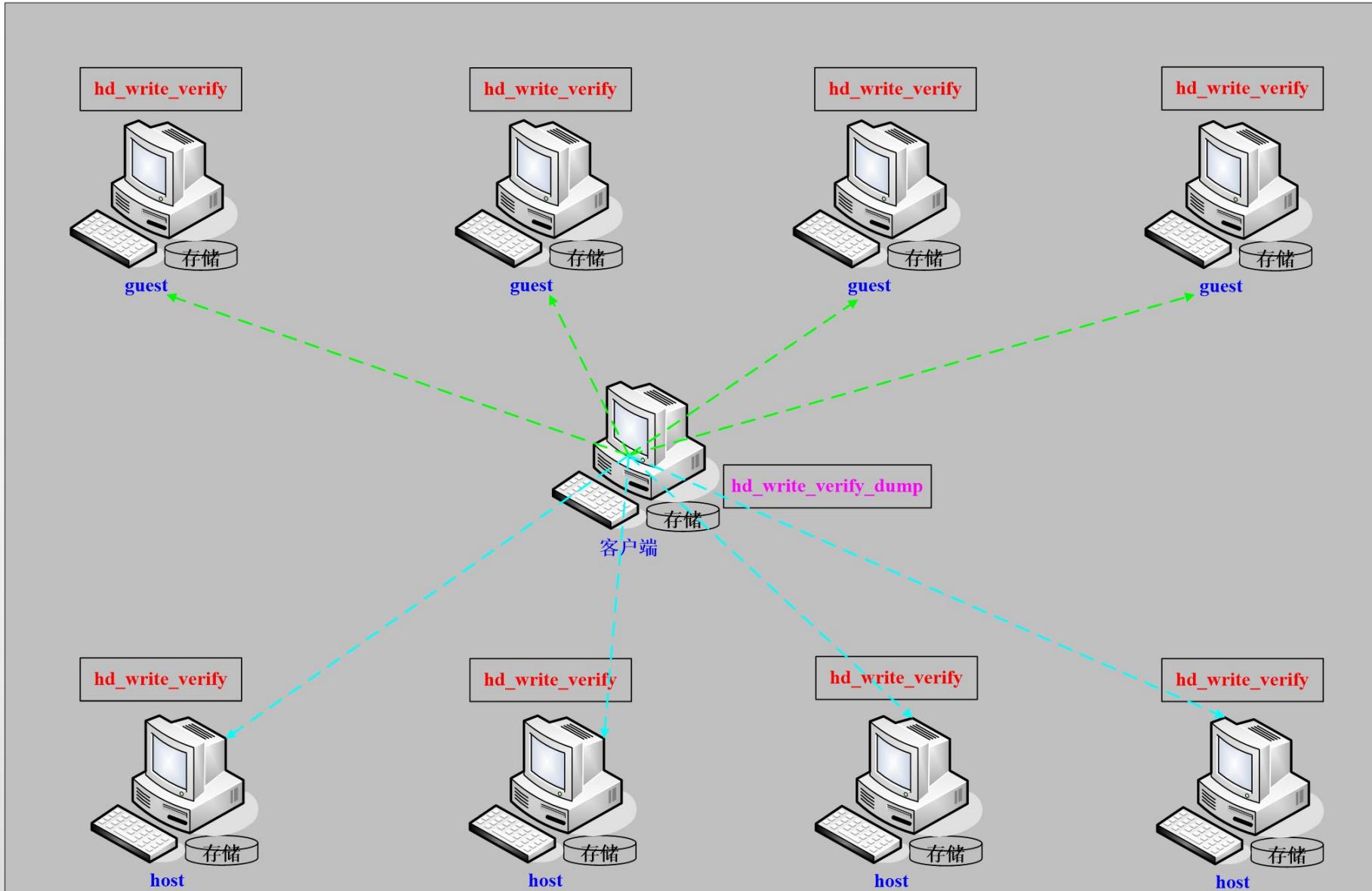
## LBA工具实现原理

➤ IO精准限速：比较稳定的IO负载 (高级功能)

**应用场景举例：** 1. 虚拟机跨存储热迁移，多大的IO负载会导致迁移无法完成？  
2. 虚拟机同存储热迁移，多大的内存负载(变脏速度)会导致迁移无法完成？

# LBA工具实现原理 (TODO: v9.0 release)

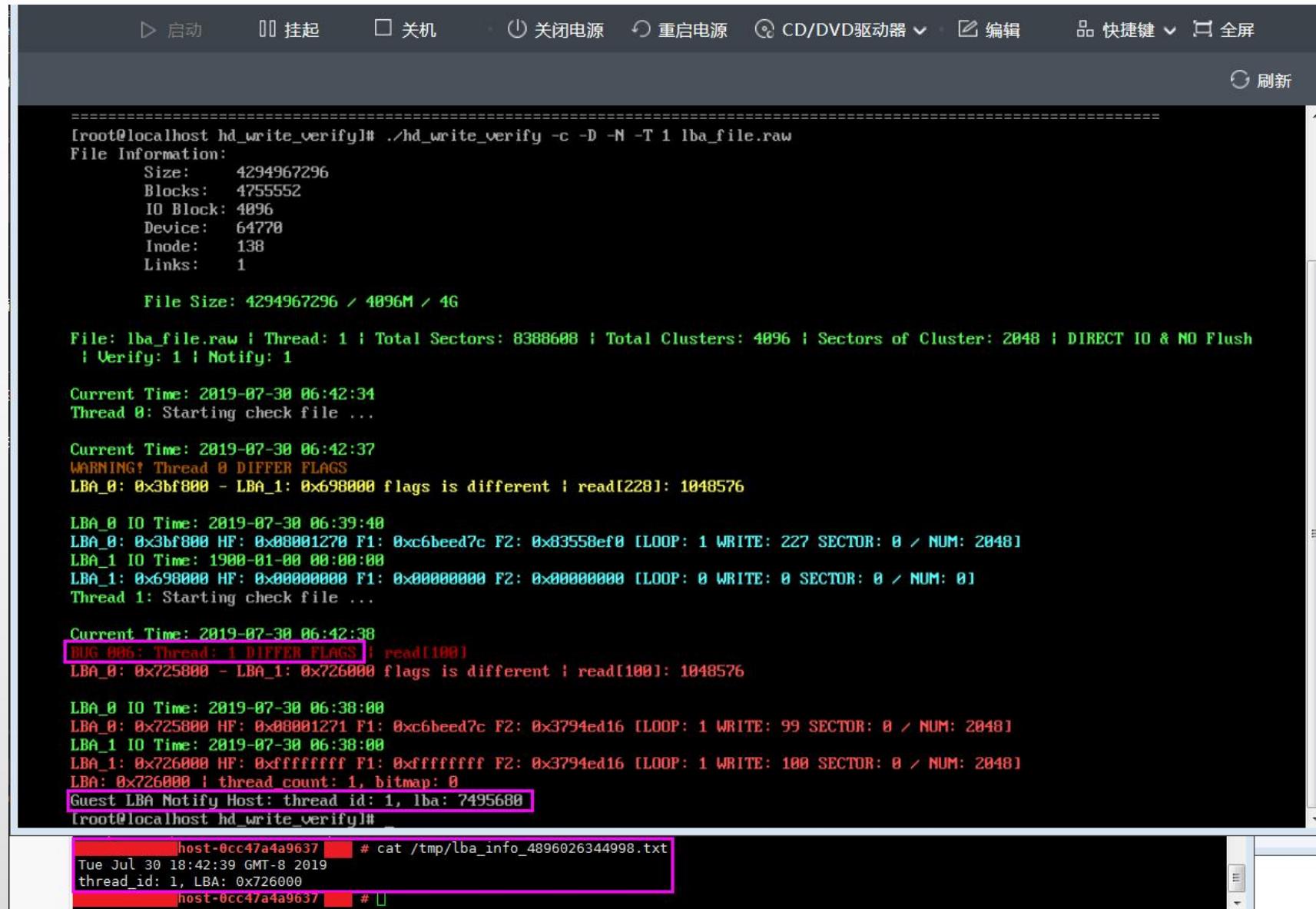
➤ 客户端(`hd_write_verify_dump`) => 通过网络链接访问 => 服务端(`hd_write_verify`) 获取测试结果



1. 目前的实现：多个`hd_write_verify`实例批量运行在物理主机或者虚拟机上，进行存储稳定性测试或者数据一致性校验，当查看每个实例的测试结果时，需要到登录每一台物理主机或者虚拟机上去查看，比较繁琐；
2. `hd_write_verify`作为服务端在物理主机或者虚拟机上运行，进行存储稳定性测试或者数据一致性校验，同时监听客户端的请求，把测试结果发送给`hd_write_verify_dump`客户端；
3. `hd_write_verify_dump`可以直接读取存储数据进行校验，也可以作为客户端，连接到`hd_write_verify`服务端，获取`hd_write_verify`工具稳定性测试或者数据一致性校验的结果；
4. `hd_write_verify_dump`作为客户端，可以批量连接同一台物理主机或者虚拟机上的多个`hd_write_verify`实例，来获取多个实例的测试结果，并进行格式化输出；

# LBA工具实现原理

- 通知功能：guest中测试出数据一致性问题后，线程号和LBA地址通知到host--可实现短信、邮件告警(高级功能)



The screenshot shows a terminal window with a dark theme. At the top, there is a menu bar with options: 启动 (Launch), 挂起 (Suspend), 关机 (Shutdown), 关闭电源 (Power Off), 重启电源 (Reboot), CD/DVD驱动器 (CD/DVD Drive), 编辑 (Edit), 快捷键 (Shortcuts), 全屏 (Full Screen), and 刷新 (Refresh). The main area of the terminal displays the output of the command `./hd_write_verify -c -D -N -T 1 lba_file.raw`. The output includes file information (Size: 4294967296, Blocks: 4755552, IO Block: 4096, Device: 64770, Inode: 138, Links: 1) and a note about the file size (File Size: 4294967296 / 4896M / 4G). It also shows the current time (2019-07-30 06:42:34) and thread activity (Thread 0: Starting check file ...). A warning message appears: "WARNING! Thread 0 DIFFER FLAGS". The log continues with IO details for LBA\_0 and LBA\_1, including their addresses (0x3bf800, 0x698000), flags (0xc6beed7c, 0x83558ef0, 0x00000000, 0x00000000), and write counts (227, 0). Thread 1 is also shown starting its check. A red box highlights a line of text: "BUG 006: Thread: 1 DIFFER FLAGS! read[100]". Another red box highlights the LBA address: "LBA\_0: 0x725800 - LBA\_1: 0x726000 flags is different ; read[100]: 1048576". A third red box highlights the guest LBA notification: "Guest LBA Notify Host: thread id: 1, lba: 7495680". The bottom of the terminal shows the host's command prompt: "host-0cc47a4a9637 # cat /tmp/lba\_info\_4896026344998.txt". The output of this command is: "Tue Jul 30 18:42:39 GMT-8 2019 thread\_id: 1, LBA: 0x726000". The bottom right corner of the terminal window has a close button.

```
froot@localhost hd_write_verify]# ./hd_write_verify -c -D -N -T 1 lba_file.raw
=====
froot@localhost hd_write_verify]# ./hd_write_verify -c -D -N -T 1 lba_file.raw
File Information:
  Size: 4294967296
  Blocks: 4755552
  IO Block: 4096
  Device: 64770
  Inode: 138
  Links: 1

  File Size: 4294967296 / 4896M / 4G

File: lba_file.raw : Thread: 1 : Total Sectors: 8388608 : Total Clusters: 4096 : Sectors of Cluster: 2048 : DIRECT IO & NO Flush
: Verify: 1 : Notify: 1

Current Time: 2019-07-30 06:42:34
Thread 0: Starting check file ...

Current Time: 2019-07-30 06:42:37
WARNING! Thread 0 DIFFER FLAGS
LBA_0: 0x3bf800 - LBA_1: 0x698000 flags is different ; read[228]: 1048576

LBA_0 IO Time: 2019-07-30 06:39:40
LBA_0: 0x3bf800 HF: 0x08001270 F1: 0xc6beed7c F2: 0x83558ef0 [LOOP: 1 WRITE: 227 SECTOR: 0 / NUM: 2048]
LBA_1 IO Time: 1900-01-00 00:00:00
LBA_1: 0x698000 HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0]
Thread 1: Starting check file ...

Current Time: 2019-07-30 06:42:38
BUG 006: Thread: 1 DIFFER FLAGS! read[100]
LBA_0: 0x725800 - LBA_1: 0x726000 flags is different ; read[100]: 1048576

LBA_0 IO Time: 2019-07-30 06:38:00
LBA_0: 0x725800 HF: 0x08001271 F1: 0xc6beed7c F2: 0x3794ed16 [LOOP: 1 WRITE: 99 SECTOR: 0 / NUM: 2048]
LBA_1 IO Time: 2019-07-30 06:38:00
LBA_1: 0x726000 HF: 0xffffffff F1: 0xffffffff F2: 0x3794ed16 [LOOP: 1 WRITE: 100 SECTOR: 0 / NUM: 2048]
LBA: 0x726000 | thread count: 1, bitmap: 0
Guest LBA Notify Host: thread id: 1, lba: 7495680
froot@localhost hd_write_verify]#
host-0cc47a4a9637 # cat /tmp/lba_info_4896026344998.txt
Tue Jul 30 18:42:39 GMT-8 2019
thread_id: 1, LBA: 0x726000
host-0cc47a4a9637 #
```

# LBA工具实现原理

## ➤ 虚拟内存地址与物理内存地址映射 (高级功能)

```
[root@localhost hd_write_verify]# ls -l
total 160
-rw----- 1 root root 0 Jun 13 17:05 lba1.raw.lock
-rw----- 1 root root 0 Jun 13 17:05 lba2.raw.lock
-rw----- 1 root root 0 Jun 13 17:05 lba3.raw.lock
-rw----- 1 root root 0 Jun 13 17:05 lba4.raw.lock
-rw-r--r-- 1 root root 4183 Jun 13 16:54 mem_map.1579591_00_1579592
-rw-r--r-- 1 root root 4183 Jun 13 16:54 mem_map.1579591_01_1579593
-rw-r--r-- 1 root root 4183 Jun 13 16:54 mem_map.1579591_02_1579594
-rw-r--r-- 1 root root 4183 Jun 13 16:54 mem_map.1579591_03_1579595
-rw-r--r-- 1 root root 4183 Jun 13 16:54 mem_map.1579591_04_1579596
-rw-r--r-- 1 root root 4183 Jun 13 16:54 mem_map.1579591_05_1579597
-rw-r--r-- 1 root root 4078 Jun 13 16:54 mem_map.1579591_06_1579598
-rw-r--r-- 1 root root 4183 Jun 13 16:54 mem_map.1579591_07_1579599
-rw-r--r-- 1 root root 4183 Jun 13 16:54 mem_map.1579591_08_1579600
-rw-r--r-- 1 root root 4183 Jun 13 16:54 mem_map.1579591_09_1579601
-rw-r--r-- 1 root root 112 Jun 13 16:54 mem_map.1579591_10_1579591
-rw-r--r-- 1 root root 4183 Jun 13 17:05 mem_map.1579805_00_1579807
-rw-r--r-- 1 root root 4183 Jun 13 17:05 mem_map.1579805_01_1579808
-rw-r--r-- 1 root root 4183 Jun 13 17:05 mem_map.1579805_02_1579809
-rw-r--r-- 1 root root 4183 Jun 13 17:05 mem_map.1579805_03_1579810
-rw-r--r-- 1 root root 4183 Jun 13 17:05 mem_map.1579805_04_1579811
-rw-r--r-- 1 root root 4183 Jun 13 17:05 mem_map.1579805_05_1579812
-rw-r--r-- 1 root root 4117 Jun 13 17:05 mem_map.1579805_06_1579813
-rw-r--r-- 1 root root 4183 Jun 13 17:05 mem_map.1579805_07_1579814
-rw-r--r-- 1 root root 4183 Jun 13 17:05 mem_map.1579805_08_1579815
-rw-r--r-- 1 root root 4052 Jun 13 17:05 mem_map.1579805_09_1579816
-rw-r--r-- 1 root root 112 Jun 13 17:05 mem_map.1579805_10_1579805
[root@localhost hd_write_verify]#
```

```
-----
LBA: 0x5f1000 [HF: 0xffffffff F1: 0aaaaaaaaa F2: 0xf043e3a4 ]LOOP: 1 WRITE: 5 SE
CTOR: 0 / NUM: 2048]
IO Time: 2020-03-03 01:25:21

Buffer addr: 0xfffff7ef2000 | Physical addr: 0x3cd70000

Breakpoint 1, hd_verify_single_cluster (verify=0xfffff7ef2000,
sector_per_cluster=1, sector_per_cluster@entry=4096)
at hd_write_verify_dump.c:728
728      in hd_write_verify_dump.c
```

200.201.184.10	3CD6FE80	C0 4E D7 00 00 00 00 E0 4E D7 00 00 00	cal addr: 0x582dae40000
200.201.24.154	3CD6FEA0	40 00 00 00 00 00 00 00 00 00 00 00	cal addr: 0x582bac30000
200.201.33.40	3CD6FEC0	72 73 70 00 00 00 00 00 00 00 00 00	cal addr: 0x58286850000
	3CD6FEE0	64 61 74 61 5F 70 74 72 00 00 00 00	cal addr: 0x582b8ea0000
	3CD6FF00	40 4F D7 00 00 00 00 00 00 00 00 00	cal addr: 0x582be010000
	3CD6FF20	40 00 00 00 00 00 00 00 00 00 00 00	cal addr: 0x582a1fe0000
	3CD6FF40	72 38 00 00 00 00 00 00 00 00 00 00	cal addr: 0x582a2200000
	3CD6FF60	69 6E 74 36 34 00 00 00 00 00 00 00	cal addr: 0x582bf3a0000
	3CD6FF80	C0 4F D7 00 00 00 00 00 00 00 00 00	cal addr: 0x582a35b0000
	3CD6FFA0	20 00 00 00 00 00 00 00 00 00 00 00	cal addr: 0x582a3590000
	3CD6FFC0	65 66 6C 61 67 73 00 00 00 00 00 00	cal addr: 0x582b4730000
	3CD6FFE0	69 33 38 36 5F 65 66 6C 61 67 73 00	cal addr: 0x582b7e00000
	3CD70000	FF FF FF FF AA AA AA AA 00 00 00 00 00	cal addr: 0x582bd830000
	---	3733563982736.qemu_back_mem_objects_mem-node0.sdcMy0	cal addr: 0x582b4740000

```
[root@localhost hd_write_verify]# cat mem_map.1579591_00_1579592
verify_bitmap: ID: 0, Tid: 1579592, Thread: 0xfffff9744f120
Buffer addr: 0xfffff90010000 | Physical addr: 0x58349b30000
```

```
no_memalign: ID: 0, Tid: 1579592, Thread: 0xfffff9744f120
Buffer addr: 0xfffff949b0000 | Physical addr: 0x58321850000
Buffer addr: 0xfffff949c0000 | Physical addr: 0x582b0dc0000
Buffer addr: 0xfffff949d0000 | Physical addr: 0x583e88a0000
Buffer addr: 0xfffff949e0000 | Physical addr: 0x58329ad0000
Buffer addr: 0xfffff949f0000 | Physical addr: 0x583caf40000
Buffer addr: 0xfffff949a0000 | Physical addr: 0x583f5500000
Buffer addr: 0xfffff94a10000 | Physical addr: 0x583cca80000
Buffer addr: 0xfffff94a20000 | Physical addr: 0x58318a60000
Buffer addr: 0xfffff94a30000 | Physical addr: 0x58310000000
Buffer addr: 0xfffff94a40000 | Physical addr: 0x5830fe70000
Buffer addr: 0xfffff94a50000 | Physical addr: 0x58394730000
Buffer addr: 0xfffff94a60000 | Physical addr: 0x582c5020000
Buffer addr: 0xfffff94a70000 | Physical addr: 0x582bf910000
Buffer addr: 0xfffff94a80000 | Physical addr: 0x583cd3c0000
Buffer addr: 0xfffff94a90000 | Physical addr: 0x582a9840000
Buffer addr: 0xfffff94aa0000 | Physical addr: 0x582b82a0000
Buffer addr: 0xfffff94ab0000 | Physical addr: 0x58285240000
```

```
test_head: ID: 0, Tid: 1579592, Thread: 0xfffff9744f120
Buffer addr: 0xfffff7d540000 | Physical addr: 0x582bca60000
Buffer addr: 0xfffff7d550000 | Physical addr: 0x582a1fb0000
Buffer addr: 0xfffff7d560000 | Physical addr: 0x582b8ea0000
Buffer addr: 0xfffff7d570000 | Physical addr: 0x582be010000
Buffer addr: 0xfffff7d580000 | Physical addr: 0x582a1fe0000
Buffer addr: 0xfffff7d590000 | Physical addr: 0x582a2200000
Buffer addr: 0xfffff7d5a0000 | Physical addr: 0x582bf3a0000
Buffer addr: 0xfffff7d5b0000 | Physical addr: 0x582a35b0000
Buffer addr: 0xfffff7d5c0000 | Physical addr: 0x582a3590000
Buffer addr: 0xfffff7d5d0000 | Physical addr: 0x582adbe0000
Buffer addr: 0xfffff7d5e0000 | Physical addr: 0x582ae070000
Buffer addr: 0xfffff7d5f0000 | Physical addr: 0x582adb00000
```

```
read: 0xfffff9744f120
cal addr: 0x5828ab20000
cal addr: 0x582b4730000
cal addr: 0x582b7e00000
cal addr: 0x582bd830000
cal addr: 0x582b4740000
```

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# LBA工具使用说明: --help

```
[root@localhost lba]# hd_write_verify_dump -h
Usage: hd_write_verify_dump [opts] disk|file

-h | --help
-v | --version
-c | --color
-l | --layout
-D | --direct-io
-A | --align-io    on|off      [default: on]
-L | --lba        sector_num [dec/hex value]
-Q | --query      sector_num [dec/hex value]
-C | --cluster     cluster_num [0: unlimit]
-T | --thread      0-9 [hd_write_verify -T N]
-S | --sector      sector_per_cluster [1-2048]
-I | --stripe       disk|file [stripe: 1-64]
-P | --policy      robin|split [default:robin]
-Z | --zero-sectors 0-1024 [default: random]

[EXAMPLES]:
eg: hd_write_verify_dump -c -T 1 /dev/sdX
eg: hd_write_verify_dump -c -D -T 1 /dev/sdX
eg: hd_write_verify_dump -c -D -T 1 -Q lba /dev/sdX
eg: hd_write_verify_dump -c -D -T 1 -C 100 /dev/sdX
eg: hd_write_verify_dump -c -D -T 2 -C 100 -Z 16 /dev/sdX
eg: hd_write_verify_dump -c -D -T 3 -C 100 /path/file.raw
eg: hd_write_verify_dump -c -D -T 1 -I /dev/sdX -I /dev/sdY
eg: hd_write_verify_dump -c -D -T 2 -P robin -I /dev/sdX -I /dev/sdY
eg: hd_write_verify_dump -c -D -T 3 -P split -I /dev/sdX -I /dev/sdY

eg: hd_write_verify_dump -c -D -L 0x0 -C 0 /dev/sdX
eg: hd_write_verify_dump -c -D -L 0x0 -C 100 /dev/sdX
eg: hd_write_verify_dump -c -L 0x8000 -C 100 /path/file.raw
eg: hd_write_verify_dump -c -L 0x8000 -C 100 -I /dev/sdX -I /dev/sdY
eg: hd_write_verify_dump -c -L 0x8000 -C 100 -P robin -I /dev/sdX -I /dev/sdY
eg: hd_write_verify_dump -c -L 0x8000 -C 100 -P split -I /dev/sdX -I /dev/sdY

eg: hd_write_verify_dump -c -D -L 0x0 -S 128 /dev/sdX
eg: hd_write_verify_dump -c -L 0x200 -S 1024 /dev/sdX
eg: hd_write_verify_dump -c -L 0x200 -S 1024 /path/file.raw
eg: hd_write_verify_dump -c -L 0x200 -S 1024 -I /dev/sdX -I /dev/sdY

eg: hd_write_verify_dump -c -D -L 0x10 [-S 1] /dev/sdX
eg: hd_write_verify_dump -c -D -A off -L 0x9 -S 8 /dev/sdX
eg: hd_write_verify_dump -c -D -L 0x10 -S 2048 /dev/sdX
eg: hd_write_verify_dump -c -D -L 0x10 -S 2048 /path/file.raw
eg: hd_write_verify_dump -D -L 10 -S 10 /dev/sdX > /var/dump.log
eg: hd_write_verify_dump -c -D -L 0x100 -S 2048 -I /dev/sdX -I /dev/sdY

[root@localhost lba]#
[root@localhost lba]# hd_write_verify_dump -v
hd_write_verify_dump version 23.07, Copyright (c) 2016-2023 YOUPPLUS
[root@localhost lba]#
```

## hd\_write\_verify -h

测试与校验工具用法与用例

## hd\_write\_verify\_dump -h

校验与查看工具用法与用例

## hd\_write\_verify\_dump -l

数据布局与字段偏移

## 校验数据的三个重要命令:

hd\_write\_verify -c -D -T 1 disk/file

hd\_write\_verify -c -D -T 10 disk/file

hd\_write\_verify\_dump -c -D -T 0-9 disk/file

# LBA工具基本功能演示：hd\_write\_verify工具参数说明

参数	说明
console running (默认)	以前端控制台方式运行(可以交互: 暂停-P键 / 继续-S键 / 退出-Q键)
daemon running (-d   --daemon)	以后端守护进程方式运行, 输出可以重定向到文件
-c   --color	以彩色输出关键信息( <b>突出重点信息</b> )
-D   --direct-io	以direct io方式读写, 否则以pagecache方式读写
-F   --flush	当以pagecache方式读写时, 刷新pagecache缓存
-K   --dmesg	LBA工具关键信息输出到dmesg日志
-A   --align-io on off[default: off]	簇对齐IO(默认: 关闭) --- 开启后, 写IO簇不会被拆分 ( <b>高级功能</b> )
-L   --bwlimit KBPS [KBytes per second]	IO限速, 单位: KB/s
-S   --sector 2-2048 [default: 8]	指定一簇包含多少扇区, LBA工具读写IO以簇为单位
-n   --loop 0-4096 [0: unlimit]	指定测试轮数, 如果设置为0, 表示不限制, 一直循环测试
-T   --thread 0-10 [0: random]	指定工作线程数, 如果设置为0, 表示工作线程数是随机的, 每隔一分钟, 工作的线程会进行切换, 线程数也随机的变换
-V   --verify check once loop random batch all	数据校验方式: <b>循环运行中校验</b> : loop(全盘数据校验), random(随机数据校验), batch(批量数据校验 + 随机数据校验), all(loop + batch) <b>校验完即退出</b> : check(只读全盘数据校验) = loop, once(只读校验一次) = all
-I   --stripe disk file [stripe: 1-64]	条带, 最多支持同时测试64个磁盘/文件, 例如: -I /dev/sda -I /dev/sdb -I /dev/sdc
-P   --policy robin split[default:robin]	条带策略: round-robin 和 cluster-split, 多磁盘/文件测试时, 条带策略才生效 ( <b>高级功能</b> )
其它参数	<b>高级功能, 略</b>

# LBA工具基本功能演示：hd\_write\_verify\_dump工具参数说明

参数	说明
-c   --color	以彩色输出关键信息(突出重点信息)
-l   --layout	输出数据布局和字段偏移及长度
-D   --direct-io	以direct io方式读写, 否则以pagecache方式读写
-A   --align-io on off [default: on]	簇对齐IO(默认: 开启) --- 开启后, 读IO簇对齐; 特殊场景, 需要以小于簇的单位读数据
-L   --lba sector_num [dec/hex value]	指定开始扇区号(支持十进制和十六进制), 读取数据进行校验或者输出查看
-S   --sector sector_per_cluster[1-2048]	簇内数据校验: 指定扇区数 (默认值: 1)
-C   --cluster cluster_num [0: unlimit]	簇间数据校验: 指定校验数据的簇数(例如: -C 100, 从指定的位置开始校验100簇数据), 0: 表示一直校验到末尾 (默认值: 1)
-T   --thread 0-9[hd_write_verify -T N]	线程数据校验(簇间数据校验): 指定线程号; 另: hd_write_verify工具-T参数是指定线程数
-I   --stripe disk file [stripe: 1-64]	条带, 最多支持同时测试64个磁盘/文件, 例如: -I /dev/sda -I /dev/sdb -I /dev/sdc
-P   --policy robin split[default:robin]	条带策略: round-robin 和 cluster-split, 多磁盘/文件测试时, 条带策略才生效 ( <b>高级功能</b> )
-Z   --zero-sectors 0-1024[default: random]	<b>高级功能</b> , 略

# LBA工具基本功能演示：hd\_write\_verify工具输出信息说明

```
[root@localhost lba]# hd_write_verify -c -D -S 1024 -V all -T 10 lba.raw
File Information: 磁盘规格/文件信息
  File: lba.raw
  Size: 4294967296
  Blocks: 0
  IO Block: 65536
  Device: 2051
  Inode: 1678094425
  Links: 1
  File Size: 4294967296 / 4096M / 4.00G

File: lba.raw | Thread: 10 | Total Sectors: 8388608 | Total Clusters: 8192 | Sectors of Cluster: 1024 | DIRECT IO & NO Flush | Verify: 5 | Notify: 0 磁盘/文件信息及生效测试参数

Current Time: 2023-06-06 15:31:05 测试开始时间
Thread 6 [tid: 805477]: Starting check file ...
Thread 7 [tid: 805478]: Starting check file ...
Thread 0 [tid: 805471]: Starting check file ...
Thread 2 [tid: 805473]: Starting check file ...
Thread 9 [tid: 805480]: Starting check file ...
Thread 5 [tid: 805476]: Starting check file ...
Thread 3 [tid: 805474]: Starting check file ...
Thread 1 [tid: 805472]: Starting check file ...
Thread 8 [tid: 805479]: Starting check file ...
Thread 4 [tid: 805475]: Starting check file ... 工作线程: 序号及ID

Starting write file: [Thread ID | Read MB - Write MB]
KEY: <P> = pause, KEY: <S> = start, KEY: <Q> = quit

Loop 1: .
Current Time: 2023-06-06 15:31:05 第1轮测试及开始时间
17, 74 | 34, 72 | 19, 72 | 32, 71 | 20, 72 | 31, 71 | 31, 70 | 29, 72 | 34, 72 | 35, 73 | 统计信息: 10个工作线程, 读写数据量, 单位MB
Pause
Start 测试过程中可交互: 暂停 / 继续 / 退出
105, 129 | 108, 125 | 101, 122 | 107, 121 | 113, 125 | 112, 124 | 107, 121 | 97, 130 | 117, 128 | 119, 130 |
Quit

Current Time: 2023-06-06 15:31:32 测试结束时间
[root@localhost lba]#
```

## 安全测试措施:

### 1. 加锁互斥:

每个磁盘/文件限制为单实例读写测试;

### 2. 文件系统挂载检测:

已挂载文件系统的磁盘不测试, 防止误操作破坏磁盘数据;

### 3. 跨主机测试识别:

通过唯一性flag和时间戳识别测试者, 防止乌龙操作,  
举例: 一个iscsi lun被同时映射到两台主机, 因为没有互斥, 跨主机同时测试同一个lun会导致误判, 乌龙问题还很难排查;

# LBA工具基本功能演示

➤ 完成第一轮存储测试及数据校验，没有检测出数据一致性问题，开始第二轮测试.....第N轮测试

```
Current Time: 2023-06-12 10:54:44
WARNING! [Thread: 0] VERIFY DIFFER FLAGS | filename: lba.raw
PREV LBA: 0x13b8000 - NEXT LBA: 0x321000 flags is different | read[959]

PREV LBA: 0x13b8000 | HF: 0x08001270 F1: 0xbef02254 F2: 0xbda73efe [LOOP: 1 WRITE: 958 SECTOR: 0 / NUM: 2048 / ZERO: 176]
PREV LBA IO Time: 2023-06-12 10:54:00

NEXT LBA: 0x321000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
NEXT LBA IO Time: 1900-01-00 00:00:00
```

```
Current Time: 2023-06-12 10:54:45
WARNING! [Thread: 2] VERIFY DIFFER FLAGS | filename: lba.raw
PREV LBA: 0x2ea000 - NEXT LBA: 0xaa4800 flags is different | read[941]

PREV LBA: 0x2ea000 | HF: 0x08001272 F1: 0xbef02254 F2: 0xe58e1ecd [LOOP: 1 WRITE: 940 SECTOR: 0 / NUM: 2048 / ZERO: 45]
PREV LBA IO Time: 2023-06-12 10:54:00

NEXT LBA: 0xaa4800 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
NEXT LBA IO Time: 1900-01-00 00:00:00
```

```
Current Time: 2023-06-12 10:54:45
WARNING! [Thread: 7] VERIFY DIFFER FLAGS | filename: lba.raw
PREV LBA: 0xbf4800 - NEXT LBA: 0x9c6000 flags is different | read[963]

PREV LBA: 0xbf4800 | HF: 0x08001277 F1: 0xbef02254 F2: 0xe9ba0e40 [LOOP: 1 WRITE: 962 SECTOR: 0 / NUM: 2048 / ZERO: 544]
PREV LBA IO Time: 2023-06-12 10:54:00

NEXT LBA: 0x9c6000 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
NEXT LBA IO Time: 1900-01-00 00:00:00
```

```
Starting write file: Thread ID | Read MB - Write MB |
KEY: <P> = pause, KEY: <S> = start, KEY: <Q> = quit

Loop 2: ..
Current Time: 2023-06-12 10:54:45
0, 708 | 0, 705 | 0, 706 | 0, 731 | 0, 689 | 0, 704 | 0, 709 | 0, 730 | 0, 727 | 0, 703 | □
```

## LBA工具基本功能演示：hd\_write\_verify\_dump工具输出信息说明

```
[root@localhost lba]# hd_write verify_dump -c -D -T 5 lba.raw
File Information: 磁盘规格/文件信息
  File: lba.raw
  Size: 10737418240
  Blocks: 20918840
  IO Block: 65536
  Device: 2051
  Inode: 1678059328
  Links: 1
  File Size: 10737418240 / 10240M / 10.00G

  Sector_Per_Cluster: 2048 簇大小: 2048扇区

  Current Time: 2023-06-12 10:59:31 数据校验开始时间

  =====
  5号线程 本次数据校验共读取827次IO
  WARNING: [Thread: 5] DIFFER FLAGS | read[827] | filename: lba.raw
  LBA_0: 0xaa4800 - LBA_1: 0x754800 flags is different

  LBA地址: 扇区号 硬编码flag、全局魔数、每轮测试魔数 第3轮测试第826次写IO 每簇数据2048扇区, 当前数据簇内偏移0扇
  LBA: 0xaa4800 | HF: 0x080001275 F1: 0xbef02254 F2: 0xd6dfda70 [LOOP: 3 WRITE: 826 SECTOR: 0 / NUM: 2048 / ZERO: 294]
  IO Time: 2023-06-12 10:59:08 LBA工具写入本簇数据的IO时间 高级功能: 全0数据扇区数

  Buffer addr: 0xfffffb16d0000 | Physical addr: 0x3006ebc0000 高级功能: 虚拟地址与物理地址的映射

  LBA LIST: 本簇数据的LBA地址 99个指针: 指向后向节点的LBA地址
  LBA[ 0]: 0x00aa4800 0x00754800 0x012a8800 0x01272000 0x0087c000 0x0011a000 0x00e89000 0x006e6000 0x012ad800
  LBA[10]: 0x00232800 0x00577800 0x001lc800 0x00af800 0x00a7b800 0x0073c000 0x00e4d000 0x00ce6000 0x00e2e000 0x01396800
  LBA[20]: 0x0134c800 0x007c5800 0x0029e800 0x0016c000 0x012e5800 0x00ccf000 0x00a2d000 0x003eb800 0x0125c000 0x0139b600
  LBA[30]: 0x004e0800 0x00b01800 0x00ce7000 0x0069e000 0x013aa800 0x00fecc800 0x00dc2000 0x01241800 0x012a7f000 0x00e5800
  LBA[40]: 0x00b13800 0x008d3000 0x00266800 0x013e6800 0x001lc4000 0x007ec800 0x0053d800 0x010e1800 0x00d0b800 0x00681800
  LBA[50]: 0x00b73800 0x00dc7000 0x01360800 0x01078800 0x0122f000 0x01345800 0x004a1000 0x00746000 0x000c1800 0x011a8000
  LBA[60]: 0x008eb000 0x00dc000 0x00a33800 0x00e62800 0x00bd4800 0x00a4e000 0x002f8800 0x0085a800 0x008ec000 0x00c05800
  LBA[70]: 0x00aa7000 0x007f6800 0x00772800 0x0045800 0x0055a800 0x00893800 0x00109000 0x00563000 0x012b8800 0x013fa000
  LBA[80]: 0x00797800 0x00870800 0x005df000 0x00c7800 0x00e9b800 0x0115c800 0x00ad8000 0x00269800 0x0074f800 0x00dc8800
  LBA[90]: 0x009e3800 0x00751800 0x0038c800 0x00c0b800 0x00dc9800 0x00885000 0x0064f000 0x00e7e800 0x009b0e00 0x0014c800

  PRE LBA LIST: 10个指针: 指向前向节点的LBA地址
  LBA[ 0]: 0x00f0e800 0x01392000 0x0136e800 0x00fea800 0x001ae800 0x01179800 0x00c21800 0x0132d800 0x0077e800 0x00fe4000

  LBA地址: 扇区号 硬编码flag、全局魔数、每轮测试魔数 第2轮测试第333次写IO 每簇数据2048扇区, 当前数据簇内偏移0扇
  LBA: 0x754800 | HF: 0x080001275 F1: 0xbef02254 F2: 0xe2a4clf1 [LOOP: 2 WRITE: 333 SECTOR: 0 / NUM: 2048 / ZERO: 159]
  IO Time: 2023-06-12 10:55:26 LBA工具写入本簇数据的IO时间 高级功能: 全0数据扇区数

  Buffer addr: 0xfffffb17f0000 | Physical addr: 0x3008ce70000 高级功能: 虚拟地址与物理地址的映射

  LBA LIST: 本簇数据的LBA地址 99个指针: 指向后向节点的LBA地址
  LBA[ 0]: 0x000754800 0x01271800 0x00c00000 0x00576800 0x00b3d000 0x00961000 0x00f29800 0x0101f000 0x00cla800 0x00bf4000
  LBA[10]: 0x00980000 0x00bd0000 0x00fd3000 0x00781800 0x00fc9800 0x00336800 0x00add000 0x00c80800 0x008b0800 0x009b0000
  LBA[20]: 0x01388800 0x00e90000 0x00981000 0x01321800 0x01ld7000 0x01084800 0x00aa7000 0x011b0800 0x0067f800 0x00f0f800
  LBA[30]: 0x00731000 0x00ca1000 0x00dc0800 0x00e76000 0x0058f000 0x007f0800 0x00410000 0x0094f000 0x009d1000 0x0032e800
  LBA[40]: 0x00fe7000 0x00e63000 0x01022800 0x008cc800 0x00778000 0x00181000 0x00650800 0x012a9800 0x013f7000 0x00129000
  LBA[50]: 0x0041d000 0x00670000 0x00c82800 0x001cb800 0x00040000 0x00bd7800 0x002c9000 0x00ed0800 0x00844000 0x00f36800
  LBA[60]: 0x005cb800 0x00fe1800 0x00b9d000 0x00d82000 0x00eef3800 0x01ld5000 0x00716000 0x00c1800 0x00897000 0x00438000
  LBA[70]: 0x008e0000 0x01125000 0x009e5800 0x00bdd000 0x009a7000 0x00909800 0x00b29800 0x007cf000 0x0074f800 0x01150800
  LBA[80]: 0x000048000 0x00d79000 0x00cb4800 0x01lc1a000 0x00ae5000 0x00a19000 0x01c5000 0x0078a800 0x00074800 0x00720000
  LBA[90]: 0x01112800 0x00420800 0x00e75000 0x0028f800 0x012le000 0x002e1000 0x00f16000 0x003dc800 0x007a6800 0x00e4b800

  PRE LBA LIST: 10个指针: 指向前向节点的LBA地址
  LBA[ 0]: 0x000667000 0x0059f800 0x00222800 0x009f6000 0x0117d000 0x00768000 0x00ca0800 0x00dbe000 0x007e6000 0x00fb0a000

  =====
  Current Time: 2023-06-12 10:59:41 数据校验结束时间
  [root@localhost lba]#
```

```
DATA LAYOUT:  
=====
```

offsetof HF:	0	[4 bytes]
offsetof MAGIC:	4	[4 bytes]
offsetof PRE_LBA[10]:	8	[40 bytes]
offsetof LBA_LIST[100]:	48	[400 bytes]
offsetof TIME:	448	[56 bytes]
offsetof RANDOM:	504	[4 bytes]
offsetof NUM:	508	[2 bytes]
offsetof INDEX:	510	[2 bytes]

```
=====
```

# LBA工具基本功能演示

- 数据校验错误类型表：(关键字：BUG 00X)

错误类型	参数	校验类型	校验时间	数据校验错误说明
BUG 001[1]	-V random	随机校验：簇间校验	runtime	FLAGS数据校验出错
BUG 001[2]	-V random	随机校验：簇间校验	runtime	LBA_LIST数据校验出错
BUG 002[1]	-V random	随机校验：簇内校验	runtime	非零扇区数据校验出错
BUG 002[2]	-V random	随机校验：簇内校验	runtime	全零扇区数据校验出错
BUG 001[3]	-V batch	批量校验：簇间校验	runtime	FLAGS数据校验出错
BUG 001[4]	-V batch	批量校验：簇间校验	runtime	LBA_LIST数据校验出错
BUG 002[3]	-V batch	批量校验：簇内校验	runtime	非零扇区数据校验出错
BUG 002[4]	-V batch	批量校验：簇内校验	runtime	全零扇区数据校验出错
BUG 003	-V loop	整体校验：簇间校验	runtime & checktime	PRE_LIST数据或者LBA_LIST数据校验出错
BUG 004	-V loop	整体校验：簇间校验	runtime & checktime	中间簇数据丢失
BUG 005	-V loop	整体校验：簇内校验	runtime	第一簇数据魔数出错
BUG 006	-V loop	整体校验：簇间校验	runtime	簇间FLAGS数据校验出错
BUG 007[1]	-V loop	整体校验：簇内校验	runtime & checktime	非零扇区：中间扇区的数据与前后扇区的数据不一致
BUG 007[2]	-V loop	整体校验：簇内校验	runtime & checktime	全零扇区：中间扇区的数据与前后扇区的数据不一致
BUG 007[3]	-V loop	整体校验：簇内校验	runtime & checktime	前后簇数据正确，中间簇非零扇区数据校验出错
BUG 007[4]	-V loop	整体校验：簇内校验	runtime & checktime	前后簇数据正确，中间簇全零扇区数据校验出错

# LBA工具基本功能演示

## ➤ BUG 001[1]: 案例一, inject SECTOR lba bug

批量校验数据, 簇间flag数据不一致

BUG 001[1]: [Thread: 1] RANDOM VERIFY DIFFER FLAGS |

ERROR LBA: 0x794400 | filename: lba.raw

LBA: 0x794400 | thread\_num: 10, bitmap: 0 1 0 0 0 0 0 0 0 0

PREV LBA: 0xe03800 | HF: 0x00401271 F1: 0x76f16720 F2:

0xa09e9c22 [LOOP: 1 WRITE: 951 SECTOR: 0 / NUM: 64 / ZERO: 4]

PREV IO Time: 2023-07-03 19:14:28

LOST LBA: 0x794400 | HF: 0x40404040 F1: 0x40404040 F2:

0x40404040 [LOOP: 1077952576 WRITE: 1077952576 SECTOR:

16448 / NUM: 16448 / ZERO: 1077952576]

LOST IO Time: 1077954476-1077952577-1077952576

NEXT LBA: 0xe22640 | HF: 0x00401271 F1: 0x76f16720 F2:

0xa09e9c22 [LOOP: 1 WRITE: 953 SECTOR: 0 / NUM: 64 / ZERO: 4]

NEXT IO Time: 2023-07-03 19:14:29

---runtime校验

BUG 004: [Thread: 1] DATA LOST | read[953] | filename: lba.raw

PREV LBA: 0xe03800 | LOST LBA: 0x794400 | NEXT LBA: 0xe22640

PREV LBA: 0xe03800 | HF: 0x00401271 F1: 0x76f16720 F2: 0xa09e9c22 [LOOP: 1 WRITE:

PREV IO Time: 2023-07-03 19:14:28

LOST LBA: 0x794400 | HF: 0x40404040 F1: 0x40404040 F2: 0x40404040 [LOOP: 1077952576]

LOST IO Time: 1077954476-1077952577-1077952576 1077952576:1077952576:1077952576

NEXT LBA: 0xe22640 | HF: 0x00401271 F1: 0x76f16720 F2: 0xa09e9c22 [LOOP: 1 WRITE:

NEXT IO Time: 2023-07-03 19:14:29

---checktime校验

Starting write file: Thread ID | Read MB - Write MB |  
KEY: <P> = pause, KEY: <S> = start, KEY: <Q> = quit

Loop 1:

Current Time: 2023-07-03 19:13:29

29, 33 | 30, 33 | 29, 33 | 29, 33 | 28, 32 | 30, 33 | 29, 33 | 30, 33 | 30, 33 | 29, 33 |

Current Time: 2023-07-03 19:14:34

BUG 001[1]: [Thread: 1] RANDOM VERIFY DIFFER FLAGS | ERROR LBA: 0x794400 | filename: lba.raw

LBA: 0x794400 | thread\_num: 10, bitmap: 0 1 0 0 0 0 0 0 0 0

LAST CORRECT WRITE:

LBA: 0x11eb5c0 | HF: 0x00401271 F1: 0x76f16720 F2: 0xa09e9c22 [LOOP: 1 WRITE: 1037 SECTOR: 0 / NUM: 64 / ZERO: 4]

LAST WRITE IO Time: 2023-07-03 19:14:34

Buffer addr: 0xffff8c050000 | Physical addr: 0x481fc130000

LBA LIST:

LBA[ 0]: 0x011eb5c0 0x011e8a00 0x00bb6680 0x00e9d700 0x0075bb00 0x010b8e00 0x01199000 0x008eca00 0x00a4c5c0 0x00f2a340

LBA[10]: 0x00095a00 0x00a75bc0 0x008b9880 0x00d80b00 0x012095c0 0x01358340 0x01236480 0x0119a300 0x01185900 0x00b40f80

LBA[20]: 0x00b4e100 0x00ff9000 0x0029c780 0x00cff900 0x00884200 0x0120bcc0 0x0082d5c0 0x0132ce40 0x00d04700 0x0013c840

LBA[30]: 0x008738c0 0x012ad2c0 0x00184380 0x00adaa00 0x0088abc0 0x00b92000 0x00ae2a80 0x00079c40 0x013b0780 0x00291e00

LBA[40]: 0x005f4e00 0x00c50880 0x010a4640 0x01327f40 0x00dca980 0x0072dec0 0x003bd800 0x00230c80 0x00428c0 0x0021e7c0

LBA[50]: 0x01013300 0x005fe880 0x00044400 0x006aa000 0x00824000 0x009fec00 0x001aacf0 0x00669300 0x00e1b680 0x00c7bbc0

LBA[60]: 0x0047b900 0x00094280 0x005ff040 0x00d40c80 0x00d2c600 0x0102ae40 0x0067b6c0 0x000d7780 0x00dc7e80 0x00365c00

LBA[70]: 0x01337080 0x002f2400 0x0108b600 0x00bdf000 0x00e03700 0x00850f40 0x00a83000 0x0098f2c0 0x001dff00 0x00847c40

LBA[80]: 0x0013a100 0x01175e00 0x013251c0 0x011f2880 0x00e94b00 0x00df3a00 0x0102b200 0x00eebf8c0 0x00a64100 0x0051fd40

LBA[90]: 0x01259900 0x00174640 0x000bab00 0x00629680 0x004fdf40 0x000d537c0 0x010a9cc0 0x00524200 0x00da4f00 0x00851fc0

PRE LBA LIST:

LBA[ 0]: 0x0100c980 0x00e4ab80 0x00a03500 0x00c28e80 0x007e5580 0x00acb080 0x00d30c00 0x00b215c0 0x001cf300 0x00384500

DETECT READ ERROR:

LBA: 0x794400 | HF: 0x40404040 F1: 0x40404040 F2: 0x40404040 [LOOP: 1077952576 WRITE: 1077952576 SECTOR: 16448 / NUM: 16448]

DETECT ERROR IO Time: 1077954476-1077952577-1077952576 1077952576:1077952576:1077952576

Buffer addr: 0xffff8c070000 | Physical addr: 0x481cdc80000

LBA LIST:

LBA[ 0]: 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040

LBA[10]: 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040

LBA[20]: 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040

LBA[30]: 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040

LBA[40]: 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040

LBA[50]: 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040

LBA[60]: 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040

LBA[70]: 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040

LBA[80]: 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040

LBA[90]: 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040

PRE LBA LIST:

LBA[ 0]: 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040 0x40404040

Current Time: 2023-07-03 19:14:34

pause\_and\_exit\_work: Press KEY: <Q> to exit!

# LBA工具基本功能演示

## ➤ BUG 001[1]: 案例二, inject FLAG lba bug

随机校验数据, 簇间flag数据不一致

BUG 001[1]: [Thread: 0] RANDOM VERIFY DIFFER FLAGS |  
ERROR LBA: 0x0 | filename: test.raw

LBA: 0x0 | thread\_num: 10, bitmap: 1 0 0 0 0 0 0 0 0 0

Line: 2572 | HF: 0x4001270 != hd\_flag: 0x400ffff, sector\_num: 1024

LBA: 0x0 | HF: 0x0400ffff F1: 0x523f39d9 F2: 0xf71538a0 [LOOP: 1  
WRITE: 1 SECTOR: 0 / NUM: 1024 / ZERO: 255]  
IO Time: 2023-07-09 23:33:05

---runtime校验

Line: 2572 | HF: 0x4001270 != hd\_flag: 0x400ffff, sector\_num: 1024  
LBA: 0x0 | HF: 0x0400ffff F1: 0x523f39d9 F2: 0xf71538a0 [LOOP: 1 WRITE: 1 SECTOR: 0 / NUM: 1024 /  
IO Time: 2023-07-09 23:33:05

Buffer addr: 0x1f810000 | Physical addr: 0x302d2550000

LBA LIST:  
LBA[ 0]: 0x00000000 0x006c6c00 0x002a6000 0x00565000 0x0049bc00 0x00659000 0x007fe000 0x004c0000  
LBA[10]: 0x00198c00 0x004e8400 0x003f800 0x00530000 0x00738000 0x00239800 0x007a5800 0x00080400  
LBA[20]: 0x000cd400 0x0060b800 0x00242000 0x0018a800 0x00080000 0x0041fc00 0x000207000 0x00618000  
LBA[30]: 0x005a5400 0x00091400 0x002e9400 0x0044fc00 0x00050000 0x004f9c00 0x0049a800 0x00320000  
LBA[40]: 0x004bc000 0x006c9000 0x005fd000 0x00497000 0x00142000 0x005f1800 0x00320800 0x001b5800  
LBA[50]: 0x00675800 0x00739c00 0x00245000 0x00378400 0x00198000 0x0009b800 0x002f4c00 0x005a3400 0x00150400  
LBA[60]: 0x002e4000 0x007e4000 0x00036400 0x005ff000 0x001f3800 0x00410c00 0x00329800 0x00450400  
LBA[70]: 0x004c1000 0x003ed000 0x0047f000 0x00279c00 0x000410c00 0x00329800 0x00450400 0x003e8400 0x0076d400  
LBA[80]: 0x00182000 0x00036800 0x000b0000 0x0064f000 0x005f7000 0x00367000 0x004fc000 0x0022ac00  
LBA[90]: 0x0028e800 0x0010a000 0x006bd800 0x0060a000 0x0057a400 0x00530c00 0x0067a000 0x0051f800

PRE LBA LIST:  
LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

---checktime校验

158, 165 | 175, 170 | 160, 156 | 162, 174 | 164, 166 | 153, 160 | 182, 172 | 171, 164 | 189, 176 | 157, 166 |

Current Time: 2023-07-09 23:36:12  
BUG 001[1]: [Thread: 0] RANDOM VERIFY DIFFER FLAGS | ERROR LBA: 0x0 | filename: test.raw  
LBA: 0x0 | thread\_num: 10, bitmap: 1 0 0 0 0 0 0 0 0 0

LAST CORRECT WRITE:  
LBA: 0x4b5000 | HF: 0x4001270 F1: 0x523f39d9 F2: 0xf71538a0 [LOOP: 1 WRITE: 282 SECTOR: 0 / NUM: 1024 / ZERO: 255]  
LAST WRITE IO Time: 2023-07-09 23:36:09

Buffer addr: 0xfffffb80f0000 | Physical addr: 0x183ef3e0000

LBA LIST:  
LBA[ 0]: 0x004b5000 0x001c4000 0x0053e000 0x00685800 0x000d4c00 0x0038d800 0x003e9000 0x001f1800 0x00623000 0x003d4800  
LBA[10]: 0x005eac00 0x005c0000 0x0073c000 0x005c1000 0x002d8400 0x00352800 0x007ff000 0x002b9000 0x004c0c00 0x00067400  
LBA[20]: 0x00228400 0x0015a800 0x00617c00 0x0055f000 0x00055400 0x0036a000 0x00651c00 0x0074b800 0x00342000 0x00783400  
LBA[30]: 0x004eac00 0x00179c00 0x007dbc00 0x004c9800 0x0017c400 0x00143000 0x004a6c00 0x00118c00 0x00456000 0x003b1800  
LBA[40]: 0x005bc800 0x005dd400 0x004c3400 0x00296000 0x001d0400 0x004d9800 0x00009800 0x002cf400 0x007e0800 0x00185000  
LBA[50]: 0x0032b000 0x0079ac00 0x00144c00 0x006d5400 0x00771800 0x006a9800 0x0008c800 0x005ac800 0x002c3400 0x00611400  
LBA[60]: 0x003a1400 0x007b9c00 0x006c7800 0x004b5c00 0x003elc00 0x00434c00 0x00289c00 0x00020000 0x0042dc00 0x00423400  
LBA[70]: 0x006dbc00 0x004e7000 0x002c1400 0x00420400 0x0015c000 0x00652400 0x004e0400 0x004d7000 0x00242c00 0x00693000  
LBA[80]: 0x00539400 0x0040f400 0x0009c000 0x00401000 0x007e5800 0x00211800 0x00330000 0x00409400 0x004df000 0x0056c400  
LBA[90]: 0x0053a000 0x00377800 0x005fa400 0x00593800 0x0035e400 0x003cac00 0x003a4000 0x007b2400 0x0024e000 0x001aac00

PRE LBA LIST:  
LBA[ 0]: 0x0009e000 0x001d6800 0x006d2c00 0x00780800 0x00345800 0x00085000 0x002e2c00 0x00437000 0x005fc400 0x0014c800

DETECT READ ERROR:  
LBA: 0x0 | HF: 0x0400ffff F1: 0x523f39d9 F2: 0xf71538a0 [LOOP: 1 WRITE: 1 SECTOR: 0 / NUM: 1024 / ZERO: 255]  
DETECT ERROR IO Time: 2023-07-09 23:33:05

Buffer addr: 0xfffff9aa00000 | Physical addr: 0x181aca30000

LBA LIST:  
LBA[ 0]: 0x00000000 0x006c6c00 0x002a6000 0x00565000 0x0049bc00 0x00659000 0x007fe000 0x004c0000 0x0062f800 0x0019b000  
LBA[10]: 0x00198c00 0x004e8400 0x003f800 0x00530000 0x00738000 0x00239800 0x007a5800 0x00080400 0x0049f000 0x001cb800  
LBA[20]: 0x000cd400 0x0060b800 0x00242000 0x0018a800 0x00080000 0x0041fc00 0x000207000 0x00618000 0x005e6000 0x00101000  
LBA[30]: 0x005a5400 0x00091400 0x002e9400 0x0044fc00 0x00050000 0x004f9c00 0x0049a800 0x00320000 0x007ef400 0x00329000  
LBA[40]: 0x004bc000 0x006c9000 0x005fd000 0x00497000 0x00142000 0x005f1800 0x00320800 0x001b5800 0x0043e800 0x0076f800  
LBA[50]: 0x00675800 0x00739c00 0x00245000 0x00378400 0x00198000 0x0009b800 0x002f4c00 0x005a3400 0x0064fc00 0x00150400  
LBA[60]: 0x002e4000 0x007e4000 0x00036400 0x005ff000 0x001f3800 0x00410c00 0x00329800 0x00450400 0x003e8400 0x0076d400  
LBA[70]: 0x004c1000 0x003ed000 0x0047f000 0x00279c00 0x000410c00 0x00329800 0x00450400 0x003e8400 0x0076d400  
LBA[80]: 0x00182000 0x00036800 0x000b0000 0x0064f000 0x005f7000 0x00367000 0x004fc000 0x0022ac00 0x0014b400 0x001cb400  
LBA[90]: 0x0028e800 0x0010a000 0x006bd800 0x0060a000 0x0057a400 0x00530c00 0x0067a000 0x0051f800 0x0035800 0x00768400

PRE LBA LIST:  
LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

Current Time: 2023-07-09 23:36:12

pause\_and\_exit\_work: Press KEY: <Q> to exit!

# LBA工具基本功能演示

## ➤ BUG 001[2]: 案例一, inject LIST lba bug

随机校验数据, 簇间list数据不一致

BUG 001[2]: [Thread: 3] RANDOM VERIFY DIFFER LBA\_LIST  
| ERROR LBA: 0x28c00 | filename: lba.raw  
LBA: 0x28c00 | thread\_num: 10, bitmap: 0 0 0 1 0 0 0 0 0 0

CORRECT LBA: 0x1c3480 | HF: 0x00801273 F1: 0x9c38fb9 F2:  
0x16672d2a [LOOP: 1 WRITE: 138 SECTOR: 0 / NUM: 128 / ZERO: 2]  
CORRECT LBA IO Time: 2023-07-04 01:13:15

ERROR LBA: 0x28c00 | HF: 0x00801273 F1: 0x9c38fb9 F2:  
0x16672d2a [LOOP: 1 WRITE: 139 SECTOR: 0 / NUM: 128 / ZERO: 2]  
ERROR LBA IO Time: 2023-07-04 01:13:16

---runtime校验

BUG 003: [Thread: 3] WRITE PART SECTOR | read[139] | filename: lba.raw  
CORRECT LBA: 0x1c3480 | HF: 0x00801273 F1: 0x9c38fb9 F2: 0x16672d2a [LOOP:  
CORRECT LBA IO Time: 2023-07-04 01:13:15  
ERROR LBA: 0x28c00 | HF: 0x00801273 F1: 0x9c38fb9 F2: 0x16672d2a [LOOP: 1 W  
ERROR LBA IO Time: 2023-07-04 01:13:16

---checktime校验

Starting write file: Thread ID | Read MB - Write MB |  
KEY: <P> = pause, KEY: <S> = start, KEY: <Q> = quit  
Loop 1: .  
Current Time: 2023-07-04 01:13:06  
8, 14 | 9, 15 | 8, 14 | 8, 15 | 8, 14 | 7, 15 | 6, 15 | 8, 14 | 8, 14 | 8, 15 |  
  
Current Time: 2023-07-04 01:13:20  
BUG 001[2]: [Thread: 3] RANDOM VERIFY DIFFER LBA\_LIST | ERROR LBA: 0x28c00 | filename: lba.raw  
LBA: 0x28c00 | thread\_num: 10, bitmap: 0 0 0 1 0 0 0 0 0 0  
  
LAST CORRECT WRITE:  
LBA: 0x156280 | HF: 0x00801273 F1: 0x9c38fb9 F2: 0x16672d2a [LOOP: 1 WRITE: 193 SECTOR: 0 / NUM: 128 / ZERO: 2]  
LAST WRITE IO Time: 2023-07-04 01:13:19  
  
Buffer addr: 0xfffff8c030000 | Physical addr: 0x383dfe30000  
  
LBA LIST:  
LBA[ 0]: 0x00156280 0x0007a800 0x000le900 0x00123d00 0x000d3d80 0x001a9a00 0x001cd900 0x00077800 0x001fac80 0x001bd280  
LBA[10]: 0x00103800 0x000ef900 0x00082000 0x001c0080 0x000d1580 0x0007c600 0x001b0f00 0x0000b400 0x00009100 0x00160900  
LBA[20]: 0x00007000 0x0012c380 0x000e8780 0x0009b580 0x00173a80 0x0009a100 0x00080f00 0x0006ea80 0x001d1400 0x00042780  
LBA[30]: 0x000ca600 0x00081100 0x001a2300 0x0012b980 0x00061e80 0x000af080 0x00123800 0x00096f80 0x000bcd00 0x001c3d00  
LBA[40]: 0x00152500 0x0013a100 0x000f9c00 0x0007fd80 0x00102000 0x0006f300 0x00170900 0x001b9580 0x00084f00 0x0014c400  
LBA[50]: 0x001f0780 0x0001f400 0x000196c00 0x001b5e00 0x00075a80 0x00193a00 0x0011c600 0x0018b880 0x00011c00 0x000fd700  
LBA[60]: 0x00090280 0x0014ba00 0x00045a00 0x0002a680 0x0019d200 0x00060400 0x000d3780 0x00033980 0x000d4c00 0x00194400  
LBA[70]: 0x000a5600 0x00163400 0x00064300 0x00121b00 0x000fbc00 0x00130700 0x00046080 0x0005b900 0x00130d80 0x00013800  
LBA[80]: 0x0001b80 0x001e3980 0x0006ee00 0x00107480 0x000a9600 0x000ae180 0x00178b80 0x001c0180 0x001e1000 0x0005ed00  
LBA[90]: 0x00104680 0x0015c400 0x0012e000 0x000b3b80 0x0015cf80 0x000ba080 0x00072880 0x001ce080 0x001cdde00 0x0004e000  
  
PRE LBA LIST:  
LBA[ 0]: 0x0006ae00 0x000f2680 0x00197080 0x000e7400 0x00020900 0x00084700 0x0014c200 0x001a7200 0x001c1580 0x000ae700  
  
DETECT READ ERROR:  
LBA: 0x28c00 | HF: 0x00801273 F1: 0x9c38fb9 F2: 0x16672d2a [LOOP: 1 WRITE: 139 SECTOR: 0 / NUM: 128 / ZERO: 2]  
DETECT ERROR IO Time: 2023-07-04 01:13:16  
  
Buffer addr: 0xfffff9c300000 | Physical addr: 0x383774a0000  
  
LBA LIST:  
LBA[ 0]: 0x00028c00 0x0009da80 0x000d0700 0x00135b00 0x00008000 0x00141480 0x000d9000 0x001ff300 0x00033d80 0x000bc300  
LBA[10]: 0x001ed600 0x00077580 0x0007d500 0x0010ac80 0x000ad400 0x001a0700 0x00167b80 0x00172b80 0x00055d00 0x0003f980  
LBA[20]: 0x001c9080 0x00054180 0x000bcb80 0x000f2e00 0x00111700 0x00118d00 0x0003e800 0x00087000 0x00129d00 0x000fb180  
LBA[30]: 0x00087280 0x00020400 0x00107600 0x001db000 0x001bef80 0x00085480 0x0015d980 0x000e7680 0x00187b00 0x001f3800  
LBA[40]: 0x00130000 0x000e8680 0x001a8e80 0x001f2600 0x000ae700 0x001c1580 0x001a7200 0x0014c200 0x00084700 0x00020900  
LBA[50]: 0x000e7400 0x000197080 0x000f2680 0x0006ae00 0xce462e3e 0x00007a80 0x0001e900 0x00123d00 0x000d3d80 0x001a9a00  
LBA[60]: 0x001cd900 0x00077800 0x001fac80 0x001bd280 0x00103800 0x000ef900 0x00082000 0x001c0080 0x000d1580 0x0007c600  
LBA[70]: 0x001b0f00 0x0000b400 0x00009100 0x00160900 0x00007000 0x0012c380 0x000e8780 0x0009b580 0x00173a80 0x0009a100  
LBA[80]: 0x00080f00 0x0006ea80 0x001d1400 0x00042780 0x000ca600 0x00081100 0x001a2300 0x0012b980 0x00061e80 0x000af080  
LBA[90]: 0x00123800 0x00096f80 0x000bdcc0 0x001c3d00 0x00152500 0x0013a100 0x000f9c00 0x0007fd80 0x00102000 0x0006f300  
  
PRE LBA LIST:  
LBA[ 0]: 0x001c3480 0x001b3400 0x00050800 0x00032500 0x00199500 0x0014f100 0x0007b580 0x00138600 0x0006bf00 0x00043500  
  
Current Time: 2023-07-04 01:13:20  
pause\_and\_exit\_work: Press KEY: <Q> to exit!

# LBA工具基本功能演示

## ➤ BUG 001[2]: 案例二, inject LIST lba bug

随机校验数据, 簇间list数据不一致

BUG 001[2]: [Thread: 7] RANDOM VERIFY DIFFER LBA\_LIST

| ERROR LBA: 0x380 | filename: lba.raw

LBA: 0x380 | thread\_num: 10, bitmap: 0 0 0 0 0 0 0 1 0 0

CORRECT LBA[0]: 0x380 | HF: 0x00801277 F1: 0x87ae66e6 F2:

0x2cdf9a00 [LOOP: 6 WRITE: 1 SECTOR: 0 / NUM: 128 / ZERO: 14]

CORRECT IO Time: 2023-07-04 01:13:00

ERROR LBA[1]: 0x381 | HF: 0x00801277 F1: 0x87ae66e6 F2:

0x2cdf9a00 [LOOP: 6 WRITE: 1 SECTOR: 1 / NUM: 128 / ZERO: 14]

INCONSISTENT IO Time: 2023-07-04 01:13:00

NEXT LBA: 0xe0000 | HF: 0x00801277 F1: 0x87ae66e6 F2:

0x2cdf9a00 [LOOP: 6 WRITE: 2 SECTOR: 0 / NUM: 128 / ZERO: 14]

NEXT IO Time: 2023-07-04 01:13:00

---runtime校验

BUG 007[3]: [Thread: 7] VERIFY SECTOR[1] DIFFER: 113 | read[2] | filename: lba.raw

hd\_write\_verify\_dump -c -D -L 0x00000000 disk/file  
hd\_write\_verify\_dump -c -D -L 0x000e0000 disk/file

CORRECT LBA[0]: 0x380 | HF: 0x00801277 F1: 0x87ae66e6 F2: 0x2cdf9a00 [LOOP: 6 WRITE: 1 SECTOR: 0 / NUM: 128 / ZERO: 14]  
CORRECT IO Time: 2023-07-04 01:13:00

ERROR LBA[1]: 0x381 | HF: 0x00801277 F1: 0x87ae66e6 F2: 0x2cdf9a00 [LOOP: 6 WRITE: 1 SECTOR: 1 / NUM: 128 / ZERO: 14]  
INCONSISTENT IO Time: 2023-07-04 01:13:00

NEXT LBA: 0xe0000 | HF: 0x00801277 F1: 0x87ae66e6 F2: 0x2cdf9a00 [LOOP: 6 WRITE: 2 SECTOR: 0 / NUM: 128 / ZERO: 14]  
NEXT IO Time: 2023-07-04 01:13:00

---checktime校验

Starting write file: Thread ID | Read MB - Write MB |  
KEY: <P> = pause, KEY: <S> = start, KEY: <Q> = quit

Loop 5: .....

Current Time: 2023-07-04 01:12:44

58, 65 | 59, 67 | 58, 65 | 57, 64 | 58, 64 | 58, 65 | 58, 65 | 60, 66 | 60, 66 | 55, 61 |

Current Time: 2023-07-04 01:13:00

Starting write file: Thread ID | Read MB - Write MB |

KEY: <P> = pause, KEY: <S> = start, KEY: <Q> = quit

Loop 6: .....

Current Time: 2023-07-04 01:13:00

Current Time: 2023-07-04 01:13:00

BUG 001[2]: [Thread: 7] RANDOM VERIFY DIFFER LBA LIST | ERROR LBA: 0x380 | filename: lba.raw  
LBA: 0x380 | thread\_num: 10, bitmap: 0 0 0 0 0 0 0 1 0 0

LAST CORRECT WRITE:

LBA: 0x5fa80 | HF: 0x00801277 F1: 0x87ae66e6 F2: 0x2cdf9a00 [LOOP: 6 WRITE: 30 SECTOR: 0 / NUM: 128 / ZERO: 14]

LAST WRITE IO Time: 2023-07-04 01:13:00

Buffer addr: 0xffffd04030000 | Physical addr: 0x23503c0000

LBA LIST:

LBA[ 0]: 0x0005fa80 0x0004c000 0x00123c00 0x00080000 0x001bb000 0x00008200 0x001lecc00 0x000dc800 0x00148700 0x00126500  
LBA[10]: 0x00084000 0x0000fe00 0x00146200 0x00089000 0x001ad500 0x00069e00 0x00126000 0x0003f400 0x00178200 0x001de900  
LBA[20]: 0x001fe00 0x00189080 0x0002a880 0x001b7400 0x000ceaa0 0x000b4180 0x00016880 0x00011b80 0x000e2000 0x001c8680  
LBA[30]: 0x00061e00 0x00021f00 0x00179980 0x00034e80 0x0012ff00 0x0008c680 0x001fcf00 0x00056080 0x0006c300 0x001d6280  
LBA[40]: 0x001d9380 0x00167000 0x0008c400 0x00191400 0x001b0800 0x001d1l00 0x001le6d00 0x00192c80 0x00181480 0x001fb800  
LBA[50]: 0x0019c200 0x0000b4200 0x000a0280 0x00014800 0x000c9600 0x0016a000 0x001f7800 0x0015a100 0x00050280 0x00164000  
LBA[60]: 0x0012e780 0x0000e900 0x0016e600 0x0001d400 0x0010ee00 0x00140100 0x00021e00 0x0006100 0x00152680 0x00110000  
LBA[70]: 0x000e0400 0x00140180 0x00026500 0x001e5400 0x000cc700 0x0010d800 0x00115180 0x0014da00 0x00021000 0x001d2e80  
LBA[80]: 0x000b5b80 0x00086380 0x00181400 0x00066280 0x00058a80 0x00005700 0x00090a80 0x0019db80 0x001d3a00 0x0007e080  
LBA[90]: 0x00092100 0x00045680 0x000144300 0x0007f1680 0x000da300 0x001fbcc0 0x00186d00 0x0018680 0x001bad80 0x000be280

PRE LBA LIST:

LBA[ 0]: 0x00007e00 0x0017c000 0x0007a000 0x00035000 0x000f3400 0x00090d80 0x000e2200 0x000f3b80 0x00031480 0x001db400

DETECT READ ERROR:

LBA: 0x380 | HF: 0x00801277 F1: 0x87ae66e6 F2: 0x2cdf9a00 [LOOP: 6 WRITE: 1 SECTOR: 0 / NUM: 128 / ZERO: 14]

DETECT ERROR IO Time: 2023-07-04 01:13:00

Buffer addr: 0xffffeee30000 | Physical addr: 0x24b3ba0000

LBA LIST:

LBA[ 0]: 0x00000380 0x000e0000 0x000d7900 0x00064880 0x001c2600 0x0002fa00 0x0007f880 0x00042200 0x0010ed80 0x0015ec00  
LBA[10]: 0x001b1800 0x0010a980 0x001c3e00 0x0011l800 0x0012ad80 0x0002c900 0x0010e880 0x00071800 0x001c6000 0x001d4000  
LBA[20]: 0x00031480 0x000fb380 0x000e2200 0x0009d80 0x000f3400 0x00035000 0x0007a000 0x0017c000 0x00007e00 0x0005f800  
LBA[30]: 0x0004c000 0x00123c00 0x00080000 0x001bb000 0x00008200 0x0001lecc00 0x000dc800 0x00148700 0x00126500 0x00084000  
LBA[40]: 0x000fe00 0x00146200 0x00008900 0x001ad500 0x00069e00 0x00126000 0x0003f400 0x00178200 0x001de900 0x0011f800  
LBA[50]: 0x00189080 0x0002a880 0x001b7400 0x000ceaa0 0x000b4180 0x00016880 0x00011b80 0x000e2000 0x001c8680 0x00061e00  
LBA[60]: 0x00021f00 0x00179980 0x00034e80 0x0012ff00 0x0008c680 0x001fcf00 0x00056080 0x0006c300 0x001d6280 0x00193800  
LBA[70]: 0x00167000 0x0000b4200 0x000a0280 0x00014800 0x000c9600 0x0016a000 0x001f7800 0x0015a100 0x00050280 0x00164000  
LBA[80]: 0x000b5b80 0x00086380 0x00181400 0x00066280 0x00058a80 0x00005700 0x00090a80 0x0019db80 0x001d3a00 0x0007e080  
LBA[90]: 0x00090900 0x0016e600 0x0001d400 0x0010e000 0x00140100 0x00021e00 0x0006100 0x00152680 0x00110000 0x000e0400

PRE LBA LIST:

LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

Current Time: 2023-07-04 01:13:00

pause\_and\_exit\_work: Press KEY: <Q> to exit!

# LBA工具基本功能演示

## ➤ BUG 001[3]: 批量校验数据，簇间flag数据不一致

BUG 001[3]: [Thread: 1] BATCH VERIFY DIFFER FLAGS  
| ERROR LBA: 0x4f5000  
| filename: lba.raw

PREV LBA: 0x24cc00 | HF: 0x04001271 F1: 0xda8a6f04 F2:  
0x51043500 [LOOP: 1 WRITE: 404 SECTOR: 0 / NUM: 1024 /  
ZERO: 106]  
PREV IO Time: 2023-06-25 20:11:47

LOST LBA: 0x4f5000 | HF: 0xb0b0b0b0 F1: 0xb0b0b0b0 F2:  
0xb0b0b0b0 [LOOP: 2964369584 WRITE: 2964369584 SECTOR:  
45232 / NUM: 45232 / ZERO: 2964369584]  
LOST IO Time: -1330595812--1330597711--1330597712 -  
1330597712:-1330597712:-1330597712

NEXT LBA: 0x2c6400 | HF: 0x04001271 F1: 0xda8a6f04 F2:  
0x51043500 [LOOP: 1 WRITE: 406 SECTOR: 0 / NUM: 1024 /  
ZERO: 106]  
NEXT IO Time: 2023-06-25 20:11:48

---runtime校验

BUG 004: [Thread: 1] DATA LOST | read[406] | filename: lba.raw  
PREV LBA: 0x24cc00 | LOST LBA: 0x4f5000 | NEXT LBA: 0x2c6400

PREV LBA: 0x24cc00 | HF: 0x04001271 F1: 0xda8a6f04 F2: 0x51043500 [LOOP: 1 WRITE: 404 SECTOR: 0 / NUM: 1024 / ZI  
PREV IO Time: 2023-06-25 20:11:47

LOST LBA: 0x4f5000 | HF: 0xb0b0b0b0 F1: 0xb0b0b0b0 F2: 0xb0b0b0b0 [LOOP: 2964369584 WRITE: 2964369584 SECTOR: 4 PRE  
LBA LIST:

LOST IO Time: -1330595812--1330597711--1330597712--1330597712--1330597712

NEXT LBA: 0x2c6400 | HF: 0x04001271 F1: 0xda8a6f04 F2: 0x51043500 [LOOP: 1 WRITE: 406 SECTOR: 0 / NUM: 1024 / ZI  
NEXT IO Time: 2023-06-25 20:11:48

```
Starting write file: Thread ID | Read MB - Write MB |
KEY: <P> = pause, KEY: <S> = start, KEY: <Q> = quit

Loop 1: .
Current Time: 2023-06-25 20:10:48
270, 230 | 292, 245 | 273, 232 | 260, 245 | 276, 234 | 270, 249 | 283, 239 | 274, 253 | 277, 243 | 270, 237 |

Current Time: 2023-06-25 20:11:49
BUG 001[3]: [Thread: 1] BATCH VERIFY DIFFER FLAGS | ERROR LBA: 0x4f5000 | filename: lba.raw
LBA: 0x4f5000 | thread_num: 10, bitmap: 0 1 0 0 0 0 0 0 0 0

LAST CORRECT WRITE:
LBA: 0x2c6400 | HF: 0x04001271 F1: 0xda8a6f04 F2: 0x51043500 [LOOP: 1 WRITE: 406 SECTOR: 0 / NUM: 1024 / ZERO: 106]
LAST WRITE IO Time: 2023-06-25 20:11:48

Buffer addr: 0xfffff98090000 | Physical addr: 0x58218d50000

LBA LIST:
LBA[ 0]: 0x002c6400 0x001d0800 0x0054ec00 0x00661400 0x00380800 0x00464800 0x0065ec00 0x005da800 0x00241c00 0x003bc800
LBA[10]: 0x006b6000 0x00105c00 0x0020e400 0x003b1400 0x0027cc00 0x000b7c00 0x005d4000 0x00301800 0x001e6800 0x004b8800
LBA[20]: 0x003c4400 0x00029000 0x0025c00 0x00057000 0x00531800 0x002fc000 0x00631800 0x005b5000 0x0050a000 0x004a8000
LBA[30]: 0x002af000 0x004fc00 0x00581c00 0x00060000 0x0037b400 0x0008fc00 0x003cf800 0x007a5400 0x003db400 0x00799400
LBA[40]: 0x002bf000 0x003e7c00 0x000e7800 0x005ea800 0x0013ec00 0x003c6400 0x00070000 0x00130000 0x002cac00 0x001d400
LBA[50]: 0x00446800 0x00787000 0x0072ac00 0x002a6800 0x002c2800 0x00231800 0x002c700 0x007a0c00 0x007b7000 0x007a8400
LBA[60]: 0x00452400 0x0054d000 0x00389000 0x002c5800 0x0002c5800 0x00556c00 0x00081800 0x007ac800 0x0046e800 0x00166c00
LBA[70]: 0x00bb0800 0x00600c00 0x002d6800 0x00131c00 0x001a9c00 0x007ed000 0x001f1c00 0x0046a800 0x0008b000 0x00125800
LBA[80]: 0x00723800 0x00574c00 0x00753800 0x006a3400 0x004a9400 0x00283c00 0x00484c00 0x006d9400 0x0024a400 0x00106000
LBA[90]: 0x00ee8400 0x00234400 0x00490400 0x0055f000 0x00758000 0x00512c00 0x002c200 0x000c2800 0x007be400 0x00366400

PRE LBA LIST:
LBA[ 0]: 0x004f5000 0x0024cc00 0x007f8800 0x003fe000 0x0002c400 0x0033f800 0x007a4c00 0x007aac00 0x001a5c00 0x003f6000

DETECT READ ERROR:
LBA: 0x4f5000 | HF: 0xb0b0b0b0 F1: 0xb0b0b0b0 F2: 0xb0b0b0b0 [LOOP: 2964369584 WRITE: 2964369584 SECTOR: 45232 / NUM: 45232 / ZERO: 2964369584]
DETECT ERROR IO Time: -1330595812--1330597711--1330597712 -1330597712:-1330597712:-1330597712

Buffer addr: 0xfffff6fd90000 | Physical addr: 0x50298440000

LBA LIST:
LBA[ 0]: 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0
LBA[10]: 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0
LBA[20]: 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0
LBA[30]: 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0
LBA[40]: 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0
LBA[50]: 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0
LBA[60]: 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0
LBA[70]: 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0
LBA[80]: 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0
LBA[90]: 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0

PRE LBA LIST:
LBA[ 0]: 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0 0xb0b0b0b0
```

Current Time: 2023-06-25 20:11:49

pause\_and\_exit\_work: Press KEY: <0> to exit!

---checktime校验

# LBA工具基本功能演示

## ➤ BUG 001[4]: 批量校验数据，簇间list数据不一致

BUG 001[4]: [Thread: 9] BATCH VERIFY DIFFER LBA\_LIST | ERROR LBA: 0x404800 | filename: lba.raw  
LBA: 0x404800 | thread\_num: 10, bitmap: 0 0 0 0 0 0 0 0 0 1

CORRECT LBA: 0x454400 | HF: 0x04001279 F1:  
0x47877c66 F2: 0x92e7f068 [LOOP: 1 WRITE: 406  
SECTOR: 0 / NUM: 1024 / ZERO: 176]  
CORRECT LBA IO Time: 2023-06-26 00:22:20

ERROR LBA: 0x404800 | HF: 0x04001279 F1: 0x47877c66  
F2: 0x92e7f068 [LOOP: 1 WRITE: 407 SECTOR: 0 / NUM:  
1024 / ZERO: 176]  
ERROR LBA IO Time: 2023-06-26 00:22:21

---runtime校验

BUG 003: [Thread: 9] WRITE PART SECTOR | read[407] | filename: lba.raw

CORRECT LBA: 0x454400 | HF: 0x04001279 F1: 0x47877c66 F2: 0x92e7f068 [LOOP: 1 WRITE: 406 SECT  
CORRECT LBA IO Time: 2023-06-26 00:22:20

ERROR LBA: 0x404800 | HF: 0x04001279 F1: 0x47877c66 F2: 0x92e7f068 [LOOP: 1 WRITE: 407 SECTOR: PRE LBA LIST:  
ERROR LBA IO Time: 2023-06-26 00:22:21

---checktime校验

362, 292 | 373, 301 | 365, 294 | 355, 298 | 365, 294 | 351, 292 | 361, 308 | 357, 293 | 354, 292 | 360, 303 |

Current Time: 2023-06-26 00:22:23  
BUG 001[4]: [Thread: 9] BATCH VERIFY DIFFER LBA\_LIST | ERROR LBA: 0x404800 | filename: lba.raw  
LBA: 0x404800 | thread\_num: 10, bitmap: 0 0 0 0 0 0 0 0 0 1

LAST CORRECT WRITE:  
LBA: 0x17b000 | HF: 0x04001279 F1: 0x47877c66 F2: 0x92e7f068 [LOOP: 1 WRITE: 416 SECTOR: 0 / NUM: 1024 / ZERO: 176]  
LAST WRITE IO Time: 2023-06-26 00:22:21

Buffer addr: 0xfffff756e0000 | Physical addr: 0x3811c9f0000

LBA LIST:  
LBA[ 0]: 0x0017b000 0x003eac00 0x00021800 0x003cec00 0x0006fc00 0x00697800 0x007c8800 0x002cc000 0x004c6c00 0x0077f400  
LBA[10]: 0x00639800 0x0022c400 0x002ea400 0x000fe000 0x001be000 0x000a0400 0x000a4c00 0x00124000 0x0014f800 0x0054e000  
LBA[20]: 0x00260800 0x007b9000 0x00301400 [0x006alc00] 0x006e3c00 0x00162000 0x002be800 0x00199400 0x003ca000 0x004e8c00  
LBA[30]: 0x001a6c00 0x004c6400 0x00672000 0x00491c00 0x005de000 0x00331800 0x00625400 0x00251800 0x0055a400 0x0010e000  
LBA[40]: 0x00336800 0x0020ac00 0x004b1000 0x003c5c00 0x000db000 0x005aec00 0x006cdc00 0x007f0800 0x001a1000 0x004c9c00  
LBA[50]: 0x0021e400 0x006ecc00 0x005b5400 0x004f7800 0x005c8800 0x001f9800 0x00492400 0x001e4400 0x003d6c00 0x00038c00  
LBA[60]: 0x002d0400 0x006b3800 0x00263400 0x004d2c00 0x005b9400 0x007alc00 0x0068a400 0x00033800 0x003e2400 0x00231400  
LBA[70]: 0x00353800 0x006e5000 0x00528800 0x007b7800 0x00421800 0x00678400 0x00413800 0x001f9c00 0x00225000 0x007f6400  
LBA[80]: 0x005f5400 0x002ccc00 0x0054c400 0x00733400 0x00728400 0x00556000 0x0022e800 0x0035a800 0x00570c00 0x007db400  
LBA[90]: 0x00160800 0x007b9400 0x00772c00 0x005db000 0x0049bc00 0x005d5800 0x0031e800 0x006e5800 0x007bbc00 0x000d5c00

PRE LBA LIST:

LBA[ 0]: 0x005eb000 0x00176400 0x0008b000 0x00152c00 0x0014e800 0x003efc00 0x00054000 0x006ca400 0x00404800 0x00454400

DETECT READ ERROR:

LBA: 0x404800 | HF: 0x04001279 F1: 0x47877c66 F2: 0x92e7f068 [LOOP: 1 WRITE: 407 SECTOR: 0 / NUM: 1024 / ZERO: 176]  
DETECT ERROR IO Time: 2023-06-26 00:22:21

Buffer addr: 0xfffff74ba0000 | Physical addr: 0x300dd980000

LBA LIST:  
LBA[ 0]: 0x00404800 0x006ca400 0x00054000 0x003efc00 0x0014e800 0x00152c00 0x0008b000 0x00176400 0x005eb000 0x0017b000  
LBA[10]: 0x003eac00 0x00021800 0x003cec00 0x0006fc00 0x00697800 0x007c8800 0x002cc000 0x004c6c00 0x0077f400 0x00639800  
LBA[20]: 0x0022c400 0x002ea400 0x000fe000 0x001be000 0x000a0400 0x000a4c00 0x00124000 0x0014f800 0x0054e000 0x00260800  
LBA[30]: 0x007b9000 0x00301400 [0xb38ffa0] 0x006e3c00 0x00162000 0x002be800 0x00199400 0x003ca000 0x004e8c00 0x001a6c00  
LBA[40]: 0x004c6400 0x00672000 0x00491c00 0x005de000 0x00331800 0x00625400 0x00251800 0x0055a400 0x0010e000 0x00336800  
LBA[50]: 0x0020ac00 0x004b1000 0x003c5c00 0x000db000 0x005aec00 0x006cdc00 0x007f0800 0x001a1000 0x004c9c00 0x0021e400  
LBA[60]: 0x006ecc00 0x005b5400 0x004f7800 0x005c8800 0x001f9800 0x00492400 0x001e4400 0x003d6c00 0x00038c00 0x002d0400  
LBA[70]: 0x006b3800 0x00263400 0x004d2c00 0x005b9400 0x007alc00 0x0068a400 0x00033800 0x003e2400 0x00231400 0x00353800  
LBA[80]: 0x006e5000 0x00528800 0x007b7800 0x00421800 0x00678400 0x00413800 0x001f9c00 0x00225000 0x007f6400 0x005f5400  
LBA[90]: 0x002ccc00 0x0054c400 0x00733400 0x00728400 0x00556000 0x0022e800 0x0035a800 0x00570c00 0x00160800

Current Time: 2023-06-26 00:22:23

pause\_and\_exit\_work: Press KEY: <Q> to exit!

# LBA工具基本功能演示

## ➤ BUG 002[1]: 案例一, inject SECTOR lba bug

随机校验数据, 簇内校验数据出错

BUG 002[1]: [Thread: 5] RANDOM VERIFY SECTOR[647] DIFFER: 1  
| CORRECT LBA[0]: 0x63f400 | ERROR LBA[647]: 0x63f687 | filename: lba.raw  
LBA: 0x63f687 | thread\_num: 10, bitmap: 0 0 0 0 0 1 0 0 0

CORRECT LBA[0]: 0x13fe000 | HF: 0x04001276 F1: 0x59f10fb8 F2: 0xe0d6306e  
[LOOP: 1 WRITE: 542 SECTOR: 0 / NUM: 1024 / ZERO: 14]  
CORRECT IO Time: 2023-06-27 01:46:46

ERROR LBA[112]: 0x13fe070 | HF: 0xd9d9d9d9 F1: 0xd9d9d9d9 F2:  
0xd9d9d9d9 [LOOP: 3654932953 WRITE: 3654932953 SECTOR: 55769 / NUM:  
55769 / ZERO: 3654932953]  
INCONSISTENT IO Time: -640032443--640034342--640034343--640034343

CORRECT LBA[125]: 0x13fe07d | HF: 0x04001276 F1: 0x59f10fb8 F2:  
0xe0d6306e [LOOP: 1 WRITE: 542 SECTOR: 125 / NUM: 1024 / ZERO: 14]  
CORRECT IO Time: 2023-06-27 01:46:46

---runtime校验

BUG 007[1] LAST IO?: [Thread: 6] VERIFY SECTOR[112] DIFFER: 13 | read[542] | filename: lba.raw  
  
hd\_write\_verify\_dump -c -D -L 0x01341000 disk/file  
hd\_write\_verify\_dump -c -D -L 0x01248000 disk/file  
  
CORRECT LBA[0]: 0x13fe000 | HF: 0x04001276 F1: 0x59f10fb8 F2: 0xe0d6306e [LOOP: 1 WRITE: 542 SECTOR: 0 / NUM:  
CORRECT IO Time: 2023-06-27 01:46:46  
  
ERROR LBA[112]: 0x13fe070 | HF: 0xd9d9d9d9 F1: 0xd9d9d9d9 F2: 0xd9d9d9d9 [LOOP: 3654932953 WRITE: 3654932953 S  
INCONSISTENT IO Time: -640032443--640034342--640034343 -640034343--640034343  
  
CORRECT LBA[125]: 0x13fe07d | HF: 0x04001276 F1: 0x59f10fb8 F2: 0xe0d6306e [LOOP: 1 WRITE: 542 SECTOR: 125 / N  
CORRECT IO Time: 2023-06-27 01:46:46

---checktime校验

Starting write file: Thread ID | Read MB - Write MB |  
KEY: <P> = pause, KEY: <S> = start, KEY: <Q> = quit  
  
Loop 1: .  
Current Time: 2023-06-27 01:45:46  
479, 374 | 470, 375 | 492, 391 | 505, 388 | 503, 387 | 485, 394 | 498, 391 | 487, 384 | 513, 394 | 488, 378 |  
  
Current Time: 2023-06-27 01:47:06  
BUG 002[1]: (Thread: 6) RANDOM VERIFY SECTOR[112] DIFFER: 13 | CORRECT LBA[0]: 0x13fe000 | ERROR LBA[112]: 0x13fe070 | filename: lba.raw  
LBA: 0x13fe070 | thread\_num: 10, bitmap: 0 0 0 0 0 1 0 0 0  
  
LAST CORRECT WRITE:  
LBA: 0xd21c00 | HF: 0x04001276 F1: 0x59f10fb8 F2: 0xe0d6306e [LOOP: 1 WRITE: 738 SECTOR: 0 / NUM: 1024 / ZERO: 14]  
LAST WRITE IO Time: 2023-06-27 01:47:06  
  
Buffer addr: 0xffff89c00000 | Physical addr: 0x2026ff30000  
  
LBA LIST:  
LBA[ 0]: 0x00d21c00 0x00c50c00 0x00bcd400 0x009f2800 0x006eb400 0x00bf1400 0x00e5f800 0x00ab0d000 0x01399400 0x00ee400  
LBA[10]: 0x00ae5c00 0x008ec000 0x00f74400 0x00040800 0x00534400 0x01245c00 0x0055b400 0x0014b000 0x00c4a800 0x00276000  
LBA[20]: 0x0066e000 0x008ac2c00 0x0090c400 0x00a36c00 0x003fc800 0x007b1000 0x00acb000 0x00ccfc00 0x00a85800 0x007a1400  
LBA[30]: 0x00416c00 0x0083b400 0x00178000 0x003a6400 0x0068d800 0x01160400 0x010ddc00 0x009e7400 0x0081c00  
LBA[40]: 0x00685000 0x0112ac00 0x00820c00 0x012db000 0x0129c000 0x012cd400 0x006c7c00 0x01116000 0x00caf400 0x003d5800  
LBA[50]: 0x00bd9000 0x005c0d00 0x0013a7400 0x00f70000 0x00958400 0x007f7000 0x01222400 0x00c7e800 0x00ff7800 0x009315c00  
LBA[60]: 0x00192000 0x0011b000 0x00274800 0x00114000 0x0004c000 0x00b3a000 0x0090c800 0x001d8400 0x01353400 0x00795000  
LBA[70]: 0x0000e000 0x01le8000 0x008c8000 0x00719000 0x012e7000 0x00d46800 0x0099f800 0x012e3400 0x01233800 0x00e6d800  
LBA[80]: 0x00226800 0x0101d400 0x01301400 0x010cac00 0x00fd2c00 0x0120a400 0x008d2400 0x00988000 0x00231800 0x00885000  
LBA[90]: 0x00140800 0x0053e400 0x00c2c800 0x000bcc00 0x00d2d000 0x0088b000 0x01180c00 0x012ee800 0x00944400 0x0061b00  
  
PRE LBA LIST:  
LBA[ 0]: 0x0037b800 0x00b9c800 0x010a9c00 0x005ef800 0x00f15c00 0x00b6d000 0x003c4000 0x0114f400 0x00cc2800 0x00c30c00  
  
-----  
  
RANDOM VERIFY:  
LBA: 0x13fe000 | HF: 0x04001276 F1: 0x59f10fb8 F2: 0xe0d6306e [LOOP: 1 WRITE: 542 SECTOR: 0 / NUM: 1024 / ZERO: 14]  
RANDOM VERIFY IO Time: 2023-06-27 01:46:46  
  
Buffer addr: 0xffff89200000 | Physical addr: 0x2026da50000  
  
LBA LIST:  
LBA[ 0]: 0x013fe000 0x01248000 0x012e0400 0x00bd7000 0x002c9400 0x00a7d800 0x002bd400 0x00d61400 0x00058c00 0x00485800  
LBA[10]: 0x00760400 0x0016f800 0x00b89800 0x008ad400 0x01316000 0x0012e800 0x0023ec00 0x00404800 0x00008c00 0x0040f400  
LBA[20]: 0x001260800 0x00a6fc00 0x001658000 0x00447800 0x0025c000 0x00f31c00 0x0038b400 0x003d4000 0x009bcc00 0x00401c00  
LBA[30]: 0x0008c000 0x00ec6800 0x008c3000 0x00731400 0x008d3000 0x011ae000 0x00974400 0x011ab800 0x00b04800 0x009a800  
LBA[40]: 0x00e49c00 0x0121f000 0x0096cc00 0x000e4000 0x001e9000 0x00a15000 0x00af0c00 0x00345000 0x00651400 0x0093f800  
LBA[50]: 0x002ba00 0x0116c400 0x00c1fc00 0x00317000 0x00a97400 0x0060c000 0x0082000 0x01140800 0x00786c00  
LBA[60]: 0x0002c2400 0x00676400 0x00dadbc00 0x013e8000 0x012d2000 0x009494c00 0x00fb0400 0x00c7c400 0x005dc400 0x0109dc00  
LBA[70]: 0x001d1000 0x00055cc00 0x006a1400 0x007f9400 0x010720800 0x00399c00 0x0024c000 0x002fd00 0x01244800  
LBA[80]: 0x00001e400 0x0003a4000 0x00c65800 0x00626800 0x0099b800 0x0093a8000 0x00e83000 0x00422400 0x00818400 0x0001c400  
LBA[90]: 0x0092c800 0x001bf000 0x008a6000 0x013f4000 0x007fa000 0x00db5800 0x00058800 0x00731800 0x00530400 0x00e43c00  
  
PRE LBA LIST:  
LBA[ 0]: 0x01341000 0x005ab000 0x012a0400 0x009dc000 0x006e3800 0x00f26000 0x00b98800 0x00396800 0x007da000 0x00227400  
  
-----  
  
DETECT READ ERROR:  
LBA: 0x13fe070 | HF: 0xd9d9d9d9 F1: 0xd9d9d9d9 F2: 0xd9d9d9d9 [LOOP: 3654932953 WRITE: 3654932953 SECTOR: 55769 / NUM: 55769 / ZERO: 3654932953]  
DETECT ERROR IO Time: -640032443--640034342--640034343 -640034343:-640034343  
  
Buffer addr: 0xffff8920e000 | Physical addr: 0x2026da5e000  
  
LBA LIST:  
LBA[ 0]: 0xd9d9d9d9  
LBA[10]: 0xd9d9d9d9  
LBA[20]: 0xd9d9d9d9  
LBA[30]: 0xd9d9d9d9  
LBA[40]: 0xd9d9d9d9  
LBA[50]: 0xd9d9d9d9  
LBA[60]: 0xd9d9d9d9  
LBA[70]: 0xd9d9d9d9  
LBA[80]: 0xd9d9d9d9  
LBA[90]: 0xd9d9d9d9  
  
PRE LBA LIST:  
LBA[ 0]: 0xd9d9d9d9  
  
-----  
  
Current Time: 2023-06-27 01:47:06  
pause and exit work: Press KEY: <Q> to exit!

# LBA工具基本功能演示

## ➤ BUG 002[1]: 案例二, inject LIST lba bug

随机校验数据, 簇内校验数据出错

BUG 002[1]: [Thread: 5] RANDOM VERIFY SECTOR[647] DIFFER: 1  
| CORRECT LBA[0]: 0x63f400 | ERROR LBA[647]: 0x63f687 | filename: lba.raw  
LBA: 0x63f687 | thread\_num: 10, bitmap: 0 0 0 0 0 1 0 0 0 0

CORRECT LBA[0]: 0x63f400 | HF: 0x04001275 F1: 0x69f556d6 F2: 0xa270f2e1  
[LOOP: 1 WRITE: 1353 SECTOR: 0 / NUM: 1024 / ZERO: 181]  
CORRECT IO Time: 2023-06-27 02:09:39

ERROR LBA[647]: 0x63f687 | HF: 0x04001275 F1: 0x69f556d6 F2: 0xa270f2e1  
[LOOP: 1 WRITE: 1353 SECTOR: 647 / NUM: 1024 / ZERO: 181]  
INCONSISTENT IO Time: 2023-06-27 02:09:39

CORRECT LBA[648]: 0x63f688 | HF: 0x04001275 F1: 0x69f556d6 F2: 0xa270f2e1  
[LOOP: 1 WRITE: 1353 SECTOR: 648 / NUM: 1024 / ZERO: 181]  
CORRECT IO Time: 2023-06-27 02:09:39

---runtime校验

```
BUG 007[1] LAST IO?: [Thread: 5] VERIFY SECTOR[647] DIFFER: 1 | read[1353] | filename: lba.raw

hd_write_verify_dump -c -D -L 0x011cf00 disk/file
hd_write_verify_dump -c -D -L 0x00cec400 disk/file

CORRECT LBA[0]: 0x63f400 | HF: 0x04001275 F1: 0x69f556d6 F2: 0xa270f2e1 [LOOP: 1 WRITE: 1353 SECTOR: 0 / NUM: 1024 / ZERO: 181]
CORRECT IO Time: 2023-06-27 02:09:39

ERROR LBA[647]: 0x63f687 | HF: 0x04001275 F1: 0x69f556d6 F2: 0xa270f2e1 [LOOP: 1 WRITE: 1353 SECTOR: 647 / NUM: 1024 / ZERO: 181]
INCONSISTENT IO Time: 2023-06-27 02:09:39

CORRECT LBA[648]: 0x63f688 | HF: 0x04001275 F1: 0x69f556d6 F2: 0xa270f2e1 [LOOP: 1 WRITE: 1353 SECTOR: 648 / NUM: 1024 / ZERO: 181]
CORRECT IO Time: 2023-06-27 02:09:39
```

---checktime校验

```
Starting write file: Thread ID | Read MB - Write MB |
KEY: <P> = pause, KEY: <S> = start, KEY: <Q> = quit

Loop 1: .
Current Time: 2023-06-27 02:08:40
1183, 843 | 1203, 855 | 1152, 843 | 1180, 842 | 1170, 840 | 1195, 850 | 1179, 849 | 1174, 844 | 1142, 815 | 1177, 839 |

Current Time: 2023-06-27 02:09:55
BUG 002[1]: [Thread: 5] RANDOM VERIFY SECTOR[647] DIFFER: 1 | CORRECT LBA[0]: 0x63f400 | ERROR LBA[647]: 0x63f687 | filename: lba.raw
LBA: 0x63f687 | thread_num: 10, bitmap: 0 0 0 0 0 1 0 0 0 0
LAST CORRECT WRITE:
LBA: 0x0ff4c00 | HF: 0x04001275 F1: 0x69f556d6 F2: 0xa270f2e1 [LOOP: 1 WRITE: 1629 SECTOR: 0 / NUM: 1024 / ZERO: 181]
LAST WRITE IO Time: 2023-06-27 02:09:55

Buffer addr: 0xffffea4ee0000 | Physical addr: 0x42bd030000

LBA LIST:
LBA[ 0]: 0x00ff4c00 0x00cd500 0x00ad7400 0x0019d000 0x000d6c00 0x00908000 0x008df800 0x01239000 0x002b7400
LBA[10]: 0x00ba400 0x0082cc00 0x00b3c00 0x00ee800 0x0078e00 0x00e4dc00 0x00e4d400 0x0055f800 0x0135ec00 0x00989400
LBA[20]: 0x00ed400 0x006d7400 0x00f37400 0x00a5c00 0x003e5400 0x00cz400 0x006bd000 0x00fe6c00 0x001eb800 0x006a6c00
LBA[30]: 0x0018e000 0x00fa400 0x00ce1c00 0x0045c000 0x0127e600 0x002b8000 0x00368c00 0x010d6400 0x00f55800 0x0006f1000
LBA[40]: 0x005b7c00 0x0124dc00 0x0070c00 0x00318c00 0x0085dc00 0x0099a400 0x004b9c00 0x00337c00 0x00456400 0x010a9400
LBA[50]: 0x005af000 0x0048f400 0x00089400 0x001e4c00 0x00cc2b400 0x00fe3400 0x00396c00 0x0064c400 0x00b03800 0x0033bc00
LBA[60]: 0x002b8000 0x002dc400 0x00db3800 0x00db3800 0x00445800 0x005dc00 0x00d0c00 0x01031400 0x0102d400 0x00818c00
LBA[70]: 0x00d7b400 0x00c09400 0x00d6e000 0x00253400 0x00e61400 0x00f8f000 0x00ac000 0x00848c00 0x00116400 0x007adc00
LBA[80]: 0x00e2e000 0x0056dc00 0x0088c800 0x012ea800 0x0129a000 0x00163800 0x01329400 0x01124400 0x00f95400 0x002ffc00
LBA[90]: 0x0003d400 0x0110f000 0x00a5c800 0x00fdcf00 0x00e2b800 0x002cc000 0x00c2b00 0x009ef400 0x00981c00 0x005b3000

PRE LBA LIST:
LBA[ 0]: 0x0110c800 0x0015d000 0x003ff400 0x003b1c00 0x0112b400 0x012b8c00 0x005e2c00 0x006dc800 0x013ba400 0x007d2800

RANDOM VERIFY:
LBA: 0x63f400 | HF: 0x04001275 F1: 0x69f556d6 F2: 0xa270f2e1 [LOOP: 1 WRITE: 1353 SECTOR: 0 / NUM: 1024 / ZERO: 181]
RANDOM VERIFY IO Time: 2023-06-27 02:09:39

Buffer addr: 0xffffea43a0000 | Physical addr: 0x435ad0b0000

LBA LIST:
LBA[ 0]: 0x0063f400 0x00cec400 0x00fb3000 0x001led800 0x00dab000 0x00483c00 0x0028a000 0x001b5800 0x00a12800 0x00183800
LBA[10]: 0x00668000 0x00bb4c00 0x0131fc00 0x001ef000 0x006c7c00 0x00234c00 0x006b9800 0x008f9800 0x00057000 0x00a56800
LBA[20]: 0x00957c00 0x00857400 0x00af5000 0x0052fc00 0x00db5000 0x0082a000 0x00da5000 0x00b5c000 0x00953400 0x00d2c000
LBA[30]: 0x002ca400 0x005cc00 0x00415800 0x010cd400 0x00368400 0x0011bc00 0x007a3800 0x002e1800 0x006e9000 0x00c69c00
LBA[40]: 0x003c3000 0x00ec3400 0x005f3c00 0x001lad400 0x0012b800 0x01067800 0x00cd00 0x00ab6800 0x008ea800 0x001b6400
LBA[50]: 0x00837c00 0x00316400 0x00666000 0x013f9000 0x0057cc00 0x011ee400 0x01055000 0x00f16c00 0x01333000 0x00c7400
LBA[60]: 0x001ld400 0x00a2l00 0x00a66000 0x00c3dc00 0x0108e400 0x003eac00 0x00fab00 0x008c1000 0x00c6c800 0x00147400
LBA[70]: 0x0028bc00 0x00d21400 0x00701400 0x011ld0400 0x013f5000 0x0099b800 0x00feb00 0x01298800 0x009a5000 0x008d4400
LBA[80]: 0x01135c00 0x00e1e800 0x00924000 0x00b51c00 0x003a1400 0x009b2800 0x0096c800 0x005c1000 0x0036b400 0x0138ec00
LBA[90]: 0x012bf800 0x00bb1400 0x00186800 0x008cd00 0x00bla800 0x00d6f000 0x01018400 0x012a6c00 0x00a7cc00 0x00f1d400

PRE LBA LIST:
LBA[ 0]: 0x011cf00 0x00970c00 0x0040a800 0x01078c00 0x01298c00 0x01069000 0x001fdc00 0x01389800 0x00cba800 0x00b62800

DETECT READ ERROR:
LBA: 0x63f687 | HF: 0x04001275 F1: 0x69f556d6 F2: 0xa270f2e1 [LOOP: 1 WRITE: 1353 SECTOR: 647 / NUM: 1024 / ZERO: 181]
DETECT ERROR IO Time: 2023-06-27 02:09:39

Buffer addr: 0xffffea43f0e00 | Physical addr: 0x443ac80e00

LBA LIST:
LBA[ 0]: 0x0063f400 0x00cec400 0x00fb3000 0x001led800 0x00dab000 0x00483c00 0x0028a000 0x001b5800 0x00a12800 0x00183800
LBA[10]: 0x00668000 0x00bb4c00 0x0131fc00 0x001ef000 0x006c7c00 0x00234c00 0x006b9800 0x008f9800 0x00057000 0x00a56800
LBA[20]: 0x00957c00 0x00857400 0x00af5000 0x0052fc00 0x042b99768 0x0082a00 0x00da5000 0x00b5c000 0x00953400 0x00d2c000
LBA[30]: 0x002ca400 0x005cc00 0x00415800 0x010cd400 0x00368400 0x0011bc00 0x007a3800 0x002e1800 0x006e9000 0x00c69c00
LBA[40]: 0x003c3000 0x00ec3400 0x005f3c00 0x001lad400 0x0012b800 0x01067800 0x00cd00 0x00ab6800 0x008ea800 0x001b6400
LBA[50]: 0x00837c00 0x00316400 0x00666000 0x013f9000 0x0057cc00 0x011ee400 0x01055000 0x00f16c00 0x01333000 0x00c7400
LBA[60]: 0x001ld400 0x00a2l00 0x00a66000 0x00c3dc00 0x0108e400 0x003eac00 0x00fab00 0x008c1000 0x00c6c800 0x00147400
LBA[70]: 0x0028bc00 0x00d21400 0x00701400 0x011ld0400 0x013f5000 0x0099b800 0x00feb00 0x01298800 0x009a5000 0x008d4400
LBA[80]: 0x01135c00 0x00e1e800 0x00924000 0x00b51c00 0x003a1400 0x009b2800 0x0096c800 0x005c1000 0x0036b400 0x0138ec00
LBA[90]: 0x012bf800 0x00bb1400 0x00186800 0x008cd00 0x00bla800 0x00d6f000 0x01018400 0x012a6c00 0x00a7cc00 0x00f1d400

PRE LBA LIST:
LBA[ 0]: 0x011cf00 0x00970c00 0x0040a800 0x01078c00 0x01298c00 0x01069000 0x001fdc00 0x01389800 0x00cba800 0x00b62800

Current Time: 2023-06-27 02:09:55
pause_and_exit_work: Press KEY: <Q> to exit!
```

# LBA工具基本功能演示

## ➤ BUG 002[1]: 案例三, inject PRE Iba bug

随机校验数据, 簇内校验数据出错

BUG 002[1]: [Thread: 4] RANDOM VERIFY SECTOR[365] DIFFER: 1  
| CORRECT LBA[0]: 0x2577c00 | ERROR LBA[365]: 0x2577d6d | filename: lba.raw  
LBA: 0x2577d6d | thread\_num: 10, bitmap: 0 0 0 0 1 0 0 0 0 0

CORRECT LBA[0]: 0x2577c00 | HF: 0x04001274 F1: 0x3daf710 F2: 0xb0241d6b  
[LOOP: 1 WRITE: 1355 SECTOR: 0 / NUM: 1024 / ZERO: 38]  
CORRECT IO Time: 2023-06-28 22:41:43

ERROR LBA[365]: 0x2577d6d | HF: 0x04001274 F1: 0x3daf710 F2: 0xb0241d6b  
[LOOP: 1 WRITE: 1355 SECTOR: 365 / NUM: 1024 / ZERO: 38]  
INCONSISTENT IO Time: 2023-06-28 22:41:43

CORRECT LBA[366]: 0x2577d6e | HF: 0x04001274 F1: 0x3daf710 F2:  
0xb0241d6b [LOOP: 1 WRITE: 1355 SECTOR: 366 / NUM: 1024 / ZERO: 38]  
CORRECT IO Time: 2023-06-28 22:41:43

---runtime校验

BUG 007[1] LAST IO?: [Thread: 4] VERIFY SECTOR[365] DIFFER: 1 | read[1355] | filename: lba.raw

hd\_write\_verify\_dump -c -D -L 0x00853400 disk/file  
hd\_write\_verify\_dump -c -D -L 0x01c3a800 disk/file

CORRECT LBA[0]: 0x2577c00 | HF: 0x04001274 F1: 0x3daf710 F2: 0xb0241d6b [LOOP: 1 WRITE: 1355 SECTOR: 0 / NUM: 1024 /  
CORRECT IO Time: 2023-06-28 22:41:43

ERROR LBA[365]: 0x2577d6d | HF: 0x04001274 F1: 0x3daf710 F2: 0xb0241d6b [LOOP: 1 WRITE: 1355 SECTOR: 365 / NUM: 1024  
INCONSISTENT IO Time: 2023-06-28 22:41:43

CORRECT LBA[366]: 0x2577d6e | HF: 0x04001274 F1: 0x3daf710 F2: 0xb0241d6b [LOOP: 1 WRITE: 1355 SECTOR: 366 / NUM: 1024  
CORRECT IO Time: 2023-06-28 22:41:43

Starting write file: Thread ID | Read MB - Write MB |  
KEY: <P> = pause, KEY: <S> = start, KEY: <Q> = quit

Loop 1: .  
Current Time: 2023-06-28 22:40:43  
2477, 1709 | 2504, 1737 | 2470, 1706 | 2489, 1732 | 2497, 1734 | 2511, 1733 | 2472, 1723 | 2503, 1728 | 2509, 1754 | 2522, 1748 |

Current Time: 2023-06-28 22:43:39  
BUG 002[1]: [Thread: 4] RANDOM VERIFY SECTOR[365] DIFFER: 1 | CORRECT LBA[0]: 0x2577c00 | ERROR LBA[365]: 0x2577d6d | filename: lba.raw  
LBA: 0x2577d6d | thread\_num: 10, bitmap: 0 0 0 0 1 0 0 0 0 0

LAST CORRECT WRITE:  
LBA: 0x9eb800 | HF: 0x04001274 F1: 0x3daf710 F2: 0xb0241d6b [LOOP: 1 WRITE: 3462 SECTOR: 0 / NUM: 1024 / ZERO: 38]  
LAST WRITE IO Time: 2023-06-28 22:43:39

Buffer addr: 0xffffee9d70000 | Physical addr: 0x203705230000

LBA LIST:  
LBA[ 0]: 0x009eb800 0x018d5400 0x005eb800 0x0221b400 0x00490c00 0x016elc00 0x00dbf400 0x01703c00 0x02573000 0x0129f000  
LBA[10]: 0x00fb0400 0x01a1b800 0x004bf800 0x01d6fc00 0x0002a800 0x00de4ec00 0x01df1800 0x00e29000 0x012fc400 0x0011bc00  
LBA[20]: 0x015ac800 0x00683c00 0x018cb400 0x01cb2c00 0x0027c800 0x02la5400 0x00457400 0x026cd00 0x026abc00 0x02546c00  
LBA[30]: 0x010dc800 0x00ec7c00 0x002bbc00 0x01f7f400 0x021f59c00 0x02efc800 0x01f91800 0x01ef4c00 0x025fb000 0x0006b400  
LBA[40]: 0x002bcc00 0x016b5c00 0x017f5000 0x013fb000 0x009dd6400 0x02087900 0x0221d900 0x01919c00 0x00aa34400 0x00661c00  
LBA[50]: 0x0057b800 0x02734c00 0x00a3b400 0x02656000 0x00476400 0x0059c400 0x0058fb00 0x0258b00 0x009e9d400 0x0176a00  
LBA[60]: 0x0162c400 0x007e3c00 0x01add800 0x000508000 0x0063a000 0x02629000 0x01838000 0x021dd400 0x00688c00  
LBA[70]: 0x01836800 0x00dd7900 0x00f02800 0x01757800 0x0027e800 0x02385000 0x008fb000 0x0084b000 0x00107c00 0x02048c00  
LBA[80]: 0x0017b400 0x0161b000 0x019d9800 0x012c8c00 0x00df2000 0x01338c00 0x018bd400 0x02429800 0x01f1c00 0x00bb5b00  
LBA[90]: 0x000ac800 0x00678c00 0x00797400 0x025f3c00 0x01b83800 0x00ad6800 0x01376c00 0x00136000 0x01be7c00 0x0101d400

PRE LBA LIST:  
LBA[ 0]: 0x006e1800 0x00b3f000 0x02249c00 0x01e6b800 0x007c4800 0x0098bc00 0x01d14400 0x0060d800 0x022da400 0x00457000

RANDOM VERIFY:  
LBA: 0x2577c00 | HF: 0x04001274 F1: 0x3daf710 F2: 0xb0241d6b [LOOP: 1 WRITE: 1355 SECTOR: 0 / NUM: 1024 / ZERO: 38]  
RANDOM VERIFY IO Time: 2023-06-28 22:41:43

Buffer addr: 0xffffee9190000 | Physical addr: 0x2025880a0000

LBA LIST:  
LBA[ 0]: 0x02577c00 0x01c3a800 0x0059b400 0x006f5000 0x026ff0c00 0x02345000 0x01603400 0x027ee000 0x02387c00 0x01340400  
LBA[10]: 0x01ff4000 0x01b6a000 0x006a8800 0x01b49400 0x021b8000 0x013b6800 0x00648400 0x00e91800 0x014da400 0x014e6400  
LBA[20]: 0x01eda800 0x0265f000 0x021bc800 0x027fb800 0x00aa44000 0x023bd800 0x00945400 0x01393000 0x00dc8400 0x00fd400  
LBA[30]: 0x01805800 0x003fc00 0x007b9000 0x004ee000 0x0002a000 0x01ad2400 0x017a2000 0x010c9800 0x01fff400 0x0064c400  
LBA[40]: 0x00716400 0x00072000 0x01b4900 0x023da000 0x00eecc00 0x00248800 0x01b47800 0x001a0e00 0x009d97800 0x00b90000  
LBA[50]: 0x015aec00 0x0067f000 0x027e7400 0x004b2000 0x0075f400 0x01849800 0x00d18c00 0x00965000 0x00dea400 0x01603800  
LBA[60]: 0x00667800 0x01ca8800 0x02621000 0x026be000 0x00cf5000 0x02275800 0x01221800 0x0092a800 0x01900000 0x022dc00  
LBA[70]: 0x00309000 0x02489000 0x01091800 0x00262800 0x00e9b400 0x02075800 0x01221800 0x0092a800 0x0225d400 0x021c4800 0x01818800  
LBA[80]: 0x02537800 0x00338800 0x00599c00 0x0146ec00 0x0197a400 0x02014800 0x01ef5c00 0x00792c00 0x01e90000 0x020ae000  
LBA[90]: 0x023bec00 0x01f79000 0x00ebf000 0x00cc1800 0x02587800 0x007c0400 0x01a9f800 0x00be1400 0x024db000 0x016b1000

PRE LBA LIST:  
LBA[ 0]: 0x00853400 0x009e0800 0x00e46000 0x02578000 0x026a3400 0x01a06400 0x01c42000 0x0036e400 0x01bb5800 0x00b99c00

Detect READ ERROR:  
LBA: 0x2577d6d | HF: 0x04001274 F1: 0x3daf710 F2: 0xb0241d6b [LOOP: 1 WRITE: 1355 SECTOR: 365 / NUM: 1024 / ZERO: 38]  
DETECT ERROR IO Time: 2023-06-28 22:41:43

Buffer addr: 0xffffee91dd00 | Physical addr: 0x20258265da00

LBA LIST:  
LBA[ 0]: 0x02577c00 0x01c3a800 0x0059b400 0x006f5000 0x026ff0c00 0x02345000 0x01603400 0x027ee000 0x02387c00 0x01340400  
LBA[10]: 0x01ff4000 0x01b6a000 0x006a8800 0x01b49400 0x021b8000 0x013b6800 0x00648400 0x00e91800 0x014da400 0x014e6400  
LBA[20]: 0x01eda800 0x0265f000 0x021bc800 0x027fb800 0x00aa4400 0x023bd800 0x00945400 0x01393000 0x00dc8400 0x00fd400  
LBA[30]: 0x01805800 0x003fc00 0x007b9000 0x004ee000 0x0002a000 0x01ad2400 0x017a2000 0x010c9800 0x01fff400 0x0064c400  
LBA[40]: 0x00716400 0x00072000 0x01b4900 0x023da000 0x00eecc00 0x00248800 0x01b47800 0x001a0e00 0x009d97800 0x00b90000  
LBA[50]: 0x015aec00 0x0067f000 0x027e7400 0x004b2000 0x0075f400 0x01849800 0x00d18c00 0x00965000 0x00dea400 0x01603800  
LBA[60]: 0x00667800 0x01ca8800 0x02621000 0x026be000 0x00cf5000 0x02275800 0x01221800 0x0092a800 0x01900000 0x022dc00  
LBA[70]: 0x00309000 0x02489000 0x01091800 0x00262800 0x00e9b400 0x02075800 0x01221800 0x0092a800 0x0225d400 0x021c4800 0x01818800  
LBA[80]: 0x02537800 0x00338800 0x00599c00 0x0146ec00 0x0197a400 0x02014800 0x01ef5c00 0x00792c00 0x01e90000 0x020ae000  
LBA[90]: 0x023bec00 0x01f79000 0x00ebf000 0x00cc1800 0x02587800 0x007c0400 0x01a9f800 0x00be1400 0x024db000 0x016b1000

PRE LBA LIST:  
LBA[ 0]: 0x00853400 0x009e0800 0x00e46000 0x02578000 0x026a3400 0x01a06400 0x01c42000 0x0036e400 0x01bb5800 0x00b99c00

---checktime校验

# LBA工具基本功能演示

## ➤ BUG 002[2]: 案例一, inject SECTOR lba bug

随机校验数据, 簇内校验数据出错

BUG 002[2]: [Thread: 2] RANDOM VERIFY ZERO SECTOR[63] DIFFER: 1  
| CORRECT LBA[0]: 0x57ef00 | ERROR LBA[63]: 0x57ef3f | filename: lba.raw  
LBA: 0x57ef3f | thread\_num: 10, bitmap: 0 0 1 0 0 0 0 0 0 0

CORRECT LBA[0]: 0x57ef00 | HF: 0x00401272 F1: 0x7f5b05a5 F2: 0x26e71923  
[LOOP: 1 WRITE: 1005 SECTOR: 0 / NUM: 64 / ZERO: 2]  
CORRECT IO Time: 2023-07-03 18:10:52

ERROR LBA[63]: 0x57ef3f | HF: 0x7c7c7c7c F1: 0x7c7c7c7c F2: 0x7c7c7c7c  
[LOOP: 2088533116 WRITE: 2088533116 SECTOR: 31868 / NUM: 31868 / ZERO:  
INCONSISTENT IO Time: 2088535016-2088533117-2088533116

NEXT LBA: 0x115dc00 | HF: 0x00401272 F1: 0x7f5b05a5 F2: 0x26e71923 [LOOP:  
1 WRITE: 1006 SECTOR: 0 / NUM: 64 / ZERO: 2]  
NEXT IO Time: 2023-07-03 18:10:52

---runtime校验

BUG 007[4]: [Thread: 2] VERIFY ZERO SECTOR[63] DIFFER: 1 | read[1006] | filename: lba.raw

```
hd_write_verify_dump -c -D -L 0x001f2200 disk/file
hd_write_verify_dump -c -D -L 0x115dc00 disk/file
```

CORRECT LBA[0]: 0x57ef00 | HF: 0x00401272 F1: 0x7f5b05a5 F2: 0x26e71923 [LOOP: 1 WRITE: 1005 SECTOR: 0 / NUM: 64 / ZERO: 2]
CORRECT IO Time: 2023-07-03 18:10:52

ERROR LBA[63]: 0x57ef3f | HF: 0x7c7c7c7c F1: 0x7c7c7c7c F2: 0x7c7c7c7c [LOOP: 2088533116 WRITE: 2088533116 SECTOR: 31868 / NUM: 31868 / ZERO: 2088533116]
INCONSISTENT IO Time: 2088535016-2088533117-2088533116 2088533116:2088533116:2088533116

NEXT LBA: 0x115dc00 | HF: 0x00401272 F1: 0x7f5b05a5 F2: 0x26e71923 [LOOP: 1 WRITE: 1006 SECTOR: 0 / NUM: 64 / ZERO: 2]
NEXT IO Time: 2023-07-03 18:10:52

---checktime校验

Starting write file: Thread ID | Read MB - Write MB |  
KEY: <P> = pause, KEY: <S> = start, KEY: <Q> = quit

Loop 1: .
Current Time: 2023-07-03 18:09:52
43, 47 | 42, 46 | 42, 46 | 44, 47 | 44, 47 | 43, 47 | 44, 47 | 43, 46 | 43, 46 | 44, 47 |

Current Time: 2023-07-03 18:11:13
BUG 002[2]: [Thread: 2] RANDOM VERIFY ZERO SECTOR[63] DIFFER: 1 | CORRECT LBA[0]: 0x57ef00 | ERROR LBA[63]: 0x57ef3f | filename: lba.raw
LBA: 0x57ef3f | thread\_num: 10, bitmap: 0 0 1 0 0 0 0 0 0 0

LAST CORRECT WRITE:
LBA: 0x13691c0 | HF: 0x00401272 F1: 0x7f5b05a5 F2: 0x26e71923 [LOOP: 1 WRITE: 1402 SECTOR: 0 / NUM: 64 / ZERO: 2]
LAST WRITE IO Time: 2023-07-03 18:11:13

Buffer addr: 0xfffff6c050000 | Physical addr: 0x28308370000

LBA LIST:
LBA[ 0]: 0x013691c0 0x00fa2f80 0x013c3880 0x00171d80 0x001fb000 0x0087f800 0x003ad400 0x00455000 0x0013c180 0x0121b480
LBA[10]: 0x00fb7400 0x0044b640 0x006d0640 0x00aa8900 0x004e7840 0x00b01140 0x003d040 0x0093da00 0x00f5e480 0x00a8a640
LBA[20]: 0x00a85f00 0x00ecce480 0x011c2980 0x000f6b00 0x00530600 0x010f7c80 0x0014da00 0x010e6300 0x00073c00 0x00788d00
LBA[30]: 0x001e7300 0x002c2040 0x00309b80 0x012d7000 0x0047a780 0x004fa000 0x01065a00 0x0038cf40 0x00d79380 0x00ab5c800
LBA[40]: 0x00683000 0x01289b40 0x0030d780 0x013d6300 0x005200c0 0x00a75180 0x00a34460 0x00521e00 0x00da4f80 0x000184c0
LBA[50]: 0x005c6000 0x00940000 0x00f35000 0x00edc100 0x00dc3140 0x005f5f00 0x00640040 0x006f9180
LBA[60]: 0x00193300 0x003a2000 0x00aa8180 0x011f9840 0x0034a140 0x00f02000 0x0096fc00 0x00d197c0 0x00074380 0x0054e980
LBA[70]: 0x006c5280 0x01115700 0x00af5e80 0x00ed1b00 0x00992a80 0x00cc1a80 0x006d9140 0x000cd500 0x012b8080 0x00df0900
LBA[80]: 0x006b0900 0x004e83c0 0x00ee2200 0x00f67e00 0x01161d00 0x004a2b80 0x008de900 0x00678300 0x001d9fc0
LBA[90]: 0x008ec740 0x0072eac0 0x0132b4c0 0x013d8040 0x00166040 0x00bb7f80 0x012faa40 0x011e3940 0x01325540 0x0035a440

PRE LBA LIST:
LBA[ 0]: 0x00fb6d00 0x00c0ebc0 0x00988000 0x008d1b40 0x000f3800 0x0052dec0 0x0066d680 0x00df7800 0x00204040 0x00e7d400

RANDOM VERIFY:
LBA: 0x57ef00 | HF: 0x00401272 F1: 0x7f5b05a5 F2: 0x26e71923 [LOOP: 1 WRITE: 1005 SECTOR: 0 / NUM: 64 / ZERO: 2]
RANDOM VERIFY IO Time: 2023-07-03 18:10:52

Buffer addr: 0xfffff6c070000 | Physical addr: 0x2005f1b0000

LBA LIST:
LBA[ 0]: 0x0057ef00 0x0115dc00 0x00176880 0x0136fc00 0x00ac8480 0x0119f1c0 0x00e129c0 0x00289a40 0x00fbba00 0x00d3fd00
LBA[10]: 0x00cf7700 0x00727240 0x00ec27c0 0x00afe200 0x00aa8380 0x003d0c80 0x0084100 0x00e43d40 0x00bc8c00 0x00606000
LBA[20]: 0x0103f800 0x004a0740 0x00686000 0x00999900 0x00aab040 0x00f03540 0x00081440 0x00d33b80 0x00682800
LBA[30]: 0x00785440 0x005c1d80 0x006dfdc0 0x00337540 0x00cefe100 0x00cf7740 0x01298940 0x0094a800 0x00791640 0x00f081c0
LBA[40]: 0x0054b6c0 0x0023f940 0x0022d040 0x00722c0 0x00dfdd00 0x00aa43c00 0x005676c0 0x01069580 0x01388500
LBA[50]: 0x00383d80 0x0124e200 0x001e7100 0x0032f000 0x00658a40 0x00e9c980 0x000fbfa00 0x00b86780 0x00660540 0x0124f700
LBA[60]: 0x0025b800 0x00fabcc0 0x012ff740 0x0034d800 0x00cd9800 0x00023900 0x004b8e40 0x007ec800 0x00768040 0x003a8000
LBA[70]: 0x0054f000 0x01077940 0x009b4d80 0x000bf280 0x0137de00 0x009ec0 0x00e46400 0x01258200 0x0012c800 0x011bd5c0
LBA[80]: 0x0100d000 0x002bd540 0x01007000 0x00ecf00 0x00584800 0x00fd4980 0x004e1c00 0x003e4800 0x000f0000 0x0084be80
LBA[90]: 0x00500c00 0x0035d40 0x01398000 0x00698000 0x00bc4280 0x006f8080 0x00cb4f00 0x009bf800 0x006ece80 0x0110a500

PRE LBA LIST:
LBA[ 0]: 0x001f2200 0x01099d80 0x00a47680 0x00829800 0x00f3f300 0x00529880 0x0091e2c0 0x00f7be00 0x00a00880 0x013bcb80

DETECT READ ERROR:
LBA: 0x57ef3f | HF: 0x7c7c7c7c F1: 0x7c7c7c7c F2: 0x7c7c7c7c [LOOP: 2088533116 WRITE: 2088533116 SECTOR: 31868 / NUM: 31868 / ZERO: 2088533116]
DETECT ERROR IO Time: 2088535016-2088533117-2088533116 2088533116:2088533116:2088533116

Buffer addr: 0xfffff6c077e00 | Physical addr: 0x2005f1b7e00

LBA LIST:
LBA[ 0]: 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c
LBA[10]: 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c
LBA[20]: 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c
LBA[30]: 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c
LBA[40]: 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c
LBA[50]: 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c
LBA[60]: 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c
LBA[70]: 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c
LBA[80]: 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c
LBA[90]: 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c

PRE LBA LIST:
LBA[ 0]: 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c 0x7c7c7c7c

Current Time: 2023-07-03 18:11:13

pause\_and\_exit\_work: Press KEY: <0> to exit!

# LBA工具基本功能演示

## ➤ BUG 002[2]: 案例二, inject LIST lba bug

随机校验数据, 簇内校验数据出错

BUG 002[2]: [Thread: 1] RANDOM VERIFY ZERO SECTOR[47] DIFFER: 1  
| CORRECT LBA[0]: 0x115e140 | ERROR LBA[47]: 0x115e16f | filename: lba.raw  
LBA: 0x115e16f | thread\_num: 10, bitmap: 0 1 0 0 0 0 0 0 0 0

CORRECT LBA[0]: 0x115e140 | HF: 0x00401271 F1: 0x2025f303 F2: 0xac7f3f18  
[LOOP: 1 WRITE: 5348 SECTOR: 0 / NUM: 64 / ZERO: 18]  
CORRECT IO Time: 2023-07-03 20:04:09

ERROR LBA[47]: 0x115e16f | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000  
[LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]  
INCONSISTENT IO Time: 1900-01-00 00:00:00

CORRECT LBA[48]: 0x115e170 | HF: 0x00000000 F1: 0x00000000 F2:  
0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]  
CORRECT IO Time: 1900-01-00 00:00:00

---runtime校验

BUG 007[2] LAST IO?: [Thread: 1] VERIFY ZERO SECTOR[47] DIFFER: 1 | read[5348] | filename: lba.raw

hd\_write\_verify\_dump -c -D -L 0x012edlc0 disk/file  
hd\_write\_verify\_dump -c -D -L 0x00bef680 disk/file

CORRECT LBA[0]: 0x115e140 | HF: 0x00401271 F1: 0x2025f303 F2: 0xac7f3f18 [LOOP: 1 WRITE: 5348 SECTOR: 0 / NUM: 64 / Z  
CORRECT IO Time: 2023-07-03 20:04:09

ERROR LBA[47]: 0x115e16f | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO:  
INCONSISTENT IO Time: 1900-01-00 00:00:00

CORRECT LBA[48]: 0x115e170 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO:  
CORRECT IO Time: 1900-01-00 00:00:00

---checktime校验

Starting write file: Thread ID | Read MB - Write MB |  
KEY: <P> = pause, KEY: <S> = start, KEY: <Q> = quit

Loop 1: .  
Current Time: 2023-07-03 20:03:09  
169, 173 | 167, 171 | 170, 173 | 169, 173 | 167, 170 | 166, 169 | 169, 172 | 163, 166 | 165, 168 | 171, 174 |  
  
Current Time: 2023-07-03 20:04:19  
BUG 002[2]: [Thread: 1] RANDOM VERIFY ZERO SECTOR[47] DIFFER: 1 | CORRECT LBA[0]: 0x115e140 | ERROR LBA[47]: 0x115e16f | filename: lba.raw  
LBA: 0x115e16f | thread\_num: 10, bitmap: 0 1 0 0 0 0 0 0 0 0

LAST CORRECT WRITE:  
LBA: 0x1185880 | HF: 0x00401271 F1: 0x2025f303 F2: 0xac7f3f18 [LOOP: 1 WRITE: 5863 SECTOR: 0 / NUM: 64 / ZERO: 18]  
LAST WRITE IO Time: 2023-07-03 20:04:19

Buffer addr: 0xffffeb8050000 | Physical addr: 0x373df70000

LBA LIST:  
LBA[ 0]: 0x01185880 0x00489e00 0x0119c000 0x013dfb00 0x00ae0000 0x00cf5480 0x005044c0 0x01359180 0x004e5400 0x00015000  
LBA[10]: 0x00992740 0x00eff100 0x00e3f580 0x00344600 0x00c8b680 0x0111b80 0x0059e340 0x00dc50c0 0x01039a00 0x001ae980  
LBA[20]: 0x00507000 0x01019380 0x00d81240 0x00f08380 0x0021ac80 0x000a5800 0x0088d000 0x00e9b800 0x003c3d00 0x009d1840  
LBA[30]: 0x0043900 0x01003080 0x00d84480 0x004ca200 0x00336c00 0x00d35080 0x0096c480 0x006e6ec0 0x00e27080 0x00b4da80  
LBA[40]: 0x00bf4c80 0x00424c00 0x0094a00 0x0044c080 0x00d7e400 0x0058d7c0 0x000aa400 0x00f27640 0x00435ac0 0x01305c00  
LBA[50]: 0x00957a40 0x00a2900 0x00354880 0x008b0880 0x01269680 0x0125f840 0x00686600 0x001d1880 0x00846a80 0x00c1e4c0  
LBA[60]: 0x003e8980 0x010f0800 0x0098e640 0x0063a040 0x00898380 0x01022cc0 0x00fd0500 0x008da4c0 0x008cb600 0x00591440  
LBA[70]: 0x0187c700 0x002ae400 0x0089cc40 0x00631440 0x00d6f600 0x009e0400 0x004746c0 0x003ed380 0x0036200 0x0005de00  
LBA[80]: 0x01395e40 0x01916180 0x00ff9ce00 0x0105fffc0 0x0087ca00 0x00fd1e80 0x003t7700 0x00ac9880 0x007f7300 0x0006f280  
LBA[90]: 0x01fb4c0 0x002d8380 0x0093c440 0x00abb40 0x00f92cc0 0x008e5540 0x00f65080 0x00ba0100 0x00919a00 0x00702ac0

PRE LBA LIST:  
LBA[ 0]: 0x00462d80 0x01094540 0x00db0240 0x008a8700 0x00cbff00 0x01025780 0x01279800 0x008d5380 0x00c19c80 0x00facf00

RANDOM VERIFY:  
LBA: 0x115e140 | HF: 0x00401271 F1: 0x2025f303 F2: 0xac7f3f18 [LOOP: 1 WRITE: 5348 SECTOR: 0 / NUM: 64 / ZERO: 18]  
RANDOM VERIFY IO Time: 2023-07-03 20:04:09

Buffer addr: 0xffffeb8070000 | Physical addr: 0x2544d50000

LBA LIST:  
LBA[ 0]: 0x0115e140 0x00bef680 0x00b1d980 0x00211680 0x01301900 0x013ad480 0x0032a580 0x01217dc0 0x003c0d00 0x008cb180  
LBA[10]: 0x010bd180 0x00aefb00 0x00458740 0x0082eac0 0x00ecd80 0x0129b40 0x00040640 0x00e5cd80 0x00235200 0x002e69c0  
LBA[20]: 0x00ed5d80 0x01088000 0x00920780 0x00098480 0x000c9400 0x01137a00 0x0134fec0 0x0001e2c0 0x008658c0 0x013491c0  
LBA[30]: 0x00d6d800 0x010b8a00 0x00216c00 0x0097f4300 0x0020b880 0x0026f6f0 0x000ccb80 0x0076c200 0x0122d200 0x010de100  
LBA[40]: 0x000cf580 0x000ae4800 0x0072a940 0x00bf6180 0x00bb2c00 0x0009b80 0x00f27440 0x003d2d80 0x00066680  
LBA[50]: 0x007908c0 0x00391a40 0x00210200 0x01158c00 0x00619a80 0x008cd300 0x008fb80 0x01090a00 0x011ef240 0x00c6a800  
LBA[60]: 0x00ee2000 0x005f61c0 0x0024d780 0x00fd0980 0x00b3c80 0x003fa800 0x002c9d80 0x00039800 0x009ce040 0x01269b00  
LBA[70]: 0x00f48040 0x013b9300 0x013142280 0x004d8e00 0x006f2280 0x00121840 0x00aecb80 0x00e6d180 0x00551200 0x010d4240  
LBA[80]: 0x00410040 0x00fd40 0x011ec0c0 0x00aed000 0x000858c0 0x008d5a00 0x012e6cc0 0x009db780 0x011df280 0x00554780  
LBA[90]: 0x009b8780 0x019c2c0 0x012f15c0 0x01154ac0 0x011da100 0x0063d80 0x00841300 0x00ab7c0 0x00fd6680 0x0051f000

PRE LBA LIST:  
LBA[ 0]: 0x012edlc0 0x00fe0880 0x00844280 0x00bb740 0x00c39440 0x00843540 0x000ed1c0 0x012f1e00 0x00c90640 0x012094c0

DETECT READ ERROR:  
LBA: 0x115e16f | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]  
DETECT ERROR IO Time: 1900-01-00 00:00:00

Buffer addr: 0xffffeb8075e00 | Physical addr: 0x2544d55e00

LBA LIST:  
LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[10]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[20]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[30]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[40]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[50]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[60]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[70]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[80]: 0x5aa6e910 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[90]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

PRE LBA LIST:  
LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

Current Time: 2023-07-03 20:04:19

pause\_and\_exit\_work: Press KEY: <0> to exit!

# LBA工具基本功能演示

## ➤ BUG 002[3]: 案例一, inject SECTOR lba bug

批量校验数据, 簇内校验数据出错

BUG 002[3]: [Thread: 3] VERIFY SECTOR[306] DIFFER: 1  
| CORRECT LBA[0]: 0xb2a000 | ERROR LBA[306]: 0xb2a132 | filename: lba.raw  
LBA: 0xb2a132 | thread\_num: 10, bitmap: 0 0 0 1 0 0 0 0 0 0

CORRECT LBA[0]: 0xb2a000 | HF: 0x08001273 F1: 0x0bc823ae F2:  
0xa2e9975f [LOOP: 1 WRITE: 515 SECTOR: 0 / NUM: 2048 / ZERO: 76]  
CORRECT IO Time: 2023-06-26 14:44:58

ERROR LBA[306]: 0xb2a132 | HF: 0x00000000 F1: 0x00000000 F2:  
0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]  
INCONSISTENT IO Time: 1900-01-00 00:00:00

CORRECT LBA[307]: 0xb2a133 | HF: 0x08001273 F1: 0x0bc823ae F2:  
0xa2e9975f [LOOP: 1 WRITE: 515 SECTOR: 307 / NUM: 2048 / ZERO: 76]  
CORRECT IO Time: 2023-06-26 14:44:58

---runtime校验

```
BUG 007[1] LAST IO?: [Thread: 3] VERIFY SECTOR[306] DIFFER: 1 | read[515] | filename: lba.raw
hd write_verify_dump -c -D -L 0x08cf800 disk/file
hd_write_verify_dump -c -D -L 0x0de7800 disk/file

CORRECT LBA[0]: 0xb2a000 | HF: 0x08001273 F1: 0x0bc823ae F2: 0xa2e9975f [LOOP: 1 WRITE: 515 SECTOR: 0 / NUM: 2048 / ZERO: 76]
CORRECT IO Time: 2023-06-26 14:44:58

ERROR LBA[306]: 0xb2a132 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
INCONSISTENT IO Time: 1900-01-00 00:00:00

CORRECT LBA[307]: 0xb2a133 | HF: 0x08001273 F1: 0x0bc823ae F2: 0xa2e9975f [LOOP: 1 WRITE: 515 SECTOR: 307 / NUM: 2048 / ZERO: 76]
CORRECT IO Time: 2023-06-26 14:44:58
```

---checktime校验

Current Time: 2023-06-26 14:44:59
BUG 002[3]: [Thread: 3] BATCH VERIFY SECTOR[306] DIFFER: 1 | CORRECT LBA[0]: 0xb2a000 | ERROR LBA[306]: 0xb2a132 | filename: lba.raw
LBA: 0xb2a132 | thread\_num: 10, bitmap: 0 0 0 1 0 0 0 0 0 0

LAST CONNECT WRITE:
LBA: 0x39d800 | HF: 0x08001273 F1: 0x0bc823ae F2: 0xa2e9975f [LOOP: 1 WRITE: 530 SECTOR: 0 / NUM: 2048 / ZERO: 76]
LAST WRITE IO Time: 2023-06-26 14:44:59

Buffer addr: 0xfffffee4430000 | Physical addr: 0x2824e20000

LBA LIST:
LBA[ 0]: 0x0039d800 0x00724000 0x00011800 0x00a21800 0x0023d800 0x012a8000 0x005eb800 0x0000e000 0x00f8a800 0x00af5000
LBA[10]: 0x009ad000 0x002cc800 0x00fd0a00 0x00f4000 0x00767800 0x005c6800 0x00402000 0x007d8800 0x01242800 0x0010b000
LBA[20]: 0x00322800 0x010e3000 0x00c9a800 0x00fc0c00 0x009dc800 0x00217000 0x0013f000 0x005b7000 0x00de6800 0x0094d800
LBA[30]: 0x0033d800 0x0028e000 0x00cf800 0x009e2000 0x00670000 0x00e0f800 0x01253800 0x012fa000 0x00f59800 0x00481000
LBA[40]: 0x00e1d800 0x005d6000 0x0119f000 0x0135f000 0x0094e000 0x0113f800 0x00424000 0x00964000 0x00fa5800 0x00a3a3000
LBA[50]: 0x009ad000 0x008c5800 0x0000d1800 0x002dc000 0x0112d8000 0x00af1800 0x000f8000 0x00456800 0x00103000 0x00126000
LBA[60]: 0x00e37000 0x006e8000 0x00289000 0x00995000 0x00a89800 0x0029d000 0x00e77800 0x00185000 0x0058a800 0x001c4800
LBA[70]: 0x00aecd000 0x0044c800 0x00e5b800 0x00dd6000 0x0092800 0x01036000 0x00648800 0x01236000 0x00b79000
LBA[80]: 0x006b6800 0x0041d800 0x00995800 0x00dc6000 0x00a9a9000 0x0117d800 0x0069d000 0x001df800 0x010cf800 0x005ff000
LBA[90]: 0x0080b800 0x00434000 0x012df000 0x01395800 0x003b5000 0x00f2f000 0x00c87800 0x002b9000 0x0055f000 0x005d1800

PRE LBA LIST:
LBA[ 0]: 0x0074b000 0x0000a0000 0x009cc000 0x00fc0000 0x0110a800 0x008d0800 0x0014e000 0x011c3000 0x0028a000 0x00e43000

BATCH VERIFY:
LBA: 0xb2a000 | HF: 0x08001273 F1: 0x0bc823ae F2: 0xa2e9975f [LOOP: 1 WRITE: 515 SECTOR: 0 / NUM: 2048 / ZERO: 76]
BATCH VERIFY IO Time: 2023-06-26 14:44:58

Buffer addr: 0xfffffea0180000 | Physical addr: 0x21e5cd0000

LBA LIST:
LBA[ 0]: 0x00b2a000 0x00de7800 0x0000f2000 0x010f3800 0x01041800 0x00e43000 0x0028a000 0x011c3000 0x0014e000 0x009d0800
LBA[10]: 0x0110a800 0x00fc0000 0x009cc000 0x0000a000 0x0074b000 0x0039d800 0x00724000 0x00011800 0x00a21800 0x0023d800
LBA[20]: 0x012a8000 0x005eb800 0x0000e000 0x00f8a800 0x00af5000 0x009ad000 0x002cc800 0x00fd0a00 0x000f4000 0x00767800
LBA[30]: 0x005c6800 0x00402000 0x007d8800 0x01242800 0x0010b000 0x00322800 0x010e3000 0x00c9a800 0x00f0c000 0x00dca800
LBA[40]: 0x00217000 0x0013f000 0x005b7000 0x00de6800 0x0094d800 0x003d6000 0x0028e000 0x009e2000 0x00670000
LBA[50]: 0x0000f000 0x012538000 0x012fa000 0x00759800 0x00481000 0x00e1d800 0x005d6000 0x0119f000 0x0135f000 0x0094e000
LBA[60]: 0x0113f800 0x00424000 0x00964000 0x00fa5800 0x00b0a3000 0x00a9d000 0x008c5800 0x0000d1800 0x002dc000 0x0112d800
LBA[70]: 0x00af1800 0x00456800 0x0000f8000 0x00103000 0x00260000 0x00e37000 0x006e6800 0x00289000 0x00995000 0x00a89800
LBA[80]: 0x0029d000 0x00e77800 0x00185000 0x0058a800 0x00117d800 0x0044c800 0x00648800 0x005b7000 0x00dd6000 0x00f2800
LBA[90]: 0x01036000 0x00648800 0x0084b800 0x01236000 0x00b79000 0x006b6800 0x0041d800 0x00995800 0x00dc6000 0x00a9a000

PRE LBA LIST:
LBA[ 0]: 0x008cf800 0x000f1800 0x01032800 0x001aa800 0x00113800 0x00710800 0x00fe4000 0x00fe4000 0x0011b000 0x00144000

DETECT READ ERROR:
LBA: 0xb2a132 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
DETECT ERROR IO Time: 1900-01-00 00:00:00

Buffer addr: 0xfffffea01a6400 | Physical addr: 0x237d7a6400

LBA LIST:
LBA[ 0]: 0x00000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000
LBA[10]: 0x00000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000
LBA[20]: 0x00000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000
LBA[30]: 0x00000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000
LBA[40]: 0x00000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000
LBA[50]: 0x00000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000
LBA[60]: 0x00000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000
LBA[70]: 0x00000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000
LBA[80]: 0x00000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000
LBA[90]: 0x00000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000

PRE LBA LIST:
LBA[ 0]: 0x00000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000 0x000000000

Current Time: 2023-06-26 14:44:59

pause\_and\_exit\_work: Press KEY: <Q> to exit!

# LBA工具基本功能演示

## ➤ BUG 002[3]: 案例二, inject SECTOR lba bug

批量校验数据, 簇内校验数据出错

BUG 002[3]: [Thread: 4] VERIFY SECTOR[283] DIFFER: 84  
| CORRECT LBA[0]: 0x39e800 | ERROR LBA[283]: 0x39e91b  
| filename: lba.raw

CORRECT LBA[0]: 0x39e800 | HF: 0x04001274 F1: 0xc079f392 F2:  
0x42a8b61c [LOOP: 1 WRITE: 474 SECTOR: 0 / NUM: 1024 / ZERO: 98]  
CORRECT IO Time: 2023-06-23 00:02:28

ERROR LBA[283]: 0x39e91b | HF: 0xbfbfbfbfb F1: 0xbfbfbfbfb F2: 0xbfbfbfbfb  
[LOOP: 3217014719 WRITE: 3217014719 SECTOR: 49087 / NUM: 49087 /  
ZERO: 3217014719]  
INCONSISTENT IO Time: -1077950677--1077952576--1077952577 -  
1077952577:-1077952577:-1077952577

CORRECT LBA[367]: 0x39e96f | HF: 0x04001274 F1: 0xc079f392 F2:  
0x42a8b61c [LOOP: 1 WRITE: 474 SECTOR: 367 / NUM: 1024 / ZERO: 98]  
CORRECT IO Time: 2023-06-23 00:02:28

---runtime校验

BUG 007[1] LAST IO?: [Thread: 4] VERIFY SECTOR[283] DIFFER: 84 | read[474] | filename: lba.raw

hd write verify\_dump -c -D -L 0x00621000 disk/file  
hd\_write\_verify\_dump -c -D -L 0x00216c00 disk/file

CORRECT LBA[0]: 0x39e800 | HF: 0x04001274 F1: 0xc079f392 F2: 0x42a8b61c [LOOP: 1 WRITE: 474 SECTOR: 0 / NUM: 1024  
CORRECT IO Time: 2023-06-23 00:02:28

ERROR LBA[283]: 0x39e91b | HF: 0xbfbfbfbfb F1: 0xbfbfbfbfb F2: 0xbfbfbfbfb [LOOP: 3217014719 WRITE: 3217014719 SECTOR  
INCONSISTENT IO Time: -1077950677--1077952576--1077952577 -1077952577:-1077952577:-1077952577

CORRECT LBA[367]: 0x39e96f | HF: 0x04001274 F1: 0xc079f392 F2: 0x42a8b61c [LOOP: 1 WRITE: 474 SECTOR: 367 / NUM: 1  
CORRECT IO Time: 2023-06-23 00:02:28

---checktime校验

BUG 002[3]: [Thread: 4] VERIFY SECTOR[283] DIFFER: 84 | CORRECT LBA[0]: 0x39e800 | ERROR LBA[283]: 0x39e91b | filename: lba.raw  
LBA: 0x39e91b | thread\_num: 10, bitmap: 0 0 0 1 0 0 0 0 0

LAST CORRECT WRITE:  
LBA: 0x39c000 | HF: 0x04001274 F1: 0xc079f392 F2: 0x42a8b61c [LOOP: 1 WRITE: 490 SECTOR: 0 / NUM: 1024 / ZERO: 98]  
LAST WRITE IO Time: 2023-06-23 00:02:29

Buffer addr: 0xffffefad80000 | Physical addr: 0x222ca40000

LBA LIST:  
LBA[ 0]: 0x039c000 0x00736c00 0x001d1000 0x006eac00 0x00073400 0x00152800 0x00721400 0x00374400 0x00438c00 0x006bbc00  
LBA[10]: 0x003ca800 0x000c7000 0x00449c00 0x0015d000 0x00276800 0x0065a000 0x0010a400 0x0043d800 0x0076c400 0x00140000  
LBA[20]: 0x0054c000 0x00223800 0x0006b7400 0x00221000 0x006fe400 0x000ef400 0x00568400 0x00663000 0x001c3c00 0x00732800  
LBA[30]: 0x004ed000 0x00759800 0x00571000 0x0073b800 0x001b5800 0x0049d400 0x005f4800 0x00115400 0x0061ac00 0x003df400  
LBA[40]: 0x0073e800 0x000e4400 0x002dc1c00 0x00133c00 0x00310800 0x000c4400 0x004d5400 0x00428800 0x00391000 0x0030c800  
LBA[50]: 0x005ae400 0x0077ec00 0x00153400 0x003a6000 0x002f6c00 0x00374c00 0x001af400 0x004f4400 0x006f9800  
LBA[60]: 0x00526c00 0x00346c00 0x007e3800 0x0073c000 0x003a9800 0x00232c00 0x00662800 0x007e7800 0x0036bc00 0x00314400  
LBA[70]: 0x0001b1400 0x00054400 0x000bb800 0x001b1800 0x00143400 0x007a4400 0x0043c00 0x00146c00 0x0066b400 0x005fa800  
LBA[80]: 0x00173400 0x0058e800 0x000aa5800 0x0073c800 0x00552400 0x00375400 0x00791400 0x006ed800 0x003f3400 0x003e4800  
LBA[90]: 0x00749400 0x00673000 0x004be800 0x00609c00 0x001f1000 0x00277800 0x00477400 0x001b1c00 0x003c1800 0x00244800

PRE LBA LIST:  
LBA[ 0]: 0x03ee000 0x0017d000 0x0076c000 0x0068dc00 0x00541000 0x006a5000 0x004c3c00 0x0057c800 0x00285800

BATCH VERIFY:  
LBA: 0x39e800 | HF: 0x04001274 F1: 0xc079f392 F2: 0x42a8b61c [LOOP: 1 WRITE: 474 SECTOR: 0 / NUM: 1024 / ZERO: 98]  
BATCH VERIFY IO Time: 2023-06-23 00:02:28

Buffer addr: 0xffffefad0000 | Physical addr: 0x221ae70000

LBA LIST:  
LBA[ 0]: 0x039e800 0x00216c00 0x00627400 0x0071b800 0x00667000 0x0079d00 0x00285800 0x003fc400 0x0057c800 0x004c3c00  
LBA[10]: 0x00a5000 0x00541000 0x0068dc00 0x0076c000 0x0017d000 0x003ee000 0x0039c000 0x00736c00 0x001d1000 0x006eac00  
LBA[20]: 0x00073400 0x00152800 0x00721400 0x00374400 0x00438c00 0x006bbc00 0x003ca800 0x000c7000 0x00449c00 0x0015d000  
LBA[30]: 0x00276800 0x0065a000 0x0010a400 0x0043d800 0x00140000 0x0054c000 0x00663000 0x00223800 0x006b7400 0x00221000  
LBA[40]: 0x007fc400 0x000ef400 0x00568400 0x00663000 0x001c3c00 0x00732800 0x004ed000 0x00759800 0x00571000 0x0073b800  
LBA[50]: 0x001b5800 0x0049d400 0x005f4800 0x00115400 0x0061ac00 0x003df400 0x0073e800 0x000e4400 0x002d1c00 0x00133c00  
LBA[60]: 0x003010800 0x000ca400 0x0004d5400 0x00428800 0x00391000 0x0030c800 0x005ae400 0x003a6000 0x00303c00 0x002f6c00  
LBA[70]: 0x000359000 0x00276c00 0x00374c00 0x001af400 0x004f4400 0x006f9800 0x00526c00 0x00346c00 0x007e3800 0x0073cc00  
LBA[80]: 0x003a9800 0x00232c00 0x00662800 0x007e7800 0x0036bc00 0x00314400 0x0001b400 0x006a5000 0x000bb800 0x001b1800  
LBA[90]: 0x00143400 0x007a4400 0x00434c00 0x00146c00 0x0066b400 0x005fa800 0x0017a400 0x0058e800 0x000a5800 0x0073c800

PRE LBA LIST:  
LBA[ 0]: 0x00621000 0x0065e400 0x00026000 0x00582800 0x00594400 0x00297400 0x0032a000 0x0079d800 0x00121800 0x0010bc00

DETECT READ ERROR:  
LBA: 0x39e91b | HF: 0xbfbfbfbfb F1: 0xbfbfbfbfb F2: 0xbfbfbfbfb [LOOP: 3217014719 WRITE: 3217014719 SECTOR: 49087 / NUM: 49087 / ZERO: 3217014719]  
DETECT ERROR IO Time: -1077950677--1077952576--1077952577 -1077952577:-1077952577:-1077952577

Buffer addr: 0xffffefad0000 | Physical addr: 0x2220e3600

LBA LIST:  
LBA[ 0]: 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb  
LBA[10]: 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb  
LBA[20]: 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb  
LBA[30]: 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb  
LBA[40]: 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb  
LBA[50]: 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb  
LBA[60]: 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb  
LBA[70]: 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb  
LBA[80]: 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb  
LBA[90]: 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb

PRE LBA LIST:  
LBA[ 0]: 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb 0xbfbfbfbfb

# LBA工具基本功能演示

## ➤ BUG 002[3]: 案例三, inject LIST lba bug

批量校验数据, 簇内校验数据出错

BUG 002[3]: [Thread: 6] VERIFY SECTOR[400] DIFFER: 1  
| CORRECT LBA[0]: 0x762800 | ERROR LBA[400]: 0x762990  
| filename: lba.raw

CORRECT LBA[0]: 0x762800 | HF: 0x04001276 F1: 0x65bbb47d F2: 0xda812af0  
[LOOP: 1 WRITE: 550 SECTOR: 0 / NUM: 1024 / ZERO: 120]  
CORRECT IO Time: 2023-06-25 16:22:21

ERROR LBA[400]: 0x762990 | HF: 0x04001276 F1: 0x65bbb47d F2: 0xda812af0  
[LOOP: 1 WRITE: 550 SECTOR: 400 / NUM: 1024 / ZERO: 120]  
INCONSISTENT IO Time: 2023-06-25 16:22:21

CORRECT LBA[401]: 0x762991 | HF: 0x04001276 F1: 0x65bbb47d F2: 0xda812af0  
[LOOP: 1 WRITE: 550 SECTOR: 401 / NUM: 1024 / ZERO: 120]  
CORRECT IO Time: 2023-06-25 16:22:21

---runtime校验

```
BUG 007[1] LAST IO?: [Thread: 6] VERIFY SECTOR[400] DIFFER: 1 | read[550] | filename: lba.raw

hd_write_verify_dump -c -D -L 0x00521800 disk/file
hd_write_verify_dump -c -D -L 0x006dec00 disk/file

CORRECT LBA[0]: 0x762800 | HF: 0x04001276 F1: 0x65bbb47d F2: 0xda812af0 [LOOP: 1 WRITE: 550 SECTOR: 0 / NUM: 1024 / ZERO: 120]
CORRECT IO Time: 2023-06-25 16:22:21

ERROR LBA[400]: 0x762990 | HF: 0x04001276 F1: 0x65bbb47d F2: 0xda812af0 [LOOP: 1 WRITE: 550 SECTOR: 400 / NUM: 1024 / ZERO: 120]
INCONSISTENT IO Time: 2023-06-25 16:22:21

CORRECT LBA[401]: 0x762991 | HF: 0x04001276 F1: 0x65bbb47d F2: 0xda812af0 [LOOP: 1 WRITE: 550 SECTOR: 401 / NUM: 1024 / ZERO: 120]
CORRECT IO Time: 2023-06-25 16:22:21
```

---checktime校验

```
BUG 002[3]: [Thread: 6] VERIFY SECTOR[400] DIFFER: 1 | CORRECT LBA[0]: 0x762800 | ERROR LBA[400]: 0x762990 | filename: lba.raw
LBA: 0x762990 | thread_num: 10, bitmap: 0 0 0 0 0 1 0 0 0

LAST CORRECT WRITE:
LBA: 0x6f2400 | HF: 0x04001276 F1: 0x65bbb47d F2: 0xda812af0 [LOOP: 1 WRITE: 564 SECTOR: 0 / NUM: 1024 / ZERO: 120]
LAST WRITE IO Time: 2023-06-25 16:22:21

Buffer addr: 0xffffeb14d0000 | Physical addr: 0x53a2320000

LBA LIST:
LBA[ 0]: 0x006f2400 0x002c8800 0x00441c00 0x005d1400 0x006f6400 0x00256000 0x006df400 0x007df800 0x00117800 0x00310c00
LBA[10]: 0x00249400 0x005f0800 0x001cac00 0x00794000 0x0003d400 0x00503c00 0x004cc800 0x001a1c00 0x00560800
LBA[20]: 0x003f6800 0x00125c00 0x00728400 0x00447c00 0x003ca000 0x00073800 0x00107000 0x006f7400 0x002dc00 0x00037800
LBA[30]: 0x003c3400 0x005d9800 0x0040c000 0x0008a000 0x0008a000 0x0005f9800 0x001a2400 0x0065bc00 0x00449c00 0x00018c00 0x00724000
LBA[40]: 0x002fc400 0x0068a000 0x001ef800 0x0067f400 0x00216000 0x006f9400 0x00182400 0x0049ab00 0x002d5400 0x0004e400
LBA[50]: 0x0072fc00 0x00376c00 0x001be400 0x00706c00 0x00057400 0x0014f400 0x00366000 0x00075400 0x00590900 0x002ad800 0x002cc400
LBA[60]: 0x0070e800 0x0013f800 0x000401400 0x001c4000 0x0005f9400 0x00559000 0x002ad800 0x002cc400
LBA[70]: 0x004c4400 0x00590900 0x00191000 0x006f8400 0x0060e400 0x001a3c00 0x002c4400 0x00366000 0x00179c00
LBA[80]: 0x00514c00 0x00484400 0x0035f000 0x0008a400 0x00585c00 0x000b9c00 0x00173c00 0x0040b800 0x00133800 0x003fac00
LBA[90]: 0x00501000 0x000d3800 0x007c8c00 0x00611400 0x000c7c00 0x006b9800 0x00174000 0x000fe400 0x00386c00 0x006bfcc00

PRE LBA LIST:
LBA[ 0]: 0x005b0c00 0x00714400 0x0030d400 0x0021ac00 0x00190c00 0x000d4800 0x0031dc00 0x00449800 0x007a9800 0x006f8c00

BATCH VERIFY:
LBA: 0x762800 | HF: 0x04001276 F1: 0x65bbb47d F2: 0xda812af0 [LOOP: 1 WRITE: 550 SECTOR: 0 / NUM: 1024 / ZERO: 120]
BATCH VERIFY IO Time: 2023-06-25 16:22:21

Buffer addr: 0xffffeb08f0000 | Physical addr: 0x45028d0000

LBA LIST:
LBA[ 0]: 0x00762800 0x006dec00 0x0069f800 0x00138800 0x006f8c00 0x007a9800 0x00449800 0x0031dc00 0x000d4800 0x00190c00
LBA[10]: 0x0021ac00 0x0030d400 0x00714400 0x005b0c00 0x006f2400 0x002c8800 0x00441c00 0x005d1400 0x006f6400 0x00256000
LBA[20]: 0x006fd400 0x007df800 0x00117800 0x00310c00 0x00249400 0x005f0800 0x001caca00 0x00794000 0x0003d400 0x000e9000
LBA[30]: 0x00503c00 0x004cc800 0x001a1c00 0x00560800 0x003f6800 0x00125c00 0x00728400 0x00447c00 0x003ca000 0x00073800
LBA[40]: 0x00107000 0x006fd400 0x002dc00 0x00037800 0x003ca000 0x005d9800 0x00404c00 0x0008a000 0x0009f800 0x001a2400
LBA[50]: 0x0065bc00 0x00449c00 0x00018c00 0x00724000 0x002fc400 0x0068a000 0x001ef800 0x0067f400 0x00216000 0x006ff9400
LBA[60]: 0x00182400 0x0049ab00 0x002d5400 0x0004e400 0x0072fc00 0x00376c00 0x001be400 0x00706c00 0x00057400 0x0014f800
LBA[70]: 0x00366000 0x0079d400 0x006b3c00 0x00489c00 0x0070e800 0x006d7c00 0x0013f800 0x00401400 0x001c4000 0x007e5400
LBA[80]: 0x00509400 0x00590900 0x002ad800 0x002c400 0x004ca00 0x00509800 0x00191000 0x006f8400 0x0060e400 0x001a3c00
LBA[90]: 0x002c4400 0x00386000 0x00179c00 0x00421400 0x00514c00 0x00484000 0x0035f000 0x0008a400 0x00585c00 0x000b9c00

PRE LBA LIST:
LBA[ 0]: 0x00521800 0x006a9c00 0x00042c00 0x006c7000 0x00755000 0x00115400 0x005c4800 0x007bf800 0x002e6000 0x002d2400

DETECT READ ERROR:
LBA: 0x762990 | HF: 0x04001276 F1: 0x65bbb47d F2: 0xda812af0 [LOOP: 1 WRITE: 550 SECTOR: 400 / NUM: 1024 / ZERO: 120]
DETECT ERROR IO Time: 2023-06-25 16:22:21

Buffer addr: 0xffffeb0922000 | Physical addr: 0x53aeff2000

LBA LIST:
LBA[ 0]: 0x00762800 0x006dec00 0x0069f800 0x00138800 0x006f8c00 0x007a9800 0x00449800 0x0031dc00 0x000d4800 0x00190c00
LBA[10]: 0x0021ac00 0x0030d400 0x00714400 0x005b0c00 0x006f2400 0x002c8800 0x00441c00 0x005d1400 0x006f6400 0x00256000
LBA[20]: 0x006971f04 0x007df800 0x00117800 0x00310c00 0x00249400 0x005f0800 0x001cac00 0x00794000 0x0003d400 0x000e9000
LBA[30]: 0x00503c00 0x004cc800 0x001a1c00 0x00560800 0x003f6800 0x00125c00 0x00728400 0x00447c00 0x003ca000 0x00073800
LBA[40]: 0x00107000 0x006fd400 0x002dc00 0x00037800 0x003ca000 0x005d9800 0x00404c00 0x0008a000 0x0009f800 0x001a2400
LBA[50]: 0x0065bc00 0x00449c00 0x00018c00 0x00724000 0x002fc400 0x0068a000 0x001ef800 0x0067f400 0x00216000 0x006ff9400
LBA[60]: 0x00182400 0x0049ab00 0x002d5400 0x0004e400 0x0072fc00 0x00376c00 0x001be400 0x00706c00 0x00057400 0x0014f800
LBA[70]: 0x00366000 0x0079d400 0x006b3c00 0x00489c00 0x0070e800 0x006d7c00 0x0013f800 0x00401400 0x001c4000 0x007e5400
LBA[80]: 0x00509400 0x00590900 0x002ad800 0x002c400 0x004ca00 0x00509800 0x00191000 0x006f8400 0x0060e400 0x001a3c00
LBA[90]: 0x002c4400 0x00386000 0x00179c00 0x00421400 0x00514c00 0x00484000 0x0035f000 0x0008a400 0x00585c00 0x000b9c00

PRE LBA LIST:
LBA[ 0]: 0x00521800 0x006a9c00 0x00042c00 0x006c7000 0x00755000 0x00115400 0x005c4800 0x007bf800 0x002e6000 0x002d2400
```

Current Time: 2023-06-25 16:22:21

pause and exit work: Press KEY: <0> to exit!

# LBA工具基本功能演示

## ➤ BUG 002[4]: 案例一, inject SECTOR lba bug

批量校验数据, 簇内校验全0扇区数据出错

BUG 002[4]: [Thread: 1] VERIFY ZERO SECTOR[970] DIFFER: 54  
| CORRECT LBA[0]: 0x7e9800 | ERROR LBA[970]: 0x7e9bca  
| filename: lba.raw

CORRECT LBA[0]: 0x7e9800 | HF: 0x04001271 F1: 0xc079f392 F2: 0x8d10bb23  
[LOOP: 1 WRITE: 533 SECTOR: 0 / NUM: 1024 / ZERO: 271]  
CORRECT IO Time: 2023-06-23 00:02:29

ERROR LBA[970]: 0x7e9bca | HF: 0xb4b4b4b4 F1: 0xb4b4b4b4 F2: 0xb4b4b4b4  
[LOOP: 3031741620 WRITE: 3031741620 SECTOR: 46260 / NUM: 46260 /  
ZERO: 3031741620]

INCONSISTENT IO Time: -1263223776--1263225675--1263225676 -  
1263225676:-1263225676:-1263225676

NEXT LBA: 0x60b000 | HF: 0x04001271 F1: 0xc079f392 F2: 0x8d10bb23  
[LOOP: 1 WRITE: 534 SECTOR: 0 / NUM: 1024 / ZERO: 271]  
NEXT IO Time: 2023-06-23 00:02:29

---runtime校验

BUG 007[4]: [Thread: 1] VERIFY ZERO SECTOR[970] DIFFER: 54 | read[534] | filename: lba.raw

hd\_write\_verify\_dump -c -D -L 0x006e5c00 disk/file  
hd\_write\_verify\_dump -c -D -L 0x0060b000 disk/file

CORRECT LBA[0]: 0x7e9800 | HF: 0x04001271 F1: 0xc079f392 F2: 0x8d10bb23 [LOOP: 1 WRITE: 533 SECTOR: 0 / NUM: 1024 / ZERO: 271]  
CORRECT IO Time: 2023-06-23 00:02:29

ERROR LBA[970]: 0x7e9bca | HF: 0xb4b4b4b4 F1: 0xb4b4b4b4 F2: 0xb4b4b4b4 [LOOP: 3031741620 WRITE: 3031741620 SECTOR: 46260 /  
NUM: 46260 / ZERO: 3031741620]

INCONSISTENT IO Time: -1263223776--1263225675--1263225676 -1263225676:-1263225676

NEXT LBA: 0x60b000 | HF: 0x04001271 F1: 0xc079f392 F2: 0x8d10bb23 [LOOP: 1 WRITE: 534 SECTOR: 0 / NUM: 1024 / ZERO: 271]  
NEXT IO Time: 2023-06-23 00:02:29

---checktime校验

BUG 002[4]: [Thread: 1] VERIFY ZERO SECTOR[970] DIFFER: 54 | CORRECT LBA[0]: 0x7e9800 | ERROR LBA[970]: 0x7e9bca | filename: lba.raw  
LBA: 0x7e9bca | thread\_num: 10, bitmap: 0 1 0 0 0 0 0 0 0 0

LAST CORRECT WRITE:  
LBA: 0x717400 | HF: 0x04001271 F1: 0xc079f392 F2: 0x8d10bb23 [LOOP: 1 WRITE: 550 SECTOR: 0 / NUM: 1024 / ZERO: 271]  
LAST WRITE IO Time: 2023-06-23 00:02:30

Buffer addr: 0xfffffb00000 | Physical addr: 0x2026e3060000

LBA LIST:  
LBA[ 0]: 0x00717400 0x00697800 0x00560000 0x00343000 0x00621400 0x003e8400 0x00010c00 0x002a8800 0x0066e000 0x0037ec00  
LBA[10]: 0x00317400 0x00769000 0x00738400 0x00003400 0x005d4000 0x00444800 0x00510c00 0x005c4400 0x007b1800 0x004de400  
LBA[20]: 0x004a4b00 0x007c5400 0x007a5800 0x003b3c00 0x00044000 0x0075fc00 0x002f6800 0x005a800 0x001a9400 0x0028ac00  
LBA[30]: 0x00254000 0x00422800 0x002a3000 0x0016bc00 0x006f9400 0x00048c00 0x0047000 0x000ba000 0x005ed000 0x00772800  
LBA[40]: 0x00793c00 0x00415400 0x006b8800 0x00095c00 0x004ff000 0x006dd400 0x00220c00 0x0012e800 0x000b8000 0x0033b000  
LBA[50]: 0x00210400 0x0028cc00 0x000af400 0x0066e800 0x0051d800 0x00170c00 0x00713800 0x0049dc00 0x00735800 0x002b8000  
LBA[60]: 0x001f8000 0x0016b400 0x00063800 0x000533400 0x00094000 0x0027400 0x001dc400 0x000c0400  
LBA[70]: 0x00485800 0x00088400 0x007bec00 0x0053e00 0x00066c00 0x0049800 0x003f800 0x00210400 0x00055400 0x00565400  
LBA[80]: 0x0028b200 0x00539400 0x000d4800 0x003cf800 0x002f7800 0x003d0c00 0x00556c00 0x0040d800 0x004f4800 0x004a0c00  
LBA[90]: 0x0077ac00 0x00347c00 0x00045c00 0x0060b400 0x0030d000 0x002a4800 0x007d8c00 0x0070c800 0x00219c00 0x00555400

PRE LBA LIST:  
LBA[ 0]: 0x000b2000 0x0054fc00 0x000bd800 0x00041800 0x00639c00 0x00247c00 0x00155000 0x005c8800 0x002dbc00 0x0021c800

BATCH VERIFY:  
LBA: 0x7e9800 | HF: 0x04001271 F1: 0xc079f392 F2: 0x8d10bb23 [LOOP: 1 WRITE: 533 SECTOR: 0 / NUM: 1024 / ZERO: 271]  
RANDOM VERIFY IO Time: 2023-06-23 00:02:29

Buffer addr: 0xfffffe380000 | Physical addr: 0x43e3fe0000

LBA LIST:  
LBA[ 0]: 0x007e9800 0x0060b000 0x003ee400 0x007af400 0x0019d400 0x00648400 0x004ffcc0 0x0021c800 0x002dbc00 0x005c8800

LBA[10]: 0x00155000 0x00247c00 0x00639c00 0x00041800 0x000bd800 0x0054fc00 0x000b2000 0x00717400 0x00697800 0x00560000  
LBA[20]: 0x00343000 0x00621400 0x003e8400 0x00001c00 0x002a8800 0x0054fc00 0x000b2000 0x0037ec00 0x00317400 0x00769000 0x00738400  
LBA[30]: 0x000d3400 0x005d4000 0x00444800 0x00510c00 0x00544800 0x007b1800 0x004de400 0x004ab400 0x007c5400 0x007a5800  
LBA[40]: 0x000b3c00 0x000e4000 0x0075fc00 0x0026f800 0x0005a800 0x001a9400 0x0028ac00 0x00254000 0x00422800 0x002a3000  
LBA[50]: 0x0016b3c00 0x000679400 0x00048c00 0x00447000 0x00051d400 0x00772800 0x00155000 0x00415400 0x000b8000  
LBA[60]: 0x00095c00 0x0004fe000 0x006d400 0x00220c00 0x0012e800 0x000bac00 0x003b000 0x00210400 0x0028cc00 0x000afa400  
LBA[70]: 0x00066e800 0x0051d800 0x00170c00 0x00713800 0x0049d00 0x00735800 0x002ba000 0x001f8000 0x001bd400 0x000d3800  
LBA[80]: 0x000505c00 0x00133400 0x0055a00 0x0009000 0x0022f400 0x001dc400 0x006c400 0x00485800 0x00088400 0x007bec00  
LBA[90]: 0x0053c00 0x00066c00 0x004b9800 0x003f6000 0x00295800 0x00655400 0x0028bc00 0x00539400 0x000d4800

PRE LBA LIST:  
LBA[ 0]: 0x006e5c00 0x005de400 0x006ad400 0x00119800 0x002d3c00 0x0013f000 0x0006a800 0x006d4800 0x00288400 0x0049bc00

Detect Read Error:  
LBA: 0x7e9bca | HF: 0xb4b4b4b4 F1: 0xb4b4b4b4 F2: 0xb4b4b4b4 [LOOP: 3031741620 WRITE: 3031741620 SECTOR: 46260 / NUM: 46260 / ZERO: 3031741620]  
Detect Error IO Time: -1263223776--1263225675--1263225676 -1263225676:-1263225676

Buffer addr: 0xfffffe3f9400 | Physical addr: 0x45f8669400

LBA LIST:  
LBA[ 0]: 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4

LBA[10]: 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4  
LBA[20]: 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4  
LBA[30]: 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4  
LBA[40]: 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4  
LBA[50]: 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4  
LBA[60]: 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4  
LBA[70]: 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4  
LBA[80]: 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4  
LBA[90]: 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4

PRE LBA LIST:  
LBA[ 0]: 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4

Current Time: 2023-06-23 00:02:35

# LBA工具基本功能演示

## ➤ BUG 002[4]: 案例二, inject LIST lba bug

批量校验数据, 簇内校验全0扇区数据出错

BUG 002[4]: [Thread: 6] VERIFY ZERO SECTOR[974] DIFFER: 1  
| CORRECT LBA[0]: 0x615c00 | ERROR LBA[974]: 0x615fce  
| filename: lba.raw  
LBA: 0x615fce | thread\_num: 10, bitmap: 0 0 0 0 0 0 1 0 0 0

CORRECT LBA[0]: 0x615c00 | HF: 0x04001276 F1: 0x47877c66 F2:  
0x657f8ed0 [LOOP: 1 WRITE: 396 SECTOR: 0 / NUM: 1024 / ZERO: 190]  
CORRECT IO Time: 2023-06-26 00:22:21

ERROR LBA[974]: 0x615fce | HF: 0x00000000 F1: 0x00000000 F2:  
0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]  
INCONSISTENT IO Time: 1900-01-00 00:00:00

CORRECT LBA[975]: 0x615fcf | HF: 0x00000000 F1: 0x00000000 F2:  
0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]  
CORRECT IO Time: 1900-01-00 00:00:00

---runtime校验

```
BUG 007[2] LAST IO?: [Thread: 6] VERIFY ZERO SECTOR[974] DIFFER: 1 | read[396] | filename: lba.raw
hd_write_verify_dump -c -D -L 0x001fa400 disk/file
hd_write_verify_dump -c -D -L 0x007b3000 disk/file

CORRECT LBA[0]: 0x615c00 | HF: 0x04001276 F1: 0x47877c66 F2: 0x657f8ed0 [LOOP: 1 WRITE: 396 SECTOR: 0 / NUM: 1024 / ZERO: 190]
CORRECT IO Time: 2023-06-26 00:22:21

ERROR LBA[974]: 0x615fce | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
INCONSISTENT IO Time: 1900-01-00 00:00:00

CORRECT LBA[975]: 0x615fcf | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
CORRECT IO Time: 1900-01-00 00:00:00
```

---checktime校验

Current Time: 2023-06-26 00:22:23
BUG 002[4]: [Thread: 6] VERIFY ZERO SECTOR[974] DIFFER: 1 | CORRECT LBA[0]: 0x615c00 | ERROR LBA[974]: 0x615fce | filename: lba.raw
LBA: 0x615fce | thread\_num: 10, bitmap: 0 0 0 0 0 0 1 0 0 0

LAST CORRECT WRITE:
LBA: 0x5fa800 | HF: 0x04001276 F1: 0x47877c66 F2: 0x657f8ed0 [LOOP: 1 WRITE: 402 SECTOR: 0 / NUM: 1024 / ZERO: 190]
LAST WRITE IO Time: 2023-06-26 00:22:21

Buffer addr: 0xfffff75820000 | Physical addr: 0x300af3d0000

LBA LIST:
LBA[ 0]: 0x005fa800 0x0062d000 0x00337000 0x00643800 0x00312800 0x0075c000 0x00080000 0x00323800 0x00486800 0x007d9400
LBA[10]: 0x002cc400 0x0013c400 0x007fac00 0x0023000 0x007d9c00 0x0012a000 0x006a2000 0x006fbcc0 0x0065a400
LBA[20]: 0x00634000 0x005c2c00 0x0029c000 0x0075f400 0x0078f800 0x0059d400 0x006ed800 0x00336400 0x00762000 0x0025a000
LBA[30]: 0x00058c00 0x001dd800 0x00062c00 0x000f1000 0x003a8000 0x00104000 0x0007b400 0x00380800 0x00698400 0x005c9400
LBA[40]: 0x00299400 0x0014d400 0x002d3c00 0x00310000 0x001d2800 0x00403000 0x00560400 0x0057d800 0x000b3400 0x003ec400
LBA[50]: 0x003a5000 0x00631c00 0x0077f800 0x00218000 0x000d2400 0x002eac00 0x0051f000 0x00200800 0x004c3800 0x00669c00
LBA[60]: 0x00460c00 0x000aa4000 0x002aa800 0x000d4400 0x005f8000 0x0057c800 0x001b2400 0x006b8400 0x00599400 0x002ff400
LBA[70]: 0x0004b8000 0x006cc800 0x00749800 0x00557800 0x00226400 0x0039c000 0x00772800 0x00022400 0x002c3800 0x00042400
LBA[80]: 0x0034fc00 0x00394400 0x005a1800 0x007ddc00 0x00632c00 0x0049e400 0x00223c00 0x001bc800 0x0031cc00 0x00638400
LBA[90]: 0x006c0400 0x00597000 0x0022c800 0x001b3000 0x000ba800 0x00007c00 0x00317c00 0x0025f800 0x00413c00 0x00283c00

PRE LBA LIST:
LBA[ 0]: 0x003elc00 0x00381c00 0x0050e000 0x0072fc00 0x007b3000 0x00615c00 0x001fa400 0x004d5800 0x004a4400 0x00322800

BATCH VERIFY:
LBA: 0x615c00 | HF: 0x04001276 F1: 0x47877c66 F2: 0x657f8ed0 [LOOP: 1 WRITE: 396 SECTOR: 0 / NUM: 1024 / ZERO: 190]
RANDOM VERIFY IO Time: 2023-06-26 00:22:21

Buffer addr: 0xfffff74d80000 | Physical addr: 0x300deb2000

LBA LIST:
LBA[ 0]: 0x00615c00 0x007b3000 0x0072fc00 0x0050e000 0x00381c00 0x003elc00 0x005fa800 0x0062d000 0x00337000 0x00643800
LBA[10]: 0x00312800 0x0075c000 0x00080000 0x00323800 0x00486800 0x007d9400 0x002cc400 0x0013c400 0x007fac00 0x0023a000
LBA[20]: 0x007d9c00 0x0012a000 0x006a2000 0x000f7000 0x006fbcc0 0x0065a400 0x00634000 0x005c2c00 0x0029c000 0x0075f400
LBA[30]: 0x0078f800 0x0059d400 0x006ed800 0x00336400 0x00762000 0x0025a000 0x00058c00 0x001dd800 0x00062c00 0x000f1000
LBA[40]: 0x0003a8000 0x00110400 0x0007b400 0x00380800 0x00698400 0x0059c400 0x0014d400 0x002d3c00 0x00331000
LBA[50]: 0x001d2800 0x00403000 0x00560400 0x0057d800 0x000b3400 0x003ec400 0x003a5000 0x00631c00 0x0077f800 0x00218000
LBA[60]: 0x0000d2400 0x002eac00 0x0051f000 0x00200800 0x0043800 0x00669c00 0x00460c00 0x000aa4000 0x002aa800 0x000d4400
LBA[70]: 0x005f8000 0x0057a800 0x001b2400 0x006b8400 0x00599400 0x000ff400 0x004h8800 0x006c800 0x00749800 0x00557000
LBA[80]: 0x00226400 0x0039cc00 0x00772800 0x00022400 0x002c3800 0x00042400 0x0034fc00 0x00394400 0x005a1800 0x007ddc00
LBA[90]: 0x00632c00 0x0049e400 0x00223c00 0x001bc800 0x0031cc00 0x00638400 0x006c0400 0x00597000 0x0022c800 0x001b3000

PRE LBA LIST:
LBA[ 0]: 0x001fa400 0x004d5800 0x004a4400 0x00322800 0x00215800 0x004c8000 0x00107000 0x00028000 0x00663000 0x005ad800

DETECT READ ERROR:
LBA: 0x615fce | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
DETECT ERROR IO Time: 1900-01-00 00:00:00

Buffer addr: 0xfffff74df9c00 | Physical addr: 0x3032a459c00

LBA LIST:
LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[10]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[20]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[30]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[40]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[50]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[60]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[70]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[80]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[90]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

PRE LBA LIST:
LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

Current Time: 2023-06-26 00:22:23

pause\_and\_exit\_work: Press KEY: <Q> to exit!

# LBA工具基本功能演示

## ➤ BUG 003

PRE\_LIST数据 或者 LBA\_LIST数据校验出错

BUG 003: [Thread: 3] WRITE PART SECTOR | read[83]  
| filename: lba.raw

CORRECT LBA: 0xb62000 | HF: 0x04001273 F1:  
0xa1b5ec90 F2: 0x31cedf50 [LOOP: 1 WRITE: 82 SECTOR:  
0 / NUM: 1024 / ZERO: 31]  
CORRECT LBA IO Time: 2023-06-12 17:11:53

ERROR LBA: 0xed4000 | HF: 0x04001273 F1: 0xa1b5ec90  
F2: 0x31cedf50 [LOOP: 1 WRITE: 83 SECTOR: 0 / NUM:  
1024 / ZERO: 31]  
ERROR LBA IO Time: 2023-06-12 17:12:03

---runtime校验 & checktime校验

BUG 003: [Thread: 3] WRITE PART SECTOR | read[83] | filename: lba.raw  
CORRECT LBA: 0xb62000 | HF: 0x04001273 F1: 0xa1b5ec90 F2: 0x31cedf50 [LOOP: 1 WRITE: 82 SECTOR: 0 / NUM: 1024 / ZERO: 31]  
CORRECT LBA IO Time: 2023-06-12 17:11:53

ERROR LBA: 0xed4000 | HF: 0x04001273 F1: 0xa1b5ec90 F2: 0x31cedf50 [LOOP: 1 WRITE: 83 SECTOR: 0 / NUM: 1024 / ZERO: 31]  
ERROR LBA IO Time: 2023-06-12 17:12:03

LBA: 0xb62000 | HF: 0x04001273 F1: 0xa1b5ec90 F2: 0x31cedf50 [LOOP: 1 WRITE: 82 SECTOR: 0 / NUM: 1024 / ZERO: 31]  
IO Time: 2023-06-12 17:11:53

Buffer addr: 0xfffff806f0000 | Physical addr: 0x502025c0000

LBA LIST:

LBA[ 0]: 0x00b62000 0x00ed4000 0x00ed3000 0x00122800 0x00ff2000 0x00d8a400 0x01090000 0x003ea000 0x01018000 0x00741c00  
LBA[10]: 0x00f00400 0x00d2c800 0x00220c00 0x0042a000 0x00af7c00 0x0096b000 0x00b62c00 0x005c3000 0x00371400 0x01280000  
LBA[20]: 0x00b0c000 0x00bbd000 0x00f9e400 0x00e77c00 0x0113d000 0x008e4800 0x0114f000 0x00c80000 0x0051d000 0x003cf000  
LBA[30]: 0x0104c800 0x00e77000 0x001df000 0x003dac00 0x00da4c00 0x00509000 0x00647000 0x002c9000 0x004a0400 0x003ddc00  
LBA[40]: 0x00830c00 0x00f50800 0x0107c000 0x01046400 0x00ae5800 0x00beb800 0x00440000 0x008b0000 0x0103bc00 0x000ee000  
LBA[50]: 0x01037c00 0x00221c00 0x00f43c00 0x0004ac00 0x0139c000 0x002dc000 0x011dd000 0x00153800 0x00d3f000 0x00670000  
LBA[60]: 0x0005d400 0x009ed000 0x00e08000 0x0060dc00 0x00a49000 0x00806c00 0x010c1c00 0x002eb000 0x00be8400 0x00eb4000  
LBA[70]: 0x00d6e000 0x00297000 0x01316800 0x009b0800 0x00ac1000 0x00a15800 0x00208000 0x005e0000 0x008af800 0x00e02000  
LBA[80]: 0x00716400 0x00ba7800 0x011f8000 0x010b9800 0x013b0000 0x00c5e000 0x00648800 0x013f6c00 0x013b8000 0x0062a800  
LBA[90]: 0x00bbcc00 0x000b5400 0x0091c800 0x009bdc00 0x00af0800 0x00bbb000 0x00bafc00 0x00872800 0x00506c00 0x008a6800

PRE LBA LIST:

LBA[ 0]: 0x00082c00 0x0138b000 0x00bb0800 0x0031b400 0x00453000 0x00466000 0x00c3d800 0x006db000 0x00631800 0x00932000

LBA: 0xed4000 | HF: 0x04001273 F1: 0xa1b5ec90 F2: 0x31cedf50 [LOOP: 1 WRITE: 83 SECTOR: 0 / NUM: 1024 / ZERO: 31]  
IO Time: 2023-06-12 17:12:03

Buffer addr: 0xfffff80790000 | Physical addr: 0x58046a70000

LBA LIST:

LBA[ 0]: 0x00ed4000 0x00ed3000 0x00122800 0x00ff2000 0x00d8a400 0x01090000 0x003ea000 0x01018000 0x00741c00 0x00f00400  
LBA[10]: 0x00d2c800 0x00220c00 0x0042a000 0x00af7c00 0x0096b000 0x00b62c00 0x005c3000 0x00371400 0x01280000 0x00b0c000  
LBA[20]: 0x00bbd000 0x00f9e400 0x00e77c00 0x0113d000 0x008e4800 0x0114f000 0x00c80000 0x0051d000 0x003cf000 0x0104c800  
LBA[30]: 0x00e77000 0x001df000 0x003dac00 0x00da4c00 0x00509000 0x00647000 0x002c9000 0x004a0400 0x003ddc00 0x00830c00  
LBA[40]: 0x00f50800 0x0107c000 0x01046400 0x00ae5800 0x00beb800 0x00440000 0x008b0000 0x0103bc00 0x000ee000 0x01037c00  
LBA[50]: 0x00221c00 0x00f43c00 0x0004ac00 0x0139c000 0x002dc000 0x011dd000 0x00153800 0x00d3f000 0x00670000 0x005d4000  
LBA[60]: 0x009ed000 0x00e08000 0x0060dc00 0x00a49000 0x00806c00 0x010c1c00 0x002eb000 0x00be8400 0x00eb4000 0x0056e000  
LBA[70]: 0x00297000 0x01316800 0x009b0800 0x00ac1000 0x00a15800 0x00208000 0x005e0000 0x008af800 0x00e02000 0x00716400  
LBA[80]: 0xe8ab4210 0x011f8000 0x010b9800 0x013b0000 0x00c5e000 0x00648800 0x013f6c00 0x013b8000 0x0062a800 0x00bbcc00  
LBA[90]: 0x000b5400 0x0091c800 0x009bdc00 0x00af0800 0x00bbb000 0x00bafc00 0x00872800 0x00506c00 0x008a6800 0x00c93800

PRE LBA LIST:

LBA[ 0]: 0x00b62000 0x00082c00 0x0138b000 0x00bb0800 0x0031b400 0x00453000 0x00466000 0x00c3d800 0x006db000 0x00631800

# LBA工具基本功能演示

## ➤ BUG 004: 簇间数据校验，中间簇数据丢失

BUG 004 [Thread: 5] DATA LOST

PREV LBA: 0x4a5100 | LOST LBA: 0x35480 | NEXT LBA: 0x1c93780

第二轮测试，5号线程第2248次写IO，LBA地址：0x35480的一簇64K数据丢失

BUG 004 [Thread: 5] DATA LOST

PREV LBA: 0x359ec00 | LOST LBA: 0x20c5c00 | NEXT LBA: 0x1d3c800

第五轮测试，5号线程第287次写IO，LBA地址：0x20c5c00的一簇512K数据丢失

```
BUG 004: [Thread: 5] DATA LOST | read[288]
PREV LBA: 0x359ec00 | LOST LBA: 0x20c5c00 | NEXT LBA: 0x1d3c800

PREV LBA: 0x359ec00 | HF: 0x04001275 F1: 0xa62d2928 F2: 0xab2eb00 [LOOP: 5 WRITE: 286 SECTOR: 0 / NUM: 1024 / ZERO: 208]
PREV IO Time: 2023-05-13 11:20:53

LOST LBA: 0x20c5c00 | HF: 0x04001272 F1: 0xa62d2928 F2: 0x1d66938a [LOOP: 4 WRITE: 8030 SECTOR: 0 / NUM: 1024 / ZERO: 142]
LOST IO Time: 2023-05-13 11:12:55

NEXT LBA: 0x1d3c800 | HF: 0x04001275 F1: 0xa62d2928 F2: 0xab2eb00 [LOOP: 5 WRITE: 288 SECTOR: 0 / NUM: 1024 / ZERO: 208]
NEXT IO Time: 2023-05-13 11:20:54
```

LBA: 0x359ec00 | HF: 0x04001275 F1: 0xa62d2928 F2: 0xab2eb00 [LOOP: 5 WRITE: 286 SECTOR: 0 / NUM: 1024 / ZERO: 208]
IO Time: 2023-05-13 11:20:53

Buffer addr: 0x7f6faadd5000 | Physical addr: 0x422516000

LBA LIST:  
LBA[0]: 0x0359ec00 0x020c5c00 0x01d3c800 0x032a8c00 0x00fa8800 0x0043a800 0x042c5c00 0x02d9e400 0x03de2c00 0x03ab1000  
LBA[10]: 0x0139b400 0x013d3800 0x040ca400 0x03b00400 0x03020800 0x00e09c00 0x00a48c00 0x03108400 0x0498d800 0x01685400  
LBA[20]: 0x00225000 0x03af2400 0x04fb000 0x02e1c00 0x03b0d100 0x001a1000 0x00045c00 0x0033c400 0x0336f000  
LBA[30]: 0x02873400 0x030f1c00 0x02aec800 0x01864400 0x03410000 0x03b9ecc0 0x044d4000 0x02507c00 0x01bd0000 0x00a4c100  
LBA[40]: 0x03390000 0x017a2000 0x045d8400 0x03232000 0x02a08000 0x03520800 0x0398a000 0x0029e000 0x0442a000 0x002d0800  
LBA[50]: 0x00500080 0x0139c400 0x02f5ec00 0x039b1000 0x01557c00 0x02055000 0x00772500 0x0202c000 0x00e0cc00 0x03128c00  
LBA[60]: 0x03a3c400 0x047f6400 0x04040400 0x000bc000 0x03ddc000 0x03a6c000 0x0305f000 0x01e4a000 0x03dac000 0x00163000  
LBA[70]: 0x0496d000 0x04c51800 0x041fc000 0x0117a400 0x03d08800 0x0308a800 0x04925000 0x01064800  
LBA[80]: 0x020cc000 0x01e32c00 0x0455c00 0x03a0cc00 0x019a9400 0x02f0c000 0x01026000 0x000bf000 0x03a1000 0x03c5b800  
LBA[90]: 0x02b82800 0x02aee400 0x00cce800 0x00d56000 0x0011c000 0x0332f000 0x04f5f000 0x02f61000

PRE LBA LIST:  
LBA[0]: 0x023f1c00 0x01fb0400 0x0027800 0x04848000 0x01281000 0x0332d800 0x03715c00 0x00c4d800 0x00534400 0x01964400

LBA: 0x20c5c00 | HF: 0x04001272 F1: 0xa62d2928 F2: 0x1d66938a [LOOP: 4 WRITE: 8030 SECTOR: 0 / NUM: 1024 / ZERO: 142]
IO Time: 2023-05-13 11:12:55

Buffer addr: 0x7f6faae57000 | Physical addr: 0x41f880000

LBA LIST:  
LBA[0]: 0x020c5c00 0x01ccb400 0x0266cc00 0x040cb400 0x00995400 0x011e3800 0x019fb00 0x00e4e800 0x008b7c00 0x0136ec00  
LBA[10]: 0x01958000 0x02b7dc00 0x011fd000 0x00946900 0x0340b100 0x048bf00 0x02347400 0x01b3d000  
LBA[20]: 0x0424b000 0x01cbc400 0x001cf000 0x03f2f000 0x0438b000 0x0147f200 0x0147f100 0x04357400 0x02ce4000 0x040dc000  
LBA[30]: 0x02b24e000 0x019ae400 0x00990c00 0x011fc000 0x0185d400 0x00eb6c00 0x01201c00 0x04c5dc00 0x0120e000 0x00215c00  
LBA[40]: 0x0437ac00 0x013dc000 0x048df400 0x0496f800 0x04a45000 0x032d8400 0x022a7000 0x04ca6000 0x01377800 0x01378c00  
LBA[50]: 0x0438c100 0x0199c00 0x03f32c00 0x03330000 0x04dbd000 0x01819400 0x0499f100 0x01f93c00 0x0137f400 0x0369f100  
LBA[60]: 0x01cde800 0x0323e000 0x049a6400 0x02f28800 0x0364cc00 0x02ff3400 0x03cd6c00 0x03293000 0x013df00 0x01391800  
LBA[70]: 0x018b2000 0x0043bac00 0x01393c00 0x01e4f400 0x0181f600 0x03b37000 0x01849000 0x0292bc00 0x0181fc00 0x0139hc00  
LBA[80]: 0x0365fc00 0x0139dc00 0x0139c000 0x045c500 0x04b9fc00 0x0145a800 0x02b51400 0x04197c00 0x02cff800

```
hd_junit_verify -c -D -K -R 33 -S 128 -V all -T 10 -L 102400 -P split -I /dev/vda
Device Topology:
Disk: /dev/vda
Logical block size: 512
Physical block size: 512
Minimum I/O size: 512
Optimal I/O size: 0 (0: unknown)
Alignment offset: 0
Disk Size: 21474836480 / 20480M / 20,008

disk: /dev/vda | Thread: 10 | Total Sectors: 41943040 | Total Clusters: 327680 | Sectors of Cluster: 128 | DIRECT IO & NO Flush | Verify: 5 | Notify: 0
Current Time: 2023-06-13 10:03:42
Thread 7 [tid: 1250]: Starting check disk ...
Thread 6 [tid: 1249]: Starting check disk ...
Thread 1 [tid: 1244]: Starting check disk ...
Thread 5 [tid: 1248]: Starting check disk ...
Thread 2 [tid: 1245]: Starting check disk ...
Thread 9 [tid: 1252]: Starting check disk ...
Thread 8 [tid: 1251]: Starting check disk ...
Thread 4 [tid: 1247]: Starting check disk ...
Thread 0 [tid: 1243]: Starting check disk ...
Thread 3 [tid: 1246]: Starting check disk ...

Current Time: 2023-06-13 10:03:57
hd_junit_verify -c -D -K -R 33 -S 128 -V all -T 10 -L 102400 -P split -I /dev/vda
PREV LBA: 0x4a5100 - NEXT LBA: 0x35480 flags is different | read[224]
PREV LBA: 0x4a5100 | HF: 0x00801275 F1: 0x01280ba6 F2: 0xa7c44528 [Loop: 2 WRITE: 2247 SECTOR: 0 / NUM: 128 / ZERO: 39]
PREV LBA ID Time: 2023-06-12 19:14:23
NEXT LBA: 0x35480 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [Loop: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
NEXT LBA ID Time: 1900-01-00 00:00:00

Current Time: 2023-06-13 10:03:57
hd_junit_verify -c -D -K -R 33 -S 128 -V all -T 10 -L 102400 -P split -I /dev/vda
PREV LBA: 0x4a5100 - NEXT LBA: 0x35480 | thread_num: 10, bitmap: 0000000000000000
PREV LBA: 0x4a5100 | HF: 0x00801275 F1: 0x01280ba6 F2: 0xa7c44528 [Loop: 2 WRITE: 2247 SECTOR: 0 / NUM: 128 / ZERO: 39]
PREV LBA ID Time: 2023-06-12 19:14:23
Buffer addr: 0x7f183c02f000 | Physical addr: 0x423ca7000
LBA LIST:
LBA[0]: 0x0004a5100 0x00035480 0x01c93780 0x0178ce080 0x00ca0800 0x01a31280 0x00870000 0x0205b000 0x02505d00 0x01ba3a00
LBA[10]: 0x00c5a5800 0x00230000 0x01583680 0x02541680 0x020fb700 0x00eddef0 0x00593200 0x0267af00 0x01c4a080 0x001b3780
LBA[20]: 0x0139e880 0x01441100 0x02126800 0x00737a00 0x00aeb300 0x00490200 0x010d3300 0x00b11000 0x0060e800
LBA[30]: 0x0095cb00 0x00ec0200 0x026d900 0x00207d00 0x004dc400 0x00ce0f00 0x02163b00 0x0093fa00 0x00a5e000
LBA[40]: 0x01a17a00 0x00327000 0x01740100 0x011b3000 0x00ea5f00 0x014f1500 0x01c29580 0x00d7d500 0x01b5b500 0x01919600
LBA[50]: 0x00029f00 0x02462900 0x00929080 0x004c7080 0x0038c200 0x01c72000 0x000b7600 0x0057bc00 0x015c2900
LBA[60]: 0x016f4f00 0x01419400 0x01f4f200 0x0062d900 0x01076800 0x024b1400 0x008ace00 0x00efdd00 0x0141cd00 0x018a1500
LBA[70]: 0x01619100 0x00208100 0x02561800 0x00205780 0x01f6b000 0x00639000 0x02505b00 0x01561f00 0x00e57c00
LBA[80]: 0x000e1700 0x011c8200 0x0119c200 0x0252ce00 0x00250900 0x001ade00 0x0193b200 0x0163d100 0x0185f100
LBA[90]: 0x000e6800 0x02790480 0x01632400 0x02030500 0x015b500 0x00194f00 0x018c2000 0x0020100 0x0078e00 0x00537800
PRE LBA LIST:
LBA[0]: 0x00bad100 0x023f580 0x01bf7100 0x00365280 0x02739680 0x0174ee00 0x0236d680 0x0045fa00 0x00d40800 0x01231f80
LOST LBA: 0x35480 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [Loop: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]
LOST LBA ID Time: 1900-01-00 00:00:00
Buffer addr: 0x7f183c01e000 | Physical addr: 0x42cd09000
LBA LIST:
LBA[0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[10]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[20]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[30]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[40]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[50]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[60]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[70]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[80]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[90]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
PRE LBA LIST:
LBA[0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[10]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[20]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[30]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[40]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[50]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[60]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[70]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[80]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[90]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
NEXT LBA: 0x1c93780 | HF: 0x00801275 F1: 0x01280ba6 F2: 0xa7c44528 [Loop: 2 WRITE: 2249 SECTOR: 0 / NUM: 128 / ZERO: 39]
NEXT LBA ID Time: 2023-06-12 19:14:23
Buffer addr: 0x7f183c040000 | Physical addr: 0x425918000
LBA LIST:
LBA[0]: 0x01c93780 0x0178ce080 0x00ca0800 0x01a31280 0x00870000 0x0205b000 0x02505d00 0x01ba3a00 0x00c5a800 0x0023a000
LBA[10]: 0x015a5680 0x02541680 0x020fb700 0x00eddef0 0x00593200 0x01c4a080 0x001b3780 0x0139e880 0x01441100
LBA[20]: 0x02021e100 0x002737a00 0x00aeb300 0x01955f00 0x00490200 0x010d3300 0x00b11000 0x0060e800 0x009cf00 0x00ecd200
LBA[30]: 0x026d900 0x02727a00 0x0027d00 0x004ce400 0x00ce0f00 0x02163b00 0x0093fa00 0x00a5e000 0x01a17a00 0x00d32700
LBA[40]: 0x01740100 0x011b3000 0x00ea5f00 0x014f1500 0x01c29580 0x00d7900 0x01b5b500 0x01919600 0x0028f00 0x0246f300
LBA[50]: 0x0242c400 0x00293080 0x0048c700 0x00172000 0x000b7600 0x0057bc00 0x016c2000 0x01574f00 0x0141b900
LBA[60]: 0x001f4f00 0x00260900 0x001f7680 0x024b1400 0x008ace00 0x00efdd00 0x0141cd00 0x018a1500 0x0145f100 0x00208100
LBA[70]: 0x02561800 0x00268700 0x01f6b000 0x00639000 0x02058000 0x02495e00 0x01561f00 0x00e57c00 0x00ef2700 0x012b2600
LBA[80]: 0x0119c200 0x0026ce00 0x026d8000 0x01056700 0x0093fa00 0x01530300 0x0163d100 0x015df100 0x00ab8000 0x0279d480
LBA[90]: 0x00183400 0x00230500 0x0139500 0x00194f00 0x0018c200 0x00020100 0x0078e000 0x00937800 0x01956900 0x01c6900
PRE LBA LIST:
LBA[0]: 0x00035480 0x004a5100 0x00bad100 0x023f580 0x001bf7100 0x00363580 0x02739680 0x0174ee00 0x0236d680 0x0045fa00
LBA[10]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[20]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[30]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[40]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[50]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[60]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[70]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[80]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
LBA[90]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000
Current Time: 2023-06-13 10:03:57
hd_junit_verify -c -D -K -R 33 -S 128 -V all -T 10 -L 102400 -P split -I /dev/vda
pause_and_exit_work: Press KEY: <Q> to exit!
```

# LBA工具基本功能演示

## ➤ BUG 005: inject FLAG lba bug

整体校验数据，首簇数据FLAG出错

BUG 005: [Thread: 0] VERIFY HD\_FLAG ERROR | HF: 0x0400ffff[0x04001270]

| filename: test.raw

LBA: 0x0 | thread\_num: 10, bitmap: 1 0 0 0 0 0 0 0 0 0

Line: 2572 | HF: 0x4001270 != hd\_flag: 0x400ffff, sector\_num: 1024

LBA: 0x0 | HF: 0x0400ffff F1: 0xba0b9c1f F2: 0xd239bb83 [LOOP: 1 WRITE: 1

SECTOR: 0 / NUM: 1024 / ZERO: 127]

IO Time: 2023-07-09 23:47:39

--runtime校验

Line: 2572 | HF: 0x4001270 != hd\_flag: 0x400ffff, sector\_num: 1024

LBA: 0x0 | HF: 0x0400ffff F1: 0xba0b9c1f F2: 0xd239bb83 [LOOP: 1 WRITE: 1 SECTOR: 0 / NUM: 1024 / ZERO: 127]

IO Time: 2023-07-09 23:47:39

Buffer addr: 0x30910000 | Physical addr: 0x1814f0e0000

LBA LIST:

LBA[ 0]: 0x00000000 0x0034f800 0x00746400 0x00116000 0x001ca400 0x0046dc00 0x003ca800 0x004b7800 0x007bf800 0x000ef000  
LBA[10]: 0x00585c00 0x0006c000 0x0033e000 0x002e5c00 0x00361c00 0x00664000 0x00444000 0x005b0000 0x00064800 0x000e0c00  
LBA[20]: 0x00260800 0x0009e9800 0x003c4000 0x003bc000 0x0036bc00 0x0052c000 0x0048d000 0x004e0400 0x0039cc00 0x00560000  
LBA[30]: 0x00718000 0x00090000 0x007c9000 0x003f6000 0x004fb000 0x000b4800 0x00695000 0x00376000 0x005d5800 0x00480000  
LBA[40]: 0x00345000 0x00634000 0x0006a800 0x00236000 0x0006e9000 0x00353c00 0x000ae400 0x00420400 0x0028a400 0x0006a000  
LBA[50]: 0x0024f800 0x007ca400 0x00220000 0x005c5800 0x0032cc00 0x00379800 0x00518400 0x0005c4000 0x0013b000 0x0032c000  
LBA[60]: 0x00140000 0x00069400 0x000b6000 0x00227c00 0x00367800 0x006e4800 0x00646000 0x000b0800 0x001f8800 0x005e3800  
LBA[70]: 0x00565800 0x00616000 0x007a3000 0x00497800 0x005cd400 0x001b9000 0x00758000 0x00318000 0x002b1400 0x00612000  
LBA[80]: 0x007b1000 0x00170400 0x0064d800 0x0024fc00 0x007bc000 0x0013b400 0x0048bc00 0x00155000 0x007fd000 0x007a7800  
LBA[90]: 0x003cb800 0x00031c00 0x00658800 0x00300000 0x00197c00 0x004d0000 0x002e1400 0x001bd400 0x007a6c00 0x006dc000

PRE LBA LIST:

LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

--checktime校验

Starting write file: Thread ID | Read MB - Write MB |  
KEY: <P> = pause, KEY: <S> = start, KEY: <Q> = quit

Loop 1: .  
Current Time: 2023-07-09 23:47:39  
0, 379 | 0, 384 | 0, 386 | 0, 391 | 0, 370 | 0, 368 | 0, 378 | 0, 380 | 0, 370 | 0, 372 |

Current Time: 2023-07-09 23:48:39  
Thread 9 [tid: 360580]: Starting check file ...  
Thread 5 [tid: 360576]: Starting check file ...  
Thread 4 [tid: 360575]: Starting check file ...  
Thread 3 [tid: 360574]: Starting check file ...  
Thread 6 [tid: 360577]: Starting check file ...  
Thread 7 [tid: 360578]: Starting check file ...  
Thread 1 [tid: 360572]: Starting check file ...  
Thread 8 [tid: 360579]: Starting check file ...  
Thread 0 [tid: 360571]: Starting check file ...  
Thread 2 [tid: 360573]: Starting check file ...

Current Time: 2023-07-09 23:48:39  
BUG 005: [Thread: 0] VERIFY HD\_FLAG ERROR | HF: 0x0400ffff[0x04001270] | filename: test.raw  
LBA: 0x0 | thread\_num: 10, bitmap: 1 0 0 0 0 0 0 0 0 0

LBA[0]: 0x0 | HF: 0x0400ffff F1: 0xba0b9c1f F2: 0xd239bb83 [LOOP: 1 WRITE: 1 SECTOR: 0 / NUM: 1024 / ZERO: 127]  
LBA[0] IO Time: 2023-07-09 23:47:39

Buffer addr: 0xfffff98af0000 | Physical addr: 0x5033ba10000

LBA LIST:

LBA[ 0]: 0x00000000 0x0034f800 0x00746400 0x00116000 0x001ca400 0x0046dc00 0x003ca800 0x004b7800 0x007bf800 0x000ef000  
LBA[10]: 0x00585c00 0x0006c000 0x0033e000 0x002e5c00 0x00361c00 0x00664000 0x00444000 0x005b0000 0x00064800 0x000e0c00  
LBA[20]: 0x00260800 0x0009e9800 0x003c4000 0x003bc000 0x0036bc00 0x0052c000 0x0048d000 0x004e0400 0x0039cc00 0x00560000  
LBA[30]: 0x00718000 0x00090000 0x007c9000 0x003f6000 0x004fb000 0x000b4800 0x00695000 0x00376000 0x005d5800 0x00480000  
LBA[40]: 0x00345000 0x00634000 0x0006a800 0x00236000 0x0006e9000 0x00353c00 0x000ae400 0x00420400 0x0028a400 0x0006a000  
LBA[50]: 0x0024f800 0x007ca400 0x00220000 0x005c5800 0x0032cc00 0x00379800 0x00518400 0x0005c4000 0x0013b000 0x0032c000  
LBA[60]: 0x00140000 0x00069400 0x000b6000 0x00227c00 0x00367800 0x006e4800 0x00646000 0x000b0800 0x001f8800 0x005e3800  
LBA[70]: 0x00565800 0x00616000 0x007a3000 0x00497800 0x005cd400 0x001b9000 0x00758000 0x00318000 0x002b1400 0x00612000  
LBA[80]: 0x007b1000 0x00170400 0x0064d800 0x0024fc00 0x007bc000 0x0013b400 0x0048bc00 0x00155000 0x007fd000 0x007a7800  
LBA[90]: 0x003cb800 0x00031c00 0x00658800 0x00300000 0x00197c00 0x004d0000 0x002e1400 0x001bd400 0x007a6c00 0x006dc000

PRE LBA LIST:

LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

LBA[1]: 0x1 | HF: 0x04001270 F1: 0xba0b9c1f F2: 0xd239bb83 [LOOP: 1 WRITE: 1 SECTOR: 1 / NUM: 1024 / ZERO: 127]  
LBA[1] IO Time: 2023-07-09 23:47:39

Buffer addr: 0xfffff98af0200 | Physical addr: 0x5033ba10200

LBA LIST:

LBA[ 0]: 0x00000000 0x0034f800 0x00746400 0x00116000 0x001ca400 0x0046dc00 0x003ca800 0x004b7800 0x007bf800 0x000ef000  
LBA[10]: 0x00585c00 0x0006c000 0x0033e000 0x002e5c00 0x00361c00 0x00664000 0x00444000 0x005b0000 0x00064800 0x000e0c00  
LBA[20]: 0x00260800 0x0009e9800 0x003c4000 0x003bc000 0x0036bc00 0x0052c000 0x0048d000 0x004e0400 0x0039cc00 0x00560000  
LBA[30]: 0x00718000 0x00090000 0x007c9000 0x003f6000 0x004fb000 0x000b4800 0x00695000 0x00376000 0x005d5800 0x00480000  
LBA[40]: 0x00345000 0x00634000 0x0006a800 0x00236000 0x0006e9000 0x00353c00 0x000ae400 0x00420400 0x0028a400 0x0006a000  
LBA[50]: 0x0024f800 0x007ca400 0x00220000 0x005c5800 0x0032cc00 0x00379800 0x00518400 0x0005c4000 0x0013b000 0x0032c000  
LBA[60]: 0x00140000 0x00069400 0x000b6000 0x00227c00 0x00367800 0x006e4800 0x00646000 0x000b0800 0x001f8800 0x005e3800  
LBA[70]: 0x00565800 0x00616000 0x007a3000 0x00497800 0x005cd400 0x001b9000 0x00758000 0x00318000 0x002b1400 0x00612000  
LBA[80]: 0x007b1000 0x00170400 0x0064d800 0x0024fc00 0x007bc000 0x0013b400 0x0048bc00 0x00155000 0x007fd000 0x007a7800  
LBA[90]: 0x003cb800 0x00031c00 0x00658800 0x00300000 0x00197c00 0x004d0000 0x002e1400 0x001bd400 0x007a6c00 0x006dc000

PRE LBA LIST:

LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

Current Time: 2023-07-09 23:48:39

pause\_and\_exit\_work: Press KEY: <Q> to exit!

# LBA工具基本功能演示

## ➤ BUG 006: inject SECTOR lba bug

### 簇间FLAGS数据校验出错

BUG 006: [Thread: 5] VERIFY DIFFER FLAGS | read[248], write[709]

| filename: lba.raw

LBA: 0xc2c00 | thread\_num: 10, bitmap: 0 0 0 0 0 1 0 0 0 0

---runtime校验

BUG 004: [Thread: 5] DATA LOST | read[249] | filename: /dev/loop4

PREV LBA: 0x66400 | LOST LBA: 0xc2c00 | NEXT LBA: 0xfa000

PREV LBA: 0x66400 | HF: 0x04001275 F1: 0x7b9930dd F2: 0x23b74b96 [LOOP: 3 WRITE: 247 SECTOR: 0 / NUM: 1024 / ZERO: 139]

PREV IO Time: 2023-06-19 15:43:11

LOST LBA: 0xc2c00 | HF: 0xe8e8e8e8 F1: 0xe8e8e8e8 F2: 0xe8e8e8e8 [LOOP: 3907578088 WRITE: 3907578088 SECTOR: 59624 / NUM: 59624 / ZERO: 3907578088]

LOST IO Time: -387387308--387389207--387389208 -387389208

NEXT LBA: 0xfa000 | HF: 0x04001275 F1: 0x7b9930dd F2: 0x23b74b96 [LOOP: 3 WRITE: 249 SECTOR: 0 / NUM: 1024 / ZERO: 139]

NEXT IO Time: 2023-06-19 15:43:57

---checktime校验

BUG 004: [Thread: 5] DATA LOST | read[249] | filename: /dev/loop4

PREV LBA: 0x66400 | LOST LBA: 0xc2c00 | NEXT LBA: 0xfa000

PREV LBA: 0x66400 | HF: 0x04001275 F1: 0x7b9930dd F2: 0x23b74b96 [LOOP: 3 WRITE: 247 SECTOR: 0 / NUM: 1024 / ZERO: 139]

PREV IO Time: 2023-06-19 15:43:11

LOST LBA: 0xc2c00 | HF: 0xe8e8e8e8 F1: 0xe8e8e8e8 F2: 0xe8e8e8e8 [LOOP: 3907578088 WRITE: 3907578088 SECTOR: 59624 / NUM: 59624 / ZERO: 3907578088]

LOST IO Time: -387387308--387389207--387389208 -387389208 -387389208

NEXT LBA: 0xfa000 | HF: 0x04001275 F1: 0x7b9930dd F2: 0x23b74b96 [LOOP: 3 WRITE: 249 SECTOR: 0 / NUM: 1024 / ZERO: 139]

NEXT IO Time: 2023-06-19 15:43:57

Start  
0, 178 | 0, 178 | 0, 177 | 0, 174 | 0, 177 | 0, 173 | 0, 181 | 0, 184 | 0, 178 | 0, 169 |

Current Time: 2023-06-19 15:43:58

Thread 0 [tid: 2212396]: Starting check disk ...  
Thread 8 [tid: 2212404]: Starting check disk ...  
Thread 7 [tid: 2212403]: Starting check disk ...  
Thread 4 [tid: 2212400]: Starting check disk ...  
Thread 5 [tid: 2212401]: Starting check disk ...  
Thread 6 [tid: 2212402]: Starting check disk ...  
Thread 9 [tid: 2212405]: Starting check disk ...  
Thread 1 [tid: 2212397]: Starting check disk ...  
Thread 3 [tid: 2212399]: Starting check disk ...  
Thread 2 [tid: 2212398]: Starting check disk ...

Current Time: 2023-06-19 15:43:59

BUG 006: [Thread: 5] VERIFY DIFFER FLAGS | read[248], write[709] | filename: /dev/loop4

PREV LBA: 0x66400 - NEXT LBA: 0xc2c00 flags is different | read[248]

LBA: 0xc2c00 | thread\_num: 10, bitmap: 0 0 0 0 0 1 0 0 0 0

PREV LBA: 0x66400 | HF: 0x04001275 F1: 0x7b9930dd F2: 0x23b74b96 [LOOP: 3 WRITE: 247 SECTOR: 0 / NUM: 1024 / ZERO: 139]

PREV LBA IO Time: 2023-06-19 15:43:11

Buffer addr: 0xfffffae70000 | Physical addr: 0x5025e7d0000

LBA LIST:

LBA[ 0]: 0x00066400 0x000c2c00 0x000fa000 0x00192000 0x0034c800 0x0021c000 0x00408000 0x004cf000 0x006d8000 0x00116c00  
LBA[10]: 0x00470400 0x00664c00 0x001bd800 0x001bcd00 0x00760800 0x007ff400 0x00159800 0x006b6800 0x006f0800 0x0050c400  
LBA[20]: 0x006e9c00 0x00339000 0x00646800 0x003af400 0x0038ac00 0x007b6800 0x00429000 0x00008c00 0x0076b400 0x000a0cc00  
LBA[30]: 0x0059b000 0x0007e000 0x001f5000 0x0059d400 0x005e8400 0x004de800 0x007e3000 0x006c9800 0x002a5400 0x0013cc00  
LBA[40]: 0x00299800 0x00216000 0x00108400 0x0079d800 0x00257800 0x00505000 0x00595c00 0x006f8800 0x00308800 0x006e3000  
LBA[50]: 0x005fa400 0x00326800 0x00618800 0x00005c00 0x006aac00 0x00100c00 0x0032a000 0x0029c400 0x004d1400 0x006f1000  
LBA[60]: 0x0066a400 0x00183400 0x005b4400 0x00140000 0x0004e000 0x004c3800 0x00519400 0x00794400 0x003b7c00 0x002d6c00  
LBA[70]: 0x0038e800 0x0017d800 0x002e8000 0x00726c00 0x006d7400 0x001c7800 0x00278800 0x003c5c00 0x00577000 0x0073c800  
LBA[80]: 0x00764800 0x0009f800 0x00230400 0x005ab800 0x006fd800 0x00521000 0x004f5800 0x003df400 0x00506c00 0x00307800  
LBA[90]: 0x004d8800 0x001dd000 0x00679c00 0x00754800 0x003e9800 0x002d9800 0x00088400 0x001d9000 0x001l9400 0x0046a400

PRE LBA LIST:

LBA[ 0]: 0x00117800 0x0072f800 0x005c2400 0x0045a000 0x003ca000 0x0014d000 0x006c5c00 0x000d7000 0x0058e400 0x00474400

---

NEXT LBA: 0xc2c00 | HF: 0xe8e8e8e8 F1: 0xe8e8e8e8 F2: 0xe8e8e8e8 [LOOP: 3907578088 WRITE: 3907578088 SECTOR: 59624 / NUM: 59624 / ZERO: 3907578088]

NEXT LBA IO Time: -387387308--387389207--387389208 -387389208:-387389208:-387389208

Buffer addr: 0xfffffa24b0000 | Physical addr: 0x58382720000

LBA LIST:

LBA[ 0]: 0xe8e8e8e8  
LBA[10]: 0xe8e8e8e8  
LBA[20]: 0xe8e8e8e8  
LBA[30]: 0xe8e8e8e8  
LBA[40]: 0xe8e8e8e8  
LBA[50]: 0xe8e8e8e8  
LBA[60]: 0xe8e8e8e8  
LBA[70]: 0xe8e8e8e8  
LBA[80]: 0xe8e8e8e8  
LBA[90]: 0xe8e8e8e8 0xe8e8e8e8 0xe8e8e8e8 0xe8e8e8e8 0xe8e8e8e8 0xe8e8e8e8 0xe8e8e8e8 0xe8e8e8e8 0xe8e8e8e8 0xe8e8e8e8

PRE LBA LIST:

LBA[ 0]: 0xe8e8e8e8 0xe8e8e8e8 0xe8e8e8e8 0xe8e8e8e8 0xe8e8e8e8 0xe8e8e8e8 0xe8e8e8e8 0xe8e8e8e8 0xe8e8e8e8 0xe8e8e8e8

---

Current Time: 2023-06-19 15:43:59

pause\_and\_exit\_work: Press KEY: <Q> to exit!

# LBA工具基本功能演示

➤ BUG 007[1]: 案例一, inject SECTOR lba bug

非零扇区: 中间扇区的数据与前后扇区的数据不一致

BUG 007[1] : [Thread: 9] VERIFY SECTOR[271] DIFFER: 1  
| read[241] | filename: /dev/loop4

CORRECT LBA[0]: 0x407000 | HF: 0x04001279 F1: 0x7b9930dd  
F2: 0x2242b959 [LOOP: 3 WRITE: 241 SECTOR: 0 / NUM: 1024 /  
ZERO: 200]  
CORRECT IO Time: 2023-06-19 15:43:57

ERROR LBA[271]: 0x40710f | HF: 0xd6d6d6d6 F1: 0xd6d6d6d6 F2:  
0xd6d6d6d6 [LOOP: 3604403926 WRITE: 3604403926 SECTOR:  
54998 / NUM: 54998 / ZERO: 3604403926]  
INCONSISTENT IO Time: -690561470--690563369--690563370 -  
690563370:-690563370:-690563370

CORRECT LBA[272]: 0x407110 | HF: 0x04001279 F1: 0x7b9930dd  
F2: 0x2242b959 [LOOP: 3 WRITE: 241 SECTOR: 272 / NUM: 1024 /  
ZERO: 200]  
CORRECT IO Time: 2023-06-19 15:43:57

---runtime校验 & checktime校验

BUG 007[1] LAST IO?: [Thread: 9] VERIFY SECTOR[271] DIFFER: 1 | read[241] | filename: /dev/loop4

hd\_write\_verify\_dump -c -D -L 0x000c4000 disk/file  
hd\_write\_verify\_dump -c -D -L 0x006ef000 disk/file

CORRECT LBA[0]: 0x407000 | HF: 0x04001279 F1: 0x7b9930dd F2: 0x2242b959 [LOOP: 3 WRITE: 241 SECTOR: 0 / NUM: 1024 / ZERO:  
200]  
CORRECT IO Time: 2023-06-19 15:43:57

ERROR LBA[271]: 0x40710f | HF: 0xd6d6d6d6 F1: 0xd6d6d6d6 F2: 0xd6d6d6d6 [LOOP: 3604403926 WRITE: 3604403926 SECTOR: 54998  
INCONSISTENT IO Time: -690561470--690563369--690563370 -690563370:-690563370

CORRECT LBA[272]: 0x407110 | HF: 0x04001279 F1: 0x7b9930dd F2: 0x2242b959 [LOOP: 3 WRITE: 241 SECTOR: 272 / NUM: 1024 /  
ZERO: 200]  
CORRECT IO Time: 2023-06-19 15:43:57

Current Time: 2023-06-19 15:43:59  
BUG 007[1]: [Thread: 9] VERIFY SECTOR[271] DIFFER: 1 | read[241] | filename: /dev/loop4  
LBA: 0x407000 | thread\_num: 10, bitmap: 0 0 0 0 0 0 0 0 0 1  
CORRECT LBA[0]: 0x407000 | HF: 0x04001279 F1: 0x7b9930dd F2: 0x2242b959 [LOOP: 3 WRITE: 241 SECTOR: 0 / NUM: 1024 / ZERO: 200]  
CORRECT IO Time: 2023-06-19 15:43:57  
Buffer addr: 0xfffffa22d0000 | Physical addr: 0x261a50000  
LBA LIST:  
LBA[ 0]: 0x000407000 0x006ef000 0x007cc800 0x00095400 0x00215400 0x004ef000 0x0049c400 0x00322000 0x003c5000 0x0020a000  
LBA[10]: 0x0029b400 0x00461400 0x0056b400 0x003dc00 0x00109800 0x00118000 0x00103800 0x004bf000 0x005e3800 0x0012f000  
LBA[20]: 0x00495000 0x0034c400 0x001a5c00 0x00497c00 0x00263400 0x000d7400 0x00062800 0x0006d800 0x001ca800 0x00315000  
LBA[30]: 0x0000dfc00 0x0004f800 0x001f0800 0x00130000 0x003c0400 0x002bbc00 0x0023a800 0x006e9400 0x0007a400 0x007c0c00  
LBA[40]: 0x006d6800 0x00707000 0x004c1c00 0x00611000 0x001f0c00 0x000a6800 0x007e7400 0x002ab400 0x0023c400 0x007fa800  
LBA[50]: 0x00132000 0x005fc800 0x0077e400 0x000a2400 0x0039c800 0x001c9000 0x003d8400 0x00520000 0x00397c00 0x00235800  
LBA[60]: 0x0029e800 0x004b9000 0x00219800 0x00073000 0x006a8800 0x00248c00 0x00420000 0x005a0c00 0x007bc000 0x0037a800  
LBA[70]: 0x00293c00 0x0037b700 0x00006400 0x0026e000 0x003e4800 0x003a7800 0x00631000 0x00472c00 0x001d1800 0x00027400  
LBA[80]: 0x00294400 0x0035b500 0x004db800 0x003b1800 0x003b9000 0x00202c00 0x007fbcc0 0x00673800 0x001d8c00 0x00544c00  
LBA[90]: 0x00062c00 0x000fd800 0x002ed800 0x0001e800 0x003cb800 0x001a0800 0x00292c00 0x00718c00 0x007fec00 0x00640c00  
PRE LBA LIST:  
LBA[ 0]: 0x0000c4000 0x00702800 0x005c5800 0x00381400 0x00500800 0x0043ac00 0x0001d400 0x001d2c00 0x001c0800 0x00663c00  
-----  
ERROR LBA[271]: 0x40710f | HF: 0xd6d6d6d6 F1: 0xd6d6d6d6 F2: 0xd6d6d6d6 [LOOP: 3604403926 WRITE: 3604403926 SECTOR: 54998 / NUM: 54998 / ZERO: 3604403926]  
INCONSISTENT IO Time: -690561470--690563369--690563370 -690563370:-690563370  
Buffer addr: 0xfffffa22f1e00 | Physical addr: 0x261a71e00  
LBA LIST:  
LBA[ 0]: 0xd6d6d6d6  
LBA[10]: 0xd6d6d6d6  
LBA[20]: 0xd6d6d6d6  
LBA[30]: 0xd6d6d6d6  
LBA[40]: 0xd6d6d6d6  
LBA[50]: 0xd6d6d6d6  
LBA[60]: 0xd6d6d6d6  
LBA[70]: 0xd6d6d6d6  
LBA[80]: 0xd6d6d6d6  
LBA[90]: 0xd6d6d6d6  
PRE LBA LIST:  
LBA[ 0]: 0xd6d6d6d6  
-----  
CORRECT LBA[272]: 0x407110 | HF: 0x04001279 F1: 0x7b9930dd F2: 0x2242b959 [LOOP: 3 WRITE: 241 SECTOR: 272 / NUM: 1024 / ZERO: 200]  
CORRECT IO Time: 2023-06-19 15:43:57  
Buffer addr: 0xfffffa22f2000 | Physical addr: 0x261a72000  
LBA LIST:  
LBA[ 0]: 0x000407000 0x006ef000 0x007cc800 0x00095400 0x00215400 0x004ef000 0x0049c400 0x00322000 0x003c5000 0x0020a000  
LBA[10]: 0x0029b400 0x00461400 0x0056b400 0x003dc00 0x00109800 0x00118000 0x00103800 0x004bf000 0x005e3800 0x0012f000  
LBA[20]: 0x00495000 0x0034c400 0x001a5c00 0x00497c00 0x00263400 0x000d7400 0x00062800 0x0006d800 0x001ca800 0x00315000  
LBA[30]: 0x0000dfc00 0x0004f800 0x001f0800 0x00130000 0x003c0400 0x002bbc00 0x0023a800 0x006e9400 0x0007a400 0x007c0c00  
LBA[40]: 0x006d6800 0x00707000 0x004c1c00 0x00611000 0x001f0c00 0x000a6800 0x007e7400 0x002ab400 0x0023c400 0x007fa800  
LBA[50]: 0x00132000 0x005fc800 0x0077e400 0x000a2400 0x0039c800 0x001c9000 0x003d8400 0x00520000 0x00397c00 0x00235800  
LBA[60]: 0x0029e800 0x004b9000 0x00219800 0x00073000 0x006a8800 0x00248c00 0x00420000 0x005a0c00 0x007bc000 0x0037a800  
LBA[70]: 0x00293c00 0x0037b700 0x00006400 0x0026e000 0x003e4800 0x003a7800 0x00631000 0x00472c00 0x001d1800 0x00027400  
LBA[80]: 0x00294400 0x0035b500 0x004db800 0x003b1800 0x003b9000 0x00202c00 0x007fbcc0 0x00673800 0x001d8c00 0x00544c00  
LBA[90]: 0x00062c00 0x000fd800 0x002ed800 0x0001e800 0x003cb800 0x001a0800 0x00292c00 0x00718c00 0x007fec00 0x00640c00  
PRE LBA LIST:  
LBA[ 0]: 0x0000c4000 0x00702800 0x005c5800 0x00381400 0x00500800 0x0043ac00 0x0001d400 0x001d2c00 0x001c0800 0x00663c00  
-----  
Current Time: 2023-06-19 15:43:59  
pause\_and\_exit\_work: Press KEY: <Q> to exit!

# LBA工具基本功能演示

## ➤ BUG 007[1]: 案例二, inject LIST lba bug

非零扇区：中间扇区的数据与前后扇区的数据不一致

BUG 007[1] : [Thread: 6] VERIFY SECTOR[400] DIFFER: 1 | read[550]

| filename: lba.raw

CORRECT LBA[0]: 0x762800 | HF: 0x04001276 F1: 0x65bbb47d F2:  
0xda812af0 [LOOP: 1 WRITE: 550 SECTOR: 0 / NUM: 1024 / ZERO: 120]  
CORRECT IO Time: 2023-06-25 16:22:21

ERROR LBA[400]: 0x762990 | HF: 0x04001276 F1: 0x65bbb47d F2:  
0xda812af0 [LOOP: 1 WRITE: 550 SECTOR: 400 / NUM: 1024 / ZERO: 120]  
INCONSISTENT IO Time: 2023-06-25 16:22:21

CORRECT LBA[401]: 0x762991 | HF: 0x04001276 F1: 0x65bbb47d F2:  
0xda812af0 [LOOP: 1 WRITE: 550 SECTOR: 401 / NUM: 1024 / ZERO: 120]  
CORRECT IO Time: 2023-06-25 16:22:21

---checktime校验

BUG 007[1] LAST IO?: [Thread: 6] VERIFY SECTOR[400] DIFFER: 1 | read[550] | filename: lba.raw  
hd\_write\_verify\_dump -c -D -L 0x00521800 disk/file  
hd\_write\_verify\_dump -c -D -L 0x006dec00 disk/file  
CORRECT LBA[0]: 0x762800 | HF: 0x04001276 F1: 0x65bbb47d F2: 0xda812af0 [LOOP: 1 WRITE: 550 SECTOR: 0 / NUM: 1024 / ZERO: 120]  
CORRECT IO Time: 2023-06-25 16:22:21  
ERROR LBA[400]: 0x762990 | HF: 0x04001276 F1: 0x65bbb47d F2: 0xda812af0 [LOOP: 1 WRITE: 550 SECTOR: 400 / NUM: 1024 / ZERO: 120]  
INCONSISTENT IO Time: 2023-06-25 16:22:21  
CORRECT LBA[401]: 0x762991 | HF: 0x04001276 F1: 0x65bbb47d F2: 0xda812af0 [LOOP: 1 WRITE: 550 SECTOR: 401 / NUM: 1024 / ZERO: 120]  
CORRECT IO Time: 2023-06-25 16:22:21

LBA: 0x76298f | HF: 0x04001276 F1: 0x65bbb47d F2: 0xda812af0 [LOOP: 1 WRITE: 550 SECTOR: 399 / NUM: 1024 / ZERO: 120]  
IO Time: 2023-06-25 16:22:21

Buffer addr: 0xffff46081e00 | Physical addr: 0x5345cfle00

LBA LIST:  
LBA[ 0]: 0x00762800 0x006dec00 0x0069f800 0x00138800 0x006fc800 0x007a9800 0x00449800 0x0031dc00 0x000d4800 0x00190c00  
LBA[10]: 0x0021ac00 0x0030d400 0x00714400 0x005b0c00 0x006f2400 0x002c8800 0x00441c00 0x005d1400 0x006f6400 0x00256000  
LBA[20]: 0x006df400 0x007df800 0x00117800 0x0031c000 0x00249400 0x005f0800 0x001cac00 0x00799400 0x0003d400 0x000e9000  
LBA[30]: 0x00503c00 0x00449c800 0x00131c00 0x00560800 0x003t6800 0x00125c00 0x00728400 0x00447c00 0x003ca000 0x00073800  
LBA[40]: 0x00187000 0x006f7400 0x002dc000 0x0003t7800 0x003ca400 0x005d9800 0x0040c000 0x0008a000 0x000d9800 0x001a2400  
LBA[50]: 0x0065bc00 0x00449c00 0x0018c00 0x00724000 0x002fc400 0x0068a000 0x001ef800 0x0067f400 0x00216000 0x006f9400  
LBA[60]: 0x00182400 0x004b4800 0x002d5400 0x0004e400 0x0072fc00 0x00376c00 0x001be400 0x00706c00 0x00057400 0x0014f800  
LBA[70]: 0x00366000 0x0079d400 0x006b3c00 0x00489c00 0x0070e800 0x006d7c00 0x0013f800 0x00401400 0x001c4000 0x007e5400  
LBA[80]: 0x00509400 0x00590000 0x002ad800 0x002c400 0x004ca400 0x00509800 0x00191000 0x006f8400 0x0066e400 0x001a3c00  
LBA[90]: 0x002c4400 0x00386000 0x00179c00 0x00421400 0x00514c00 0x00484000 0x0035f000 0x0008a400 0x00585c00 0x000b9c00  
PRE LBA LIST:  
LBA[ 0]: 0x00521800 0x006a9c00 0x00042c00 0x006c7000 0x00755000 0x00115400 0x005c4800 0x007bf800 0x002e6000 0x002d2400

LBA: 0x762990 | HF: 0x04001276 F1: 0x65bbb47d F2: 0xda812af0 [LOOP: 1 WRITE: 550 SECTOR: 400 / NUM: 1024 / ZERO: 120]  
IO Time: 2023-06-25 16:22:21

Buffer addr: 0xffff46082000 | Physical addr: 0x5345cf2000

LBA LIST:  
LBA[ 0]: 0x00762800 0x006dec00 0x0069f800 0x00138800 0x006fc800 0x007a9800 0x00449800 0x0031dc00 0x000d4800 0x00190c00  
LBA[10]: 0x0021ac00 0x0030d400 0x00714400 0x005b0c00 0x006f2400 0x002c8800 0x00441c00 0x005d1400 0x006f6400 0x00256000  
LBA[20]: 0x005037fb04 0x007df800 0x00117800 0x0031c000 0x00249400 0x005f0800 0x001cac00 0x00799400 0x0003d400 0x000e9000  
LBA[30]: 0x00503c00 0x004cc800 0x001a1c00 0x00560800 0x003f6800 0x00125c00 0x00728400 0x00447c00 0x003ca000 0x00073800  
LBA[40]: 0x00107000 0x006f7400 0x002dc000 0x0003t7800 0x003ca400 0x005d9800 0x0040c000 0x0008a000 0x000d9800 0x001a2400  
LBA[50]: 0x0065bc00 0x00449c00 0x0018c00 0x00724000 0x002fc400 0x0068a000 0x001ef800 0x0067f400 0x00216000 0x006f9400  
LBA[60]: 0x00182400 0x004b4800 0x002d5400 0x0004e400 0x0072fc00 0x00376c00 0x001be400 0x00706c00 0x00057400 0x0014f800  
LBA[70]: 0x00366000 0x0079d400 0x006b3c00 0x00489c00 0x0070e800 0x006d7c00 0x0013f800 0x00401400 0x001c4000 0x007e5400  
LBA[80]: 0x00509400 0x00590000 0x002ad800 0x002c400 0x004ca400 0x00509800 0x00191000 0x006f8400 0x0066e400 0x001a3c00  
LBA[90]: 0x002c4400 0x00386000 0x00179c00 0x00421400 0x00514c00 0x00484000 0x0035f000 0x0008a400 0x00585c00 0x000b9c00  
PRE LBA LIST:  
LBA[ 0]: 0x00521800 0x006a9c00 0x00042c00 0x006c7000 0x00755000 0x00115400 0x005c4800 0x007bf800 0x002e6000 0x002d2400

LBA: 0x762991 | HF: 0x04001276 F1: 0x65bbb47d F2: 0xda812af0 [LOOP: 1 WRITE: 550 SECTOR: 401 / NUM: 1024 / ZERO: 120]  
IO Time: 2023-06-25 16:22:21

Buffer addr: 0xffff46082200 | Physical addr: 0x5345cf2200

LBA LIST:  
LBA[ 0]: 0x00762800 0x006dec00 0x0069f800 0x00138800 0x006fc800 0x007a9800 0x00449800 0x0031dc00 0x000d4800 0x00190c00  
LBA[10]: 0x0021ac00 0x0030d400 0x00714400 0x005b0c00 0x006f2400 0x002c8800 0x00441c00 0x005d1400 0x006f6400 0x00256000  
LBA[20]: 0x006df400 0x007df800 0x00117800 0x0031c000 0x00249400 0x005f0800 0x001cac00 0x00799400 0x0003d400 0x000e9000  
LBA[30]: 0x00503c00 0x004cc800 0x001a1c00 0x00560800 0x003f6800 0x00125c00 0x00728400 0x00447c00 0x003ca000 0x00073800  
LBA[40]: 0x00107000 0x006f7400 0x002dc000 0x0003t7800 0x003ca400 0x005d9800 0x0040c000 0x0008a000 0x000d9800 0x001a2400  
LBA[50]: 0x0065bc00 0x00449c00 0x0018c00 0x00724000 0x002fc400 0x0068a000 0x001ef800 0x0067f400 0x00216000 0x006f9400  
LBA[60]: 0x00182400 0x004b4800 0x002d5400 0x0004e400 0x0072fc00 0x00376c00 0x001be400 0x00706c00 0x00057400 0x0014f800  
LBA[70]: 0x00366000 0x0079d400 0x006b3c00 0x00489c00 0x0070e800 0x006d7c00 0x0013f800 0x00401400 0x001c4000 0x007e5400  
LBA[80]: 0x00509400 0x00590000 0x002ad800 0x002c400 0x004ca400 0x00509800 0x00191000 0x006f8400 0x0066e400 0x001a3c00  
LBA[90]: 0x002c4400 0x00386000 0x00179c00 0x00421400 0x00514c00 0x00484000 0x0035f000 0x0008a400 0x00585c00 0x000b9c00  
PRE LBA LIST:  
LBA[ 0]: 0x00521800 0x006a9c00 0x00042c00 0x006c7000 0x00755000 0x00115400 0x005c4800 0x007bf800 0x002e6000 0x002d2400

Current Time: 2023-06-25 16:49:11

BUG 002[3]: [Thread: 6] VERIFY SECTOR[400] DIFFER: 1 | CORRECT LBA[0]: 0x762800 | ERROR LBA[400]: 0x762990 | filename: lba.raw  
LBA: 0x762990 | thread\_num: 10, bitmap: 0 0 0 0 0 0 1 0 0 0  
LAST CORRECT WRITE:  
LBA: 0x6f2400 | HF: 0x04001276 F1: 0x65bbb47d F2: 0xda812af0 [LOOP: 1 WRITE: 564 SECTOR: 0 / NUM: 1024 / ZERO: 120]  
LAST WRITE IO Time: 2023-06-25 16:22:21  
Buffer addr: 0xffffeb14d0000 | Physical addr: 0x53a2320000

---runtime校验

## LBA工具基本功能演示

- BUG 007[2]: 案例一, inject SECTOR Iba bug

**全零扇区**: 中间扇区的数据与前后扇区的数据不一致

BUG 007[2] : [Thread: 8] VERIFY ZERO SECTOR[853] DIFFER: 1  
| read[259] | filename: /dev/loop4

**CORRECT LBA[0]: 0x793000 | HF: 0x04001278 F1: 0x7b9930dd F2: 0x75218ae0 [LOOP: 3 WRITE: 259 SECTOR: 0 / NUM: 1024 / ZERO: 254]**  
**CORRECT IO Time: 2023-06-19 15:43:57**

**ERROR LBA[853]: 0x793355** | HF: 0xb5b5b5b5 F1: 0xb5b5b5b5 F2: 0xb5b5b5b5 [LOOP: 3048584629 WRITE: 3048584629 SECTOR: 46517 / NUM: 46517 / ZERO: 3048584629]  
INCONSISTENT IO Time: -1246380767--1246382666--1246382667 - 1246382667:-1246382667:-1246382667

**CORRECT LBA[854]: 0x793356 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]**  
**CORRECT IO Time: 1900-01-00 00:00:00**

---checktime校验

# LBA工具基本功能演示

## ➤ BUG 007[2]: 案例二, inject LIST lba bug

全零扇区：中间扇区的数据与前后扇区的数据不一致

BUG 007[2] : [Thread: 4] VERIFY ZERO SECTOR[930] DIFFER: 1

| read[79] | filename: lba.raw

CORRECT LBA[0]: 0x52d400 | HF: 0x04001274 F1: 0xa1b5ec90 F2: 0x205d950c

[LOOP: 1 WRITE: 79 SECTOR: 0 / NUM: 1024 / ZERO: 328]

CORRECT IO Time: 2023-06-12 17:12:00

ERROR LBA[930]: 0x52d7a2 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000

[LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]

INCONSISTENT IO Time: 1900-01-00 00:00:00

CORRECT LBA[931]: 0x52d7a3 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000

[LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]

CORRECT IO Time: 1900-01-00 00:00:00

---runtime校验 & checktime校验

BUG 007[2] LAST IO?: [Thread: 4] VERIFY ZERO SECTOR[930] DIFFER: 1 | read[79] | filename: lba.raw

hd\_write\_verify\_dump -c -D -L 0x00d8b000 disk/file  
hd\_write\_verify\_dump -c -D -L 0x00538000 disk/file

CORRECT LBA[0]: 0x52d400 | HF: 0x04001274 F1: 0xa1b5ec90 F2: 0x205d950c [LOOP: 1 WRITE: 79 SECTOR: 0 / NUM: 1024 / ZERO: 328]  
CORRECT IO Time: 2023-06-12 17:12:00

ERROR LBA[930]: 0x52d7a2 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]  
INCONSISTENT IO Time: 1900-01-00 00:00:00

CORRECT LBA[931]: 0x52d7a3 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]  
CORRECT IO Time: 1900-01-00 00:00:00

LBA: 0x52d7a1 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]  
IO Time: 1900-01-00 00:00:00

Buffer addr: 0xfffffa82f4200 | Physical addr: 0x78165c54200

LBA LIST:

LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[10]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[20]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[30]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[40]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[50]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[60]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[70]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[80]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[90]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

PRE LBA LIST:

LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

LBA: 0x52d7a2 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]  
IO Time: 1900-01-00 00:00:00

Buffer addr: 0xfffffa82f4400 | Physical addr: 0x78165c54400

LBA LIST:

LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[10]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[20]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[30]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[40]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[50]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[60]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[70]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[80]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[90]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

PRE LBA LIST:

LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

LBA: 0x52d7a3 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]  
IO Time: 1900-01-00 00:00:00

Buffer addr: 0xfffffa82f4600 | Physical addr: 0x78165c54600

LBA LIST:

LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[10]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[20]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[30]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[40]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[50]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[60]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[70]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[80]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[90]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

PRE LBA LIST:

LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

Current Time: 2023-06-23 11:13:38

## LBA工具基本功能演示

- BUG 007[3]: inject SECTOR lba bug

前后簇数据正确，中间簇非零扇区数据校验出错

BUG 007[3]: [Thread: 7] VERIFY SECTOR[310] DIFFER: 11  
| read[498] | filename: lba.raw

**CORRECT LBA[0]: 0x5ad000 | HF: 0x04001277 F1: 0xc079f392  
F2: 0x662da7b8 [LOOP: 1 WRITE: 498 SECTOR: 0 / NUM: 1024  
/ ZERO: 224]  
CORRECT IO Time: 2023-06-23 00:02:28**

ERROR LBA[310]: 0x5ad136 | HF: 0x19191919 F1: 0x19191919  
F2: 0x19191919 [LOOP: 421075225 WRITE: 421075225  
SECTOR: 6425 / NUM: 6425 / ZERO: 421075225]  
INCONSISTENT IO Time: 421077125-421075226-421075225  
421075225:421075225:421075225

**CORRECT LBA[321]: 0x5ad141 | HF: 0x04001277 F1:  
0xc079f392 F2: 0x662da7b8 [LOOP: 1 WRITE: 498 SECTOR:  
321 / NUM: 1024 / ZERO: 224]  
CORRECT IO Time: 2023-06-23 00:02:28**

---checktime校验

Current Time: 2023-06-23 11:01:27  
 BUG 007[3]: [Thread: 7] VERIFY SECTOR[310] DIFFER: 11 | read[498] | filename: lba.raw  
 LBA: 0x5ad000 | thread\_num: 10, bitmap: 0 0 0 0 0 0 0 0 0

CORRECT LBA[0]: 0x5ad000 | HF: 0x04001277 F1: 0xc079f392 F2: 0x662da7b8 [LOOP: 1 WRITE: 498 SECTOR: 0 / NUM: 1024 / ZERO: 224]  
 CORRECT IO Time: 2023-06-23 00:02:28

Buffer addr: 0xfffff024d0000 | Physical addr: 0x420fb10000

LBA LIST:

LBA[ 0]: 0x005ad000 0x0060cc00 0x002f1000 0x00495000 0x0012f000 0x00459c00 0x0012f400 0x00154800 0x00366c00 0x00175800  
 LBA[10]: 0x0075e800 0x003b1c00 0x0008e800 0x005a6400 0x00099c00 0x00550400 0x00632c00 0x000e1c00 0x0055d800 0x00136000  
 LBA[20]: 0x00302c00 0x007cbc00 0x00073800 0x00058400 0x00491000 0x003c4c00 0x00787400 0x0067ec00 0x00359800 0x006e7400  
 LBA[30]: 0x00687800 0x001f5c00 0x004b5800 0x002e3400 0x0073a400 0x0075f400 0x0044c00 0x007f1000 0x00794800 0x005f9400  
 LBA[40]: 0x002c9800 0x000505800 0x003d5c00 0x00445000 0x004e9c00 0x00420400 0x00526800 0x001e7800 0x0031bc00 0x0001cc00  
 LBA[50]: 0x0030b400 0x0052e800 0x001e1000 0x006dd000 0x00539800 0x00422c00 0x00696c00 0x006a0400 0x00542400 0x002b4400  
 LBA[60]: 0x005be000 0x00289c00 0x00650000 0x000f3400 0x004ca800 0x005f1000 0x00748400 0x00603400 0x005fd400 0x004b0c00  
 LBA[70]: 0x007d0400 0x00743c00 0x000b2800 0x00419800 0x0076a800 0x00307800 0x0056d800 0x00142c00 0x0047b400 0x007af800  
 LBA[80]: 0x0066c400 0x003d4800 0x00127c00 0x00585400 0x001a9800 0x004c4c00 0x007de000 0x003b7000 0x0059a400 0x006da000  
 LBA[90]: 0x00176400 0x00223c00 0x000ddc00 0x00159400 0x002ac800 0x006c4400 0x001e0400 0x006c6800 0x002e9000 0x000d4400

PRE LBA LIST:

LBA[ 0]: 0x005da400 0x0060e800 0x00092400 0x0051f800 0x00433800 0x00289000 0x005b3c00 0x00128c00 0x0022b000 0x00342c00

---

ERROR LBA[310]: 0x5ad136 | HF: 0x19191919 F1: 0x19191919 F2: 0x19191919 [LOOP: 421075225 WRITE: 421075225 SECTOR: 6425 / NUM: 6425 / ZERO: 421075225]  
 INCONSISTENT IO Time: 421077125-421075226-421075225 421075225:421075225:421075225

Buffer addr: 0xfffff024f6c00 | Physical addr: 0x4490226c00

LBA LIST:

LBA[ 0]: 0x19191919  
 LBA[10]: 0x19191919  
 LBA[20]: 0x19191919  
 LBA[30]: 0x19191919  
 LBA[40]: 0x19191919  
 LBA[50]: 0x19191919  
 LBA[60]: 0x19191919  
 LBA[70]: 0x19191919  
 LBA[80]: 0x19191919  
 LBA[90]: 0x19191919 0x19191919 0x19191919 0x19191919 0x19191919 0x19191919 0x19191919 0x19191919 0x19191919 0x19191919

PRE LBA LIST:

LBA[ 0]: 0x19191919 0x19191919 0x19191919 0x19191919 0x19191919 0x19191919 0x19191919 0x19191919 0x19191919 0x19191919

---

NEXT LBA: 0x60cc00 | HF: 0x04001277 F1: 0xc079f392 F2: 0x662da7b8 [LOOP: 1 WRITE: 499 SECTOR: 0 / NUM: 1024 / ZERO: 224]  
 NEXT IO Time: 2023-06-23 00:02:28

Buffer addr: 0xfffff018f0000 | Physical addr: 0x48a45f0000

LBA LIST:

LBA[ 0]: 0x0060cc00 0x002f1000 0x00495000 0x0012f000 0x00459c00 0x0012f400 0x00154800 0x00366c00 0x00175800 0x0075e800  
 LBA[10]: 0x003b1c00 0x0008e800 0x005a6400 0x00099c00 0x00550400 0x00632c00 0x000e1c00 0x0055d800 0x00136000 0x00302c00  
 LBA[20]: 0x007cbc00 0x00073800 0x00058400 0x00491000 0x003c4c00 0x00787400 0x0067ec00 0x00359800 0x006e7400 0x00687800  
 LBA[30]: 0x001f5c00 0x004b5800 0x002e3400 0x0073a400 0x0075f400 0x0044c00 0x007f1000 0x00794800 0x005f9400 0x002c9800  
 LBA[40]: 0x00505800 0x003d5c00 0x00445000 0x004e9c00 0x00420400 0x00526800 0x001e7800 0x0031bc00 0x0001cc00 0x0030b400  
 LBA[50]: 0x0052e800 0x001e1000 0x006dd000 0x00539800 0x00422c00 0x00696c00 0x006a0400 0x00542400 0x002b4400 0x005be000  
 LBA[60]: 0x00289c00 0x00650000 0x000f3400 0x004ca800 0x005f1000 0x00748400 0x00603400 0x005fd400 0x004b0c00 0x007d0400  
 LBA[70]: 0x00743c00 0x000b2800 0x00419800 0x0076a800 0x00307800 0x0056d800 0x00142c00 0x0047b400 0x007af800 0x006cc400  
 LBA[80]: 0x003d4800 0x00127c00 0x00585400 0x001a9800 0x004c4c00 0x007de000 0x003b7000 0x0059a400 0x006da000 0x00176400  
 LBA[90]: 0x00223c00 0x000ddc00 0x00159400 0x002ac800 0x006c4400 0x001e0400 0x006c6800 0x002e9000 0x000d4400 0x0006a400

PRE LBA LIST:

LBA[ 0]: 0x005ad000 0x005da400 0x0060e800 0x00092400 0x0051f800 0x00433800 0x00289000 0x005b3c00 0x00128c00 0x0022b000

# LBA工具基本功能演示

## ➤ BUG 007[4]: inject SECTOR lba bug

前后簇数据正确，中间簇全零扇区数据校验出错

BUG 007[4]: [Thread: 1] VERIFY ZERO SECTOR[970] DIFFER: 54  
| read[534] | filename: lba.raw

CORRECT LBA[0]: 0x7e9800 | HF: 0x04001271 F1: 0xc079f392 F2:  
0x8d10bb23 [LOOP: 1 WRITE: 533 SECTOR: 0 / NUM: 1024 / ZERO: 271]  
CORRECT IO Time: 2023-06-23 00:02:29

ERROR LBA[970]: 0x7e9bca | HF: 0xb4b4b4b4 F1: 0xb4b4b4b4 F2:  
0xb4b4b4b4 [LOOP: 3031741620 WRITE: 3031741620 SECTOR: 46260 /  
NUM: 46260 / ZERO: 3031741620]  
INCONSISTENT IO Time: -1263223776--1263225675--1263225676 -  
1263225676:-1263225676:-1263225676

NEXT LBA: 0x60b000 | HF: 0x04001271 F1: 0xc079f392 F2: 0x8d10bb23  
[LOOP: 1 WRITE: 534 SECTOR: 0 / NUM: 1024 / ZERO: 271]  
NEXT IO Time: 2023-06-23 00:02:29

--checktime校验

BUG 007[4]: [Thread: 1] VERIFY ZERO SECTOR[970] DIFFER: 54 | read[534] | filename: lba.raw  
hd\_write\_verify\_dump -c -D -L 0x006e5c00 disk/file  
hd\_write\_verify\_dump -c -D -L 0x0060b000 disk/file  
CORRECT LBA[0]: 0x7e9800 | HF: 0x04001271 F1: 0xc079f392 F2: 0x8d10bb23 [LOOP: 1 WRITE: 533 SECTOR: 0 / NUM: 1024 / ZERO: 271]  
CORRECT IO Time: 2023-06-23 00:02:29  
  
ERROR LBA[970]: 0x7e9bca | HF: 0xb4b4b4b4 F1: 0xb4b4b4b4 F2: 0xb4b4b4b4 [LOOP: 3031741620 WRITE: 3031741620 SECTOR: 46260 / NUM: 46260 / ZERO: 3031741620]  
INCONSISTENT IO Time: -1263223776--1263225675--1263225676 -1263225676:-1263225676  
  
NEXT LBA: 0x60b000 | HF: 0x04001271 F1: 0xc079f392 F2: 0x8d10bb23 [LOOP: 1 WRITE: 534 SECTOR: 0 / NUM: 1024 / ZERO: 271]  
NEXT IO Time: 2023-06-23 00:02:29  
  
-----  
LBA: 0x7e9bc9 | HF: 0x00000000 F1: 0x00000000 F2: 0x00000000 [LOOP: 0 WRITE: 0 SECTOR: 0 / NUM: 0 / ZERO: 0]  
IO Time: 1900-01-01 00:00:00  
  
Buffer addr: 0xfffff55489200 | Physical addr: 0x223be19200  
  
LBA LIST:  
LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[10]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[20]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[30]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[40]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[50]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[60]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[70]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[80]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
LBA[90]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
  
PRE LBA LIST:  
LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000  
  
-----  
LBA: 0x7e9bca | HF: 0xb4b4b4b4 F1: 0xb4b4b4b4 F2: 0xb4b4b4b4 [LOOP: 3031741620 WRITE: 3031741620 SECTOR: 46260 / NUM: 46260 / ZERO: 3031741620]  
IO Time: -1263223776--1263225675--1263225676 -1263225676:-1263225676  
  
Buffer addr: 0xfffff55489400 | Physical addr: 0x223be19400  
  
LBA LIST:  
LBA[ 0]: 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4  
LBA[10]: 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4  
LBA[20]: 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4  
LBA[30]: 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4  
LBA[40]: 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4  
LBA[50]: 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4  
LBA[60]: 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4  
LBA[70]: 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4  
LBA[80]: 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4  
LBA[90]: 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4  
  
PRE LBA LIST:  
LBA[ 0]: 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4 0xb4b4b4b4  
  
-----  
LBA: 0x60b000 | HF: 0x04001271 F1: 0xc079f392 F2: 0x8d10bb23 [LOOP: 1 WRITE: 534 SECTOR: 0 / NUM: 1024 / ZERO: 271]  
IO Time: 2023-06-23 00:02:29  
  
Buffer addr: 0xfffff552d0000 | Physical addr: 0x21a2df0000  
  
LBA LIST:  
LBA[ 0]: 0x0006b000 0x003ee400 0x007af400 0x0019d400 0x00648400 0x004ffcc0 0x0021c800 0x002dbcc0 0x005c8800 0x00155000  
LBA[10]: 0x00247c00 0x00639c00 0x00041800 0x000bd800 0x0054fc00 0x000b2000 0x00717400 0x00697800 0x00560000 0x00343000  
LBA[20]: 0x00621400 0x003e8400 0x00010c00 0x00066e00 0x0037ec00 0x00317400 0x00769000 0x00738400 0x000d3400  
LBA[30]: 0x005d4000 0x00444800 0x00051c00 0x005c4400 0x007b1800 0x004de400 0x004ab400 0x007c5400 0x007a5800 0x003b3c00  
LBA[40]: 0x000e4000 0x0075fc00 0x0026f800 0x00056800 0x001a9400 0x0028ac00 0x00252400 0x00422800 0x002a3000 0x0016bc00  
LBA[50]: 0x006f9400 0x00048c00 0x004a7000 0x000ba00 0x005ed000 0x00772800 0x00793c00 0x00415400 0x006b8800 0x00095c00  
LBA[60]: 0x004ef000 0x006d400 0x000220c0 0x0012800 0x000bac00 0x0033b000 0x00210400 0x0028cc00 0x000af400 0x006e8800  
LBA[70]: 0x0051d800 0x00173800 0x0049dc00 0x00735800 0x002ba00 0x00178000 0x001bd400 0x000d3800 0x00505c00  
LBA[80]: 0x00133400 0x00555a00 0x0009a000 0x0022f400 0x0001dc400 0x0006c0400 0x00485800 0x00088400 0x007bec00 0x0053ce00  
LBA[90]: 0x00066c00 0x004b9800 0x003f6000 0x00295800 0x00655400 0x0028bc00 0x00539400 0x000d4800 0x003cf800  
  
PRE LBA LIST:  
LBA[ 0]: 0x007e9bca 0x006e5c00 0x005de400 0x006ad400 0x0019800 0x002d3c00 0x0013f000 0x0006a800 0x006d4800 0x00288400  
  
-----  
Current Time: 2023-06-23 11:23:18

# LBA工具基本功能演示：hd\_write\_verify\_dump工具数据校验功能

## ➤ 线程数据校验：(-T参数)

(1) 校验2号线程写入的所有数据，第85簇IO与前面簇的数据不一致：  
BUG 003

```
[root@localhost lba]# hd_write_verify_dump -c -D -T 2 lba.raw
File Information:
  File: lba.raw
  Size: 10737418240
  Blocks: 965680
  IO Block: 65536
  Device: 2051
  Inode: 1678094440
  Links: 1
  File Size: 10737418240 / 10240M / 10.00G

  Sector_Per_Cluster: 1024

Current Time: 2023-06-24 12:29:30
```

```
=====
BUG 003: [Thread: 2] WRITE PART SECTOR | read[85] | filename: lba.raw
=====
CORRECT LBA: 0x11de000 | HF: 0x04001272 F1: 0xalb5ec90 F2: 0x27c3ef0a [L0OP: 1 WRITE: 84 SECTOR: 0 / NUM: 1024 / ZERO: 246]
CORRECT LBA IO Time: 2023-06-12 17:11:59

ERROR LBA: 0x95d000 | HF: 0x04001272 F1: 0xalb5ec90 F2: 0x27c3ef0a [L0OP: 1 WRITE: 85 SECTOR: 0 / NUM: 1024 / ZERO: 246]
ERROR LBA IO Time: 2023-06-12 17:12:00
```

```
=====
LBA: 0x11de000 | HF: 0x04001272 F1: 0xalb5ec90 F2: 0x27c3ef0a [L0OP: 1 WRITE: 84 SECTOR: 0 / NUM: 1024 / ZERO: 246]
IO Time: 2023-06-12 17:11:59

Buffer addr: 0xfffff92050000 | Physical addr: 0x7024d560000

LBA LIST:
LBA[ 0]: 0x011de000 0x0095d000 0x002e1400 0x0130fc00 0x00ecc800 0x00176000 0x00fb5000 0x011c0c00 0x00d49000 0x00898000
LBA[10]: 0x00bb6c00 0x001cc000 0x00f46400 0x00013c00 0x0192800 0x00e60400 0x0015a800 0x0094c000 0x00db6000 0x00f92c00
LBA[20]: 0x003ec000 0x0081d000 0x000ca000 0x00222000 0x008d7800 0x010f4800 0x002a8000 0x00ca1000 0x011c4000 0x000cb000
LBA[30]: 0x007e8000 0x00f14000 0x00872400 0x010c8000 0x008c6800 0x011e5000 0x00664000 0x000e34c00 0x00ab5800 0x00768400
LBA[40]: 0x00d77000 0x00901c00 0x00e16000 0x00499000 0x008a80000 0x0007e800 0x00c2a000 0x00217800 0x0074f800 0x00a67800
LBA[50]: 0x00847000 0x012a0400 0x006fb800 0x004e1400 0x004e1000 0x0055cc00 0x00976000 0x00118000 0x0105c500 0x00370000
LBA[60]: 0x001b1000 0x00f40000 0x000e8c00 0x00f2a000 0x00638000 0x00780000 0x00fb6400 0x008c1c00 0x00d08800 0x002a3800
LBA[70]: 0x011af000 0x00a62000 0x00cf4400 0x005b4000 0x013ed800 0x01195800 0x008c3400 0x00509c00 0x00513800 0x00e16400
LBA[80]: 0x007c9400 0x00462000 0x00088800 0x0095c000 0x00d4b000 0x0008e000 0x00a9d000 0x01038000 0x00b50000 0x00e16400
LBA[90]: 0x00b28000 0x00807800 0x00ff1000 0x011e9000 0x00c61400 0x0135bc00 0x013e2000 0x00316400 0x00c76000 0x00b62400

PRE LBA LIST:
LBA[ 0]: 0x00a30000 0x001cc400 0x00417000 0x00e5c000 0x0105c400 0x01138000 0x01010400 0x0052f000 0x009fa400 0x00eb8000
```

```
=====
LBA: 0x95d000 | HF: 0x04001272 F1: 0xalb5ec90 F2: 0x27c3ef0a [L0OP: 1 WRITE: 85 SECTOR: 0 / NUM: 1024 / ZERO: 246]
IO Time: 2023-06-12 17:12:00

Buffer addr: 0xfffff920f0000 | Physical addr: 0x782b6920000

LBA LIST:
LBA[ 0]: 0x0095d000 0x002e1400 0x0130fc00 0x00ecc800 0x00176000 0x00fb5000 0x011c0c00 0x00d49000 0x00898000 0x00bb6c00
LBA[10]: 0x0001c2800 0x00013c00 0x00fb6400 0x0005d0400 0x0015a800 0x0094c000 0x00db6000 0x00f92c00 0x003ec000
LBA[20]: 0x0081d000 0x000ca000 0x0032a000 0x008d7800 0x010f4800 0x002a8000 0x00ca1000 0x011c4000 0x000cb000 0x007e8000
LBA[30]: 0x001f4000 0x008572400 0x010c8000 0x008c6800 0x011e5000 0x00664000 0x000e34c00 0x00ab5800 0x00768400 0x00d77000
LBA[40]: 0x0001c000 0x00e16000 0x00499000 0x008a80000 0x0007e800 0x00c2a000 0x00217800 0x0074f800 0x00a67800 0x00847000
LBA[50]: 0x012a0400 0x00f08000 0x004e1400 0x004e1000 0x0055cc00 0x00976000 0x00118000 0x0105c500 0x01d4822 0x001b1000
LBA[60]: 0x00f40000 0x00e62000 0x00f2a000 0x000838000 0x00780000 0x008c3400 0x00098800 0x00238000 0x011af000
LBA[70]: 0x00962000 0x0080f4400 0x005b4000 0x013ed800 0x01195800 0x008c3400 0x000509c00 0x00513800 0x00e16400 0x00774000
LBA[80]: 0x00462000 0x00088800 0x0095c000 0x00d4b000 0x0008e000 0x00a9d000 0x01038000 0x00b50000 0x00c76000 0x00b62400
LBA[90]: 0x00b67800 0x00ff1000 0x011e9000 0x00c61400 0x0135bc00 0x013e2000 0x00316400 0x00c76000 0x00b62400 0x0005a400

PRE LBA LIST:
LBA[ 0]: 0x011de000 0x00a30000 0x001cc400 0x00417000 0x00e5c000 0x0105c400 0x01138000 0x01010400 0x0052f000 0x009fa400
```

Current Time: 2023-06-24 12:29:31

```
[root@localhost lba]# hd_write_verify_dump -c -D -T 2 -C 30 lba.raw
File Information:
  File: lba.raw
  Size: 10737418240
  Blocks: 965680
  IO Block: 65536
  Device: 2051
  Inode: 1678094440
  Links: 1
  File Size: 10737418240 / 10240M / 10.00G

  Sector_Per_Cluster: 1024

Current Time: 2023-06-24 12:30:11
```

```
=====
LBA: 0x800 | HF: 0x04001272 F1: 0xalb5ec90 F2: 0x27c3ef0a [L0OP: 1 WRITE: 1 SECTOR: 0 / NUM: 1024 / ZERO: 246]
IO Time: 2023-06-12 17:11:00
```

Buffer addr: 0x26c20000 | Physical addr: 0x10195ad0000

```
LBA LIST:
LBA[ 0]: 0x00000000 0x0022a000 0x00efcc00 0x01303000 0x01264000 0x00461c00 0x0034a400 0x010ad000 0x003a2c00 0x0035bc00
LBA[10]: 0x00eb7c00 0x00144000 0x00406800 0x00522000 0x00914000 0x00611800 0x00c78000 0x005f7800 0x00493000 0x00f9bc00
LBA[20]: 0x00395400 0x010fe000 0x0016d000 0x0007fc00 0x00d00000 0x008b0800 0x00be6400 0x001bf000 0x00d10800 0x01168000
LBA[30]: 0x01029000 0x00c74000 0x0001b400 0x004a0000 0x00fc0c00 0x00a80400 0x00c22000 0x00350000 0x00f60000 0x001295000
LBA[40]: 0x007fb800 0x00291c00 0x003b7800 0x010f8000 0x00d52000 0x00bca7000 0x00534000 0x002ff000 0x006c8000 0x01la1400
LBA[50]: 0x0077b400 0x0001d000 0x012a5800 0x0046f000 0x00ee62000 0x009d3c00 0x00aa0000 0x00d3000 0x000eb000 0x000f1800
LBA[60]: 0x011fa000 0x003dc800 0x0007a000 0x00ef7f000 0x0107c400 0x01100000 0x00ff5f000 0x00cccd00 0x00c7000 0x00f31000
LBA[70]: 0x00891400 0x0040c000 0x00ba1c00 0x00eb000 0x009fa400 0x0052f000 0x01010400 0x01138000 0x0105c400 0x00e5c000
LBA[80]: 0x00417000 0x001cc400 0x000a30000 0x011de000 0x0130fc00 0x0095d000 0x0002e1400 0x00eccc800 0x010176000 0x00fb5000
LBA[90]: 0x011c0c00 0x00d49000 0x00898000 0x0001c000 0x00f46400 0x00013c00 0x00192800 0x00e60400 0x0015a800
```

PRE LBA LIST:

LBA[ 0]: 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000 0x00000000

```
=====
LBA: 0x1168000 | HF: 0x04001272 F1: 0xalb5ec90 F2: 0x27c3ef0a [L0OP: 1 WRITE: 30 SECTOR: 0 / NUM: 1024 / ZERO: 246]
IO Time: 2023-06-12 17:11:18
```

Buffer addr: 0xfffffa4a20000 | Physical addr: 0x1032c530000

```
LBA LIST:
LBA[ 0]: 0x01168000 0x01029000 0x00c74000 0x00ble400 0x004a0000 0x00cf0c00 0x00a80400 0x00c22000 0x00350000 0x00cf6000
LBA[10]: 0x01295000 0x007fb800 0x00291c00 0x003b7800 0x010f8000 0x00d52000 0x00bca000 0x00534000 0x002ff000 0x006c8000
LBA[20]: 0x011a1400 0x0077b400 0x0001d000 0x012a5800 0x0046f000 0x009d3c00 0x00aa0000 0x00d3000 0x000eb000 0x000f1800
LBA[30]: 0x0001f1800 0x001fa000 0x0032d000 0x00077800 0x0107c400 0x01100000 0x005f5f000 0x00cccd00 0x00ac7000
LBA[40]: 0x000f31000 0x00891400 0x004b0000 0x00ba1c00 0x00eb000 0x009fa400 0x0052f000 0x01010400 0x01138000 0x0105c400
LBA[50]: 0x00e5c000 0x00417000 0x001cc400 0x00a30000 0x011de000 0x0095d000 0x002e1400 0x0130fc00 0x00ecc800 0x00176000
LBA[60]: 0x00fb5000 0x001cc000 0x000d49000 0x00898000 0x00bb6c00 0x001c0000 0x00192800 0x00f46400 0x00013c00 0x00192800 0x00e60400
LBA[70]: 0x0015a800 0x0094c000 0x000bd6000 0x000fb2c00 0x003e0ca00 0x0001c000 0x000ca800 0x0032a000 0x0009d7800 0x010f4800
LBA[80]: 0x002a8000 0x00cal000 0x011c4000 0x000cb000 0x007e8800 0x0001f4000 0x00872400 0x010ce000 0x008c6800 0x011e5000
LBA[90]: 0x00664000 0x00e34c00 0x00ab5800 0x000768400 0x00d77000 0x00901c00 0x00e16000 0x00499000 0x00a80000 0x0007e800
```

PRE LBA LIST:

LBA[ 0]: 0x00d10800 0x001bf000 0x00be6400 0x008b0800 0x00d00000 0x0007fc00 0x0016d000 0x010fe000 0x00395400 0x00f9bc00

Current Time: 2023-06-24 12:30:11

# LBA工具基本功能演示：hd\_write\_verify\_dump工具数据校验功能

➤ 簇间数据校验：  
(-L和-C参数)

(1) 校验LBA地址：  
0x63000开始的之后  
30簇数据，所有数据  
是一致的。

```
[root@localhost lba]# hd_write_verify_dump -c -D -L 0x63000 -C 50 lba.raw
File Information:
  File: lba.raw
  Size: 10737418240
  Blocks: 965680
  IO Block: 65536
  Device: 2051
  Inode: 1678094440
  Links: 1
  File Size: 10737418240 / 10240M / 10.00G
  Sector_Per_Cluster: 1024
  Current Time: 2023-06-24 13:06:25
  =====
  LBA: 0x63000 | HF: 0x04001275 F1: 0xalb5ec90 F2: 0x29d3a78e [L0OP: 1 WRITE: 21 SECTOR: 0 / NUM: 1024 / ZERO: 208]
  IO Time: 2023-06-12 17:11:12
  Buffer addr: 0x14160000 | Physical addr: 0x10076980000
  LBA LIST:
  LBA[ 0]: 0x00063000 0x013ffc00 0x00c98000 0x0060d800 0x01329c00 0x00da4800 0x00e28400 0x0127c800 0x013bac00 0x00afcd00
  LBA[10]: 0x008c8000 0x013bc800 0x00f84c00 0x003b2000 0x003eb400 0x00b05c00 0x004af000 0x0096f800 0x01121800 0x00b7ac00
  LBA[20]: 0x00e9d000 0x00160000 0x00483800 0x00c6d000 0x0054d800 0x0058c000 0x00b02000 0x00be0000 0x00690000 0x00314800
  LBA[30]: 0x000f7000 0x00e5b000 0x0057e000 0x003df400 0x00f95000 0x00b21800 0x004b2400 0x00acb800 0x00ceb800 0x01057000
  LBA[40]: 0x00e00000 0x00804000 0x00c4f800 0x00e20000 0x0114b800 0x00492000 0x0105b000 0x00266800 0x0012cc00 0x008e6400
  LBA[50]: 0x006c5000 0x012ab800 0x010c0800 0x0091c000 0x00f63000 0x005a4400 0x00d40400 0x00b11800 0x00ae1000 0x00673000
  LBA[60]: 0x00a05800 0x00f24000 0x00dc4c00 0x0020bc00 0x01341400 0x00ae6800 0x009c6400 0x00fe4000 0x00983800 0x004e2800
  LBA[70]: 0x00661800 0x010d4000 0x01298800 0x00233000 0x0037f800 0x013ab800 0x005c3800 0x003e7c00 0x013a6800 0x00e3e000
  LBA[80]: 0x006fc000 0x0072e000 0x01220000 0x011df000 0x01105000 0x00d14400 0x007b5000 0x0068c800 0x01144000 0x00bec800
  LBA[90]: 0x00e69800 0x00a43000 0x01002800 0x0115a800 0x00d0b800 0x003c2800 0x011c3400 0x00cd1800 0x01256400 0x00d69000
  PRE LBA LIST:
  LBA[ 0]: 0x0134d000 0x004d0000 0x008d6000 0x0093e000 0x01134000 0x004f0000 0x001d7c00 0x00822800 0x01392000 0x00122000
  =====
```

(2) 校验LBA地址：  
0x63000开始的之后  
所有数据，第82簇  
IO，簇内偏移234扇  
区的数据与前后扇区  
的数据不一致：  
**BUG 007[1]**

```
[root@localhost lba]# hd_write_verify_dump -c -D -L 0x63000 -C 0 lba.raw
File Information:
  File: lba.raw
  Size: 10737418240
  Blocks: 965680
  IO Block: 65536
  Device: 2051
  Inode: 1678094440
  Links: 1
  File Size: 10737418240 / 10240M / 10.00G
  Sector_Per_Cluster: 1024
  Current Time: 2023-06-24 13:06:17
  =====
  BUG 007[1] LAST IO: [Thread: 5] VERIFY SECTOR[234] DIFFER: 1 | read[62] | filename: lba.raw
  hd_write_verify_dump -c -D -L 0x63000 disk/file
  hd_write_verify_dump -c -D -L 0x00dc4c00 disk/file
  CORRECT LBA[0]: 0xf24000 | HF: 0x04001275 F1: 0xalb5ec90 F2: 0x29d3a78e [L0OP: 1 WRITE: 82 SECTOR: 0 / NUM: 1024 / ZERO: 208]
  CORRECT IO Time: 2023-06-12 17:12:00
  ERROR LBA[234]: 0xf24000 | HF: 0x04001275 F1: 0xalb5ec90 F2: 0x29d3a78e [L0OP: 1 WRITE: 82 SECTOR: 234 / NUM: 1024 / ZERO: 208]
  INCONSISTENT IO Time: 2023-06-12 17:12:00
  CORRECT LBA[235]: 0xf24000 | HF: 0x04001275 F1: 0xalb5ec90 F2: 0x29d3a78e [L0OP: 1 WRITE: 82 SECTOR: 235 / NUM: 1024 / ZERO: 208]
  CORRECT IO Time: 2023-06-12 17:12:00
  =====
  LBA: 0xf24000 | HF: 0x04001275 F1: 0xalb5ec90 F2: 0x29d3a78e [L0OP: 1 WRITE: 82 SECTOR: 233 / NUM: 1024 / ZERO: 208]
  IO Time: 2023-06-12 17:12:00
  Buffer addr: 0xfffff9327d200 | Physical addr: 0x30325eld200
  LBA LIST:
  LBA[ 0]: 0x00f24000 0x00dc4c00 0x0020bc00 0x01341400 0x00ae6800 0x009c6400 0x00fe4000 0x00983800 0x004e2800 0x00661800
  LBA[10]: 0x010d4000 0x01298800 0x00233000 0x0037f800 0x013ab800 0x005c3800 0x003e7c00 0x013a6800 0x00e3e000 0x006f9000
  LBA[20]: 0x0072e000 0x01220000 0x011df000 0x01105000 0x00d14400 0x007b5000 0x0068c800 0x01144000 0x00bec800 0x007e7800
  LBA[30]: 0x00a43000 0x01028000 0x0115a800 0x0060b800 0x003c2800 0x011c3400 0x00cd1800 0x01256400 0x00d59000 0x007f7800
  LBA[40]: 0x007f7800 0x0052d400 0x00375000 0x00328000 0x00d0b800 0x00334000 0x003e7c00 0x011c3400 0x00cd1800 0x01256400 0x00d59000
  LBA[50]: 0x0057a800 0x005d000 0x011df000 0x01105000 0x00d14400 0x007b5000 0x0068c800 0x01144000 0x00bec800 0x007e7800
  LBA[60]: 0x008a2800 0x00595800 0x004f1800 0x0128000 0x013ab800 0x005c3800 0x003e7c00 0x013a6800 0x00e3e000 0x006f9000
  LBA[70]: 0x008b8400 0x00271400 0x00846000 0x00846000 0x0033e400 0x003e7c00 0x013a6800 0x00e3e000 0x006f9000
  LBA[80]: 0x0025f400 0x009fb500 0x00c3800 0x00fci100 0x004f1800 0x0128000 0x013ab800 0x005c3800 0x003e7c00 0x013a6800 0x00e3e000
  LBA[90]: 0x00955800 0x00b04000 0x007aac00 0x005b7c00 0x004f78000 0x011f6900 0x0138c000 0x00451000 0x00f91c00
  PRE LBA LIST:
  LBA[ 0]: 0x00a05800 0x00673000 0x00ae1000 0x00b11800 0x00d40400 0x005a4400 0x00f63000 0x0091c000 0x010c0800 0x012ab800
  =====
  LBA: 0xf24000 | HF: 0x04001275 F1: 0xalb5ec90 F2: 0x29d3a78e [L0OP: 1 WRITE: 82 SECTOR: 234 / NUM: 1024 / ZERO: 208]
  IO Time: 2023-06-12 17:12:00
  Buffer addr: 0xfffff9327d400 | Physical addr: 0x30325eld400
  LBA LIST:
  LBA[ 0]: 0x00f24000 0x00dc4c00 0x0020bc00 0x01341400 0x00ae6800 0x009c6400 0x00fe4000 0x00983800 0x004e2800 0x00661800
  LBA[10]: 0x010d4000 0x01298800 0x00233000 0x0037f800 0x013ab800 0x005c3800 0x003e7c00 0x013a6800 0x00e3e000 0x006f9000
  LBA[20]: 0x0072e000 0x01220000 0x011df000 0x01105000 0x00d14400 0x007b5000 0x0068c800 0x01144000 0x00bec800 0x007e7800
  LBA[30]: 0x00a43000 0x01028000 0x0115a800 0x0060b800 0x003c2800 0x011c3400 0x00cd1800 0x01256400 0x00d59000 0x007f7800
  LBA[40]: 0x007f7800 0x0052d400 0x00375000 0x00328000 0x00d0b800 0x00334000 0x003e7c00 0x011c3400 0x00cd1800 0x01256400 0x00d59000
  LBA[50]: 0x0057a800 0x005d000 0x011df000 0x01105000 0x00d14400 0x007b5000 0x0068c800 0x01144000 0x00bec800 0x007e7800
  LBA[60]: 0x008a2800 0x00595800 0x004f1800 0x0128000 0x013ab800 0x005c3800 0x003e7c00 0x013a6800 0x00e3e000 0x006f9000
  LBA[70]: 0x008b8400 0x00271400 0x00846000 0x00846000 0x0033e400 0x003e7c00 0x013a6800 0x00e3e000 0x006f9000
  LBA[80]: 0x0025f400 0x009fb500 0x00c3800 0x00fci100 0x004f1800 0x0128000 0x013ab800 0x005c3800 0x003e7c00 0x013a6800 0x00e3e000
  LBA[90]: 0x00955800 0x00b04000 0x007aac00 0x005b7c00 0x004f78000 0x011f6900 0x0138c000 0x00451000 0x00f91c00
  PRE LBA LIST:
  LBA[ 0]: 0x00a05800 0x00673000 0x00ae1000 0x00b11800 0x00d40400 0x005a4400 0x00f63000 0x0091c000 0x010c0800 0x012ab800
  =====
  LBA: 0xf240eb0 | HF: 0x04001275 F1: 0xalb5ec90 F2: 0x29d3a78e [L0OP: 1 WRITE: 82 SECTOR: 235 / NUM: 1024 / ZERO: 208]
  IO Time: 2023-06-12 17:12:00
  Buffer addr: 0xfffff9327d600 | Physical addr: 0x30325eld600
  LBA LIST:
  LBA[ 0]: 0x00f24000 0x00dc4c00 0x0020bc00 0x01341400 0x00ae6800 0x009c6400 0x00fe4000 0x00983800 0x004e2800 0x00661800
  LBA[10]: 0x010d4000 0x01298800 0x00233000 0x0037f800 0x013ab800 0x005c3800 0x003e7c00 0x013a6800 0x00e3e000 0x006f9000
  LBA[20]: 0x0072e000 0x01220000 0x011df000 0x01105000 0x00d14400 0x007b5000 0x0068c800 0x01144000 0x00bec800 0x007e7800
  LBA[30]: 0x00a43000 0x01028000 0x0115a800 0x0060b800 0x003c2800 0x011c3400 0x00cd1800 0x01256400 0x00d59000 0x007f7800
  LBA[40]: 0x007f7800 0x0052d400 0x00375000 0x00328000 0x00d0b800 0x00334000 0x003e7c00 0x011c3400 0x00cd1800 0x01256400 0x00d59000
  LBA[50]: 0x0057a800 0x005d000 0x011df000 0x01105000 0x00d14400 0x007b5000 0x0068c800 0x01144000 0x00bec800 0x007e7800
  LBA[60]: 0x008a2800 0x00595800 0x004f1800 0x0128000 0x013ab800 0x005c3800 0x003e7c00 0x013a6800 0x00e3e000 0x006f9000
  LBA[70]: 0x008b8400 0x00271400 0x00846000 0x00846000 0x0033e400 0x003e7c00 0x013a6800 0x00e3e000 0x006f9000
  LBA[80]: 0x0025f400 0x009fb500 0x00c3800 0x00fci100 0x004f1800 0x0128000 0x013ab800 0x005c3800 0x003e7c00 0x013a6800 0x00e3e000
  LBA[90]: 0x00955800 0x00b04000 0x007aac00 0x005b7c00 0x004f78000 0x011f6900 0x0138c000 0x00451000 0x00f91c00
  PRE LBA LIST:
  LBA[ 0]: 0x00a05800 0x00673000 0x00ae1000 0x00b11800 0x00d40400 0x005a4400 0x00f63000 0x0091c000 0x010c0800 0x012ab800
  =====
  LBA: 0xf240eb0 | HF: 0x04001275 F1: 0xalb5ec90 F2: 0x29d3a78e [L0OP: 1 WRITE: 82 SECTOR: 234 / NUM: 1024 / ZERO: 208]
  IO Time: 2023-06-24 13:06:17
  Buffer addr: 0xfffff9327d600 | Physical addr: 0x30325eld600
  LBA LIST:
  LBA[ 0]: 0x00f24000 0x00dc4c00 0x0020bc00 0x01341400 0x00ae6800 0x009c6400 0x00fe4000 0x00983800 0x004e2800 0x00661800
  LBA[10]: 0x010d4000 0x01298800 0x00233000 0x0037f800 0x013ab800 0x005c3800 0x003e7c00 0x013a6800 0x00e3e000 0x006f9000
  LBA[20]: 0x0072e000 0x01220000 0x011df000 0x01105000 0x00d14400 0x007b5000 0x0068c800 0x01144000 0x00bec800 0x007e7800
  LBA[30]: 0x00a43000 0x01028000 0x0115a800 0x0060b800 0x003c2800 0x011c3400 0x00cd1800 0x01256400 0x00d59000 0x007f7800
  LBA[40]: 0x007f7800 0x0052d400 0x00375000 0x00328000 0x00d0b800 0x00334000 0x003e7c00 0x011c3400 0x00cd1800 0x01256400 0x00d59000
  LBA[50]: 0x0057a800 0x005d000 0x011df000 0x01105000 0x00d14400 0x007b5000 0x0068c800 0x01144000 0x00bec800 0x007e7800
  LBA[60]: 0x008a2800 0x00595800 0x004f1800 0x0128000 0x013ab800 0x005c3800 0x003e7c00 0x013a6800 0x00e3e000 0x006f9000
  LBA[70]: 0x008b8400 0x00271400 0x00846000 0x00846000 0x0033e400 0x003e7c00 0x013a6800 0x00e3e000 0x006f9000
  LBA[80]: 0x0025f400 0x009fb500 0x00c3800 0x00fci100 0x004f1800 0x0128000 0x013ab800 0x005c3800 0x003e7c00 0x013a6800 0x00e3e000
  LBA[90]: 0x00955800 0x00b04000 0x007aac00 0x005b7c00 0x004f78000 0x011f6900 0x0138c000 0x00451000 0x00f91c00
  PRE LBA LIST:
  LBA[ 0]: 0x00a05800 0x00673000 0x00ae1000 0x00b11800 0x00d40400 0x005a4400 0x00f63000 0x0091c000 0x010c0800 0x012ab800
  =====
```

# LBA工具基本功能演示：hd\_write\_verify\_dump工具数据校验功能

## ➤ 簇内数据校验：(-L和-S参数)

```
[root@localhost lba]# hd_write_verify_dump -c -D -L 0xa89ab0 -S 2 lba_test.raw
File Information:
  File:    lba_test.raw
  Size:   10737418240
  Blocks: 965680
  IO Block: 65536
  Device: 2051
  Inode: 1678094440
  Links: 1
  File Size: 10737418240 / 10240M / 10.00G
  Sector_Per_Cluster: 1024
Current Time: 2023-07-12 15:13:18
```

```
LBA: 0xa89ab0 | HF: 0x04001270 F1: 0x1b5ec90 F2: 0x29701e70 [L0OP: 1 WRITE: 103 SECTOR: 688 / NUM: 1024 / ZERO: 282]
IO Time: 2023-06-12 17:12:00
```

```
Buffer addr: 0xfffffa1926000 | Physical addr: 0x682a12b6000
```

```
LBA LIST:
LBA[ 0]: 0x00a89800 0x0133b000 0x013c0400 0x00bae800 0x00928000 0x007b1000 0x0068a000 0x00b03000 0x01131000
LBA[10]: 0x00a94800 0x0074b000 0x00b89000 0x01250c00 0x0123800 0x00fa7400 0x00e86400 0x005d0400 0x00de5800 0x00046400
LBA[20]: 0x00a1ec00 0x001db000 0x000720400 0x00ce6000 0x006f3000 0x001c5000 0x010ea800 0x00050000 0x009d2000 0x00256800
LBA[30]: 0x00ae5000 0x01078c00 0x001b4800 0x00666000 0x000d8f000 0x00788000 0x0012f800 0x0004e1800 0x0136dc00 0x008f0800
LBA[40]: 0x005d2000 0x00326000 0x01111800 0x00223800 0x013cc800 0x01375800 0x0096b400 0x00735000 0x011cb000 0x00cec000
LBA[50]: 0x00be0800 0x01118c00 0x00314000 0x002ea000 0x00876000 0x000aa000 0x0071d000 0x00583c00 0x00853000 0x010db000
LBA[60]: 0x00cc1800 0x0010c400 0x002b3800 0x00ce8800 0x00e3b000 0x00c50000 0x00444400 0x00456000 0x01211400 0x00ca4800
LBA[70]: 0x00a56400 0x00879400 0x0051ec00 0x00abbb00 0x011f0400 0x00a90000 0x002c6400 0x00c8a000 0x00ed3800 0x00164800
LBA[80]: 0x0036e400 0x00902000 0x00234800 0x00196400 0x0133e800 0x0128ac00 0x00550000 0x00cca800 0x00924000 0x00cc1000
LBA[90]: 0x0073e000 0x007efc00 0x013f0800 0x00ab7000 0x00c3f000 0x01303800 0x00fcc000 0x00eba800 0x001ee400 0x00ff12000
```

```
PRE LBA LIST:
LBA[ 0]: 0x01172000 0x01206000 0x002e8000 0x00810000 0x00a86400 0x0043e000 0x00493800 0x01le4000 0x010e4000 0x00f08c00
```

```
LBA: 0xa89ab1 | HF: 0x04001270 F1: 0x1b5ec90 F2: 0x29701e70 [L0OP: 1 WRITE: 103 SECTOR: 689 / NUM: 1024 / ZERO: 282]
IO Time: 2023-06-12 17:12:00
```

```
Buffer addr: 0xfffffa1926200 | Physical addr: 0x682a12b6200
```

```
LBA LIST:
LBA[ 0]: 0x00a89800 0x0133b000 0x013c0400 0x00bae800 0x00928000 0x007b1000 0x0068a000 0x00b03000 0x01131000
LBA[10]: 0x00a94800 0x0074b000 0x00b89000 0x01250c00 0x0123800 0x00fa7400 0x00e86400 0x005d0400 0x00de5800 0x00046400
LBA[20]: 0x00a1ec00 0x001db000 0x000720400 0x00ce6000 0x006f3000 0x001c5000 0x010ea800 0x00050000 0x009d2000 0x00256800
LBA[30]: 0x00ae5000 0x01078c00 0x001b4800 0x00666000 0x000d8f000 0x00788000 0x0012f800 0x0004e1800 0x0136dc00 0x008f0800
LBA[40]: 0x005d2000 0x00326000 0x01111800 0x00223800 0x013cc800 0x01375800 0x0096b400 0x00735000 0x011cb000 0x00cec000
LBA[50]: 0x00be0800 0x01118c00 0x00314000 0x002ea000 0x00876000 0x000aa000 0x0071d000 0x00583c00 0x00853000 0x010db000
LBA[60]: 0x00cc1800 0x0010c400 0x002b3800 0x00ce8800 0x00e3b000 0x00c50000 0x00444400 0x00456000 0x01211400 0x00ca4800
LBA[70]: 0x00a56400 0x00879400 0x0051ec00 0x00abbb00 0x011f0400 0x00a90000 0x002c6400 0x00c8a000 0x00ed3800 0x00164800
LBA[80]: 0x0036e400 0x00902000 0x00234800 0x00196400 0x0133e800 0x0128ac00 0x00550000 0x00cca800 0x00924000 0x00cc1000
LBA[90]: 0x0073e000 0x007efc00 0x013f0800 0x00ab7000 0x00c3f000 0x01303800 0x00fcc000 0x00eba800 0x001ee400 0x00ff12000
```

```
PRE LBA LIST:
LBA[ 0]: 0x01172000 0x01206000 0x002e8000 0x00810000 0x00a86400 0x0043e000 0x00493800 0x01le4000 0x010e4000 0x00f08c00
```

```
Current Time: 2023-07-12 15:13:18
```

```
[root@localhost lba]# 
```

```
[root@localhost lba]# hd_write_verify_dump -c -D -L 0x649418 -S 2 lba.raw
File Information:
  File:    lba.raw
  Size:   4294967296
  Blocks: 7375232
  IO Block: 65536
  Device: 2051
  Inode: 1678094460
  Links: 1
  File Size: 4294967296 / 4096M / 4.00G
  Sector_Per_Cluster: 1024
Current Time: 2023-07-12 15:38:30
```

```
LBA: 0x649418 | HF: 0x04001277 F1: 0x0892947a F2: 0x9b232b74 [L0OP: 1 WRITE: 629 SECTOR: 24 / NUM: 1024 / ZERO: 4]
IO Time: 2023-07-12 15:37:04
```

```
Buffer addr: 0xfffff9d133000 | Physical addr: 0x182b4613000
```

```
LBA LIST:
LBA[ 0]: 0x00649400 0x000ec800 0x00557c00 0x005fcfc00 0x003c6800 0x0017e400 0x00285400 0x00158c00 0x0058f000 0x0018b400
LBA[10]: 0x007b000 0x001bcc00 0x0075ec00 0x00397c00 0x0064c400 0x007e0c00 0x00259800 0x0015a000 0x005fb800 0x004f5c00
LBA[20]: 0x0057d800 0x00674400 0x00399800 0x0002b400 0x00308800 0x004f6000 0x001f7c00 0x0016a800 0x00638800 0x00409c00
LBA[30]: 0x0040b400 0x005e5000 0x00699000 0x0020c400 0x000fa800 0x007bb400 0x0016ac00 0x0077e400 0x002a8c00 0x00274400
LBA[40]: 0x000d4000 0x0002d000 0x00249400 0x001bf800 0x0040b800 0x0021ec00 0x0033e000 0x005d0400 0x003b8800 0x0072f800
LBA[50]: 0x00389800 0x00202400 0x0017ec00 0x007fe800 0x0021f400 0x0027f400 0x00795c00 0x003bf000 0x005c4c00 0x002d4400
LBA[60]: 0x00191c00 0x0049d000 0x001d6400 0x005ca400 0x00333c00 0x004df400 0x0064b00 0x005eb800 0x0076b800 0x002da400
LBA[70]: 0x000db800 0x0030a000 0x007db800 0x00212800 0x002ec400 0x000b5800 0x003f1400 0x004fd400 0x0066a000 0x007dd400
LBA[80]: 0x0064cc00 0x003d9c00 0x007de800 0x0038cc00 0x0034e000 0x001fc00 0x001f0800 0x0064d800 0x001f8400 0x001af400
LBA[90]: 0x005f3400 0x004c5400 0x003c4800 0x0059b000 0x0057a800 0x0019ec00 0x006cac00 0x00789800 0x001cf800 0x00263400
```

```
PRE LBA LIST:
LBA[ 0]: 0x0002a000 0x00740c00 0x0055ec00 0x00039400 0x007d4c00 0x0071b000 0x007adc00 0x005e3400 0x0013d000 0x0034fc00
```

```
LBA: 0x649419 | HF: 0x3a3a3a3a F1: 0x3a3a3a3a F2: 0x3a3a3a3a [L0OP: 976894522 WRITE: 976894522 SECTOR: 14906 / NUM: 149
IO Time: 976896422-976894523-976894522 976894522:976894522:976894522
```

```
Buffer addr: 0xfffff9d133200 | Physical addr: 0x182b4613200
```

```
LBA LIST:
LBA[ 0]: 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a
LBA[10]: 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a
LBA[20]: 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a
LBA[30]: 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a
LBA[40]: 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a
LBA[50]: 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a
LBA[60]: 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a
LBA[70]: 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a
LBA[80]: 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a
LBA[90]: 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a
```

```
PRE LBA LIST:
LBA[ 0]: 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a 0x3a3a3a3a
```

```
Current Time: 2023-07-12 15:38:30
```

```
[root@localhost lba]# 
```

# LBA工具基本功能演示：hd\_write\_verify\_dump工具数据校验功能

- dump指定LBA的数据：(-L和-S参数)



dump.log

```
[root@localhost lba]# hd_write_verify_dump -c -D -L 0xc5800 -S 2 lba.raw
File Information:
  File:      lba.raw
  Size:     4294967296
  Blocks:   7375232
  IO Block: 65536
  Device:   2051
  Inode:    1678094460
  Links:    1
  File Size: 4294967296 / 4096M / 4.00G

  Sector_Per_Cluster: 1024

  Current Time: 2023-07-12 16:58:29

=====
LBA: 0xc5800 | HF: 0x04001275 F1: 0x0892947a F2: 0x0e0fab86 [LOOP: 1 WRITE: 629 SECTOR: 0 / NUM: 1024 / ZERO: 262]
IO Time: 2023-07-12 15:37:03

  Buffer addr: 0xfffff92ad0000 | Physical addr: 0x50181300000

  LBA LIST:
  LBA[ 0]: 0x000c5800 0x001acc00 0x00246800 0x00739800 0x00202000 0x0037c400 0x006d7000 0x00175c00 0x0017e800 0x00688400
  LBA[10]: 0x00588800 0x0045c000 0x007f2400 0x00091c00 0x002b8800 0x00088800 0x003b1800 0x00273000 0x0015a400 0x001b7c00
  LBA[20]: 0x004c9c00 0x0021lc00 0x0023f400 0x000a3800 0x006ee800 0x00409800 0x006c8c00 0x0069d800 0x0035e000 0x0070a000
  LBA[30]: 0x00092800 0x00370000 0x0034ac00 0x005ec800 0x001c5400 0x004ca000 0x001c3400 0x001c3c00 0x000a7000 0x00486c00
  LBA[40]: 0x0008fc00 0x003ab000 0x004fd800 0x006c9400 0x004e0800 0x0058dc00 0x00059400 0x0053ac00 0x0037cc00 0x00683800
  LBA[50]: 0x00369800 0x004b3c00 0x00454400 0x003ab800 0x003c3400 0x0036a000 0x00194800 0x00076c00 0x003c3c00 0x00455400
  LBA[60]: 0x003c7400 0x004e6c00 0x003f0400 0x00766400 0x00730c00 0x0043fc00 0x0063ac00 0x00687400 0x00261800 0x0068f800
  LBA[70]: 0x00732000 0x007dcc00 0x005eec00 0x00753400 0x00207800 0x005ef800 0x006cb800 0x00353c00 0x00313800 0x00233800
  LBA[80]: 0x001ce000 0x002e7400 0x0003dc00 0x00578400 0x0073a800 0x00797800 0x0038f000 0x006da800 0x003e1800 0x00797c00
  LBA[90]: 0x0009d000 0x00776000 0x00249c00 0x00733c00 0x0062c000 0x00042400 0x001e9c00 0x005b4800 0x005f3c00 0x00655c00

  PRE LBA LIST:
  LBA[ 0]: 0x00307000 0x001b0c00 0x001d5400 0x0056f000 0x00224c00 0x0004fc00 0x0068ec00 0x0049ac00 0x00727c00 0x003a9c00

=====
LBA: 0xc5801 | HF: 0x04001275 F1: 0x0892947a F2: 0x0e0fab86 [LOOP: 1 WRITE: 629 SECTOR: 1 / NUM: 1024 / ZERO: 262]
IO Time: 2023-07-12 15:37:03

  Buffer addr: 0xfffff92ad0200 | Physical addr: 0x50181300200

  LBA LIST:
  LBA[ 0]: 0x000c5800 0x001acc00 0x00246800 0x00739800 0x00202000 0x0037c400 0x006d7000 0x00175c00 0x0017e800 0x00688400
  LBA[10]: 0x00588800 0x0045c000 0x007f2400 0x00091c00 0x002b8800 0x00088800 0x003b1800 0x00273000 0x0015a400 0x001b7c00
  LBA[20]: 0x004c9c00 0x0021lc00 0x0023f400 0x000a3800 0x006ee800 0x00409800 0x006c8c00 0x0069d800 0x0035e000 0x0070a000
  LBA[30]: 0x00092800 0x00370000 0x0034ac00 0x005ec800 0x001c5400 0x004ca000 0x001c3400 0x001c3c00 0x000a7000 0x00486c00
  LBA[40]: 0x0008fc00 0x003ab000 0x004fd800 0x006c9400 0x004e0800 0x0058dc00 0x00059400 0x0053ac00 0x0037cc00 0x00683800
  LBA[50]: 0x00369800 0x004b3c00 0x00454400 0x003ab800 0x003c3400 0x0036a000 0x00194800 0x00076c00 0x003c3c00 0x00455400
  LBA[60]: 0x003c7400 0x004e6c00 0x003f0400 0x00766400 0x00730c00 0x0043fc00 0x0063ac00 0x00687400 0x00261800 0x0068f800
  LBA[70]: 0x00732000 0x007dcc00 0x005eec00 0x00753400 0x00207800 0x005ef800 0x006cb800 0x00353c00 0x00313800 0x00233800
  LBA[80]: 0x001ce000 0x002e7400 0x0003dc00 0x00578400 0x0073a800 0x00797800 0x0038f000 0x006da800 0x003e1800 0x00797c00
  LBA[90]: 0x0009d000 0x00776000 0x00249c00 0x00733c00 0x0062c000 0x00042400 0x001e9c00 0x005b4800 0x005f3c00 0x00655c00

  PRE LBA LIST:
  LBA[ 0]: 0x00307000 0x001b0c00 0x001d5400 0x0056f000 0x00224c00 0x0004fc00 0x0068ec00 0x0049ac00 0x00727c00 0x003a9c00

=====
Current Time: 2023-07-12 16:58:29

[root@localhost lba]# hd_write_verify_dump -c -D -L 0xc5800 -S 1024 lba.raw > dump.log
[root@localhost lba]#
```

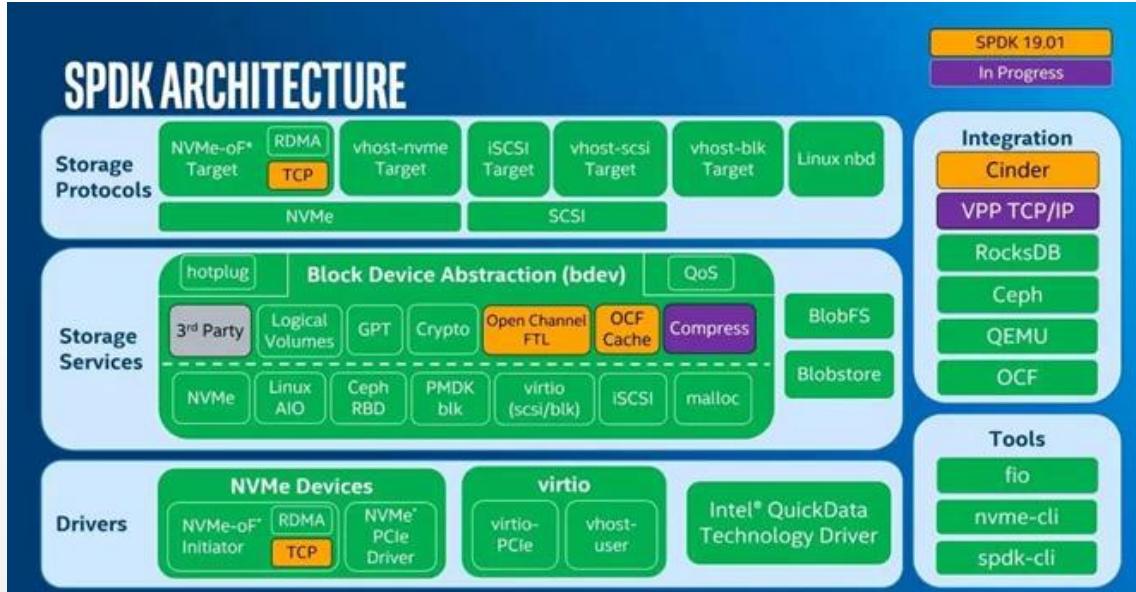
# 目 录



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  - 05 存储稳定性测试与数据一致性校验  
自动化测试系统演示
  - 06 展望
-

# LBA工具典型应用场景：存储、OS

➤ 各种类型存储及文件系统的稳定性、可靠性测试



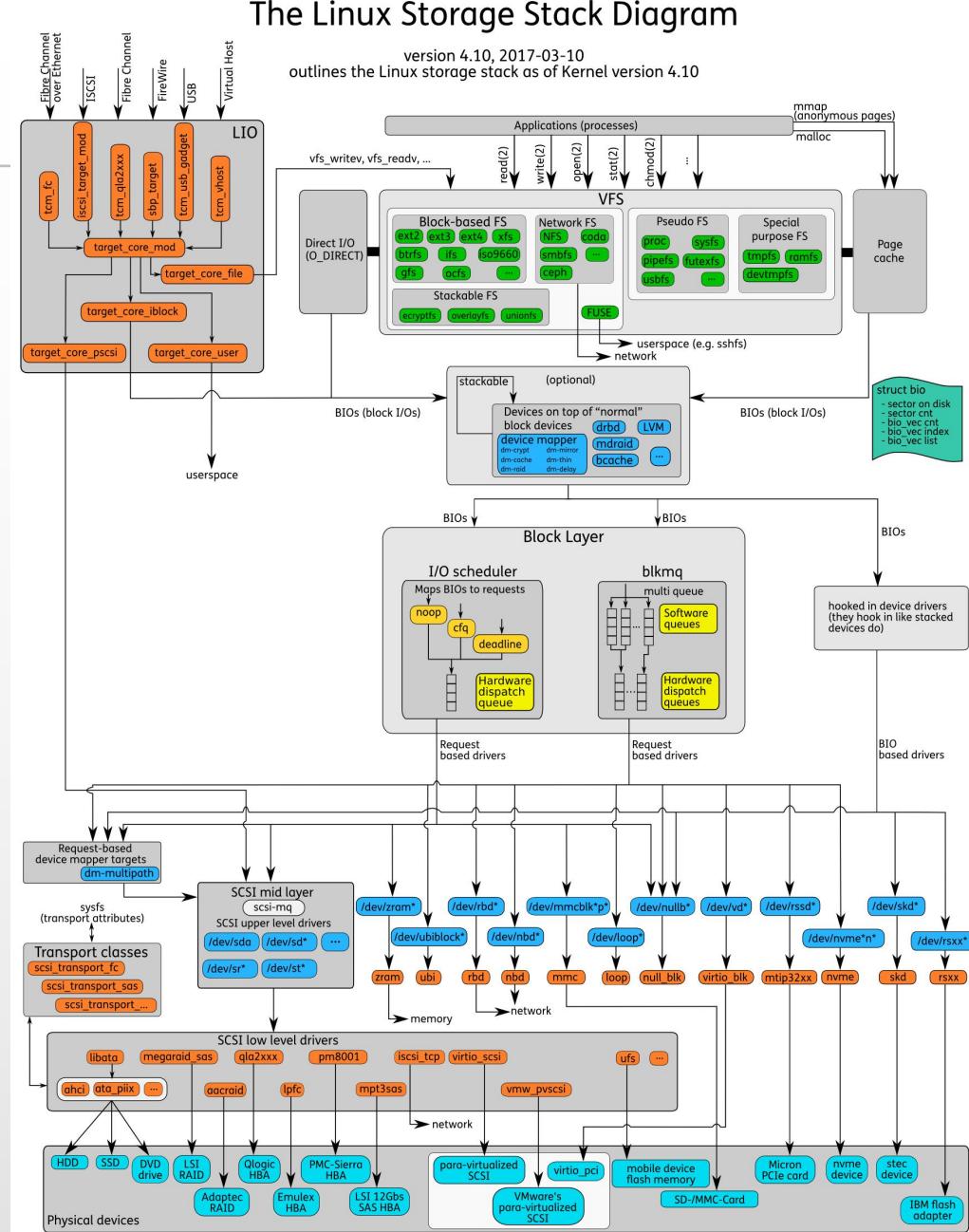
## 存储:

1. 内核存储协议栈
  2. spdk
  3. ceph
  4. glusterfs
  5. linstor
  6. longhorn
  7. ipsan/fcsan/multipath/nas/.....



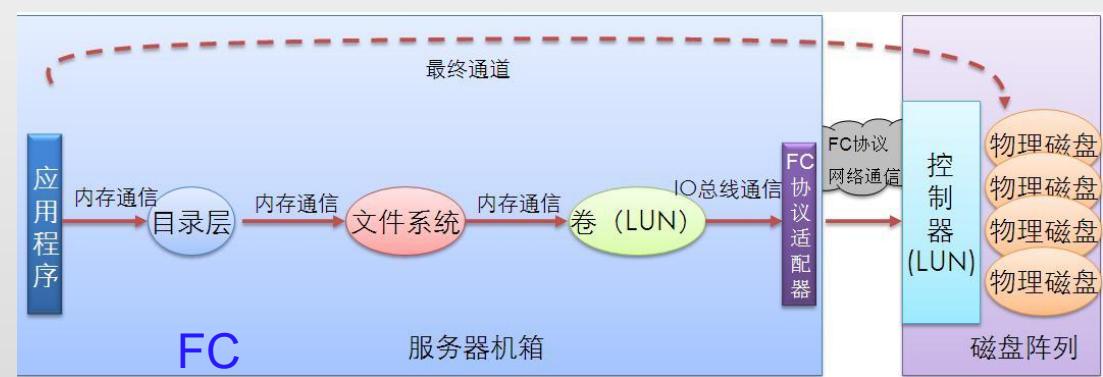
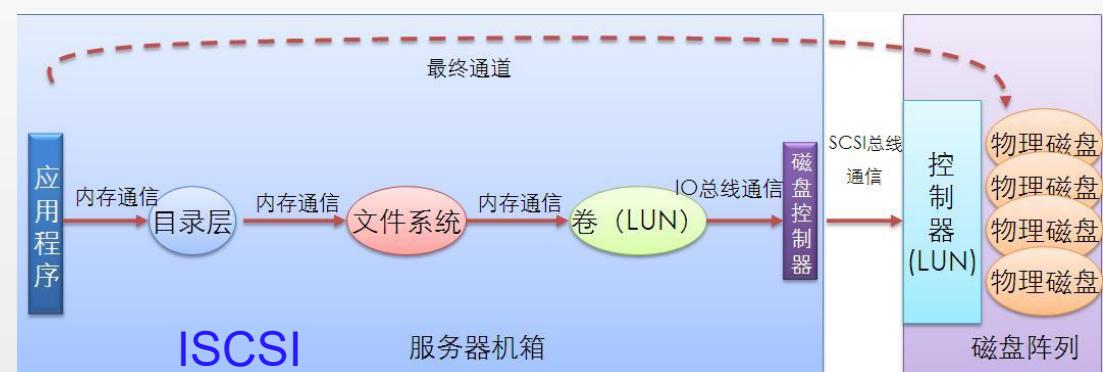
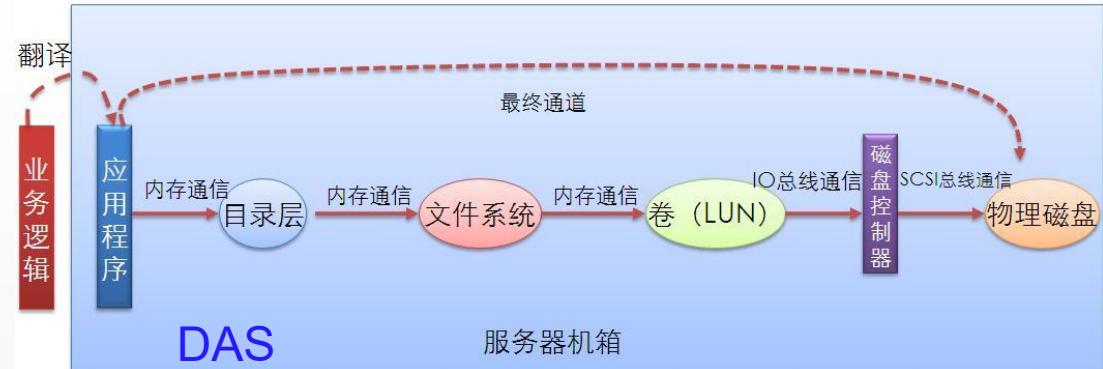
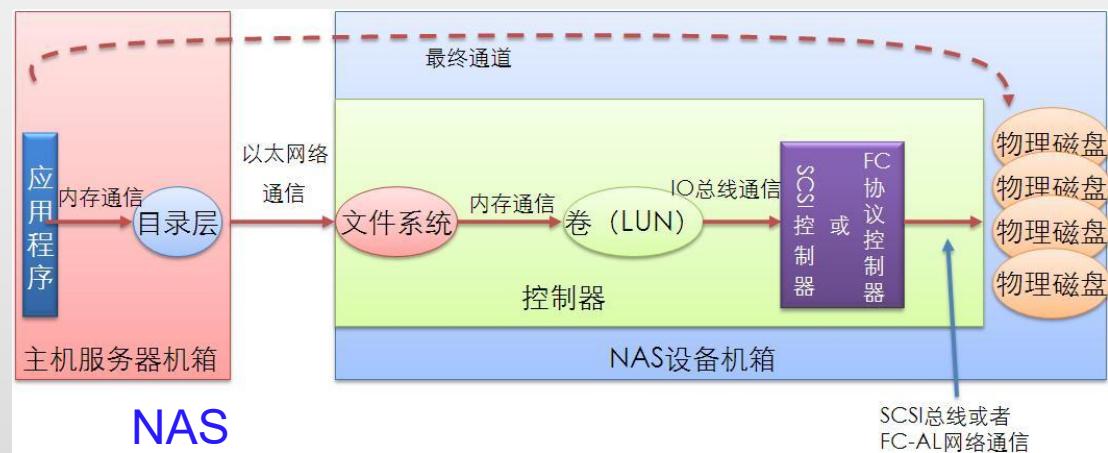
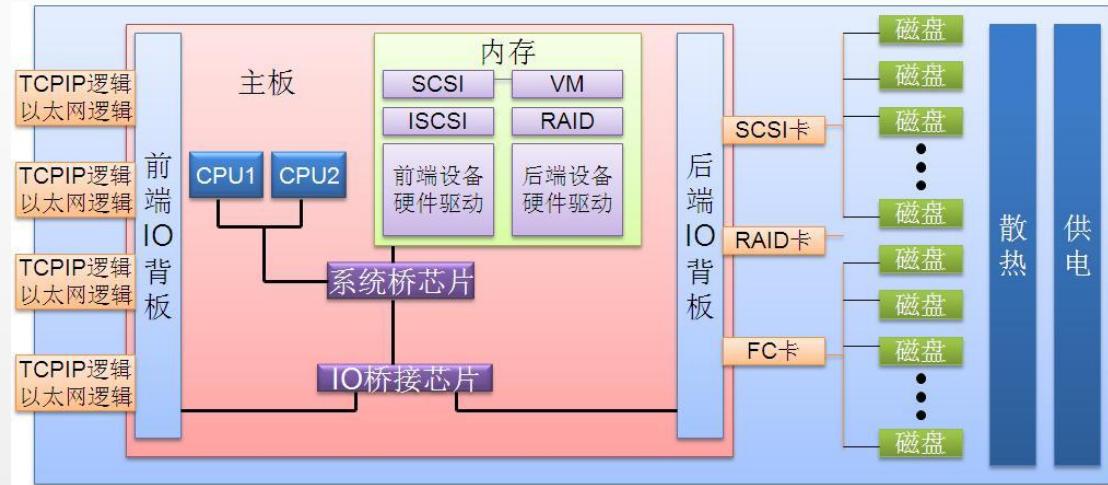
## 文件系统:

1. 本地文件系统: ext2/ext3/ext4/xfs/.....
  2. 分布式文件系统: ocfs2/gfs2/.....
  3. 内存文件系统: tmpfs/.....



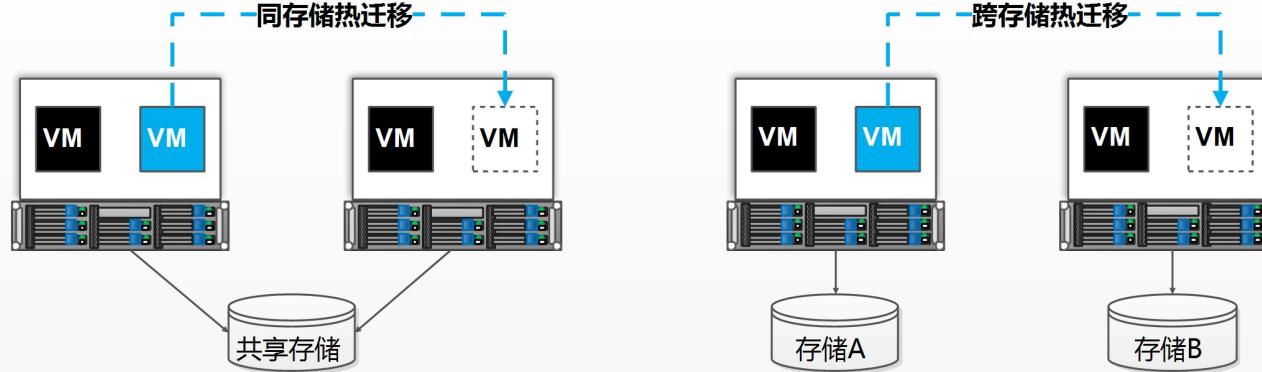
# LBA工具典型应用场景：存储、OS

1. 磁盘硬件(磁盘坏道等--badblocks)
2. 间接测试校验存储压缩功能(例如: qcow2压缩等)
3. 间接测试校验存储加密功能(例如: qcow2加密、磁盘luks加密等)

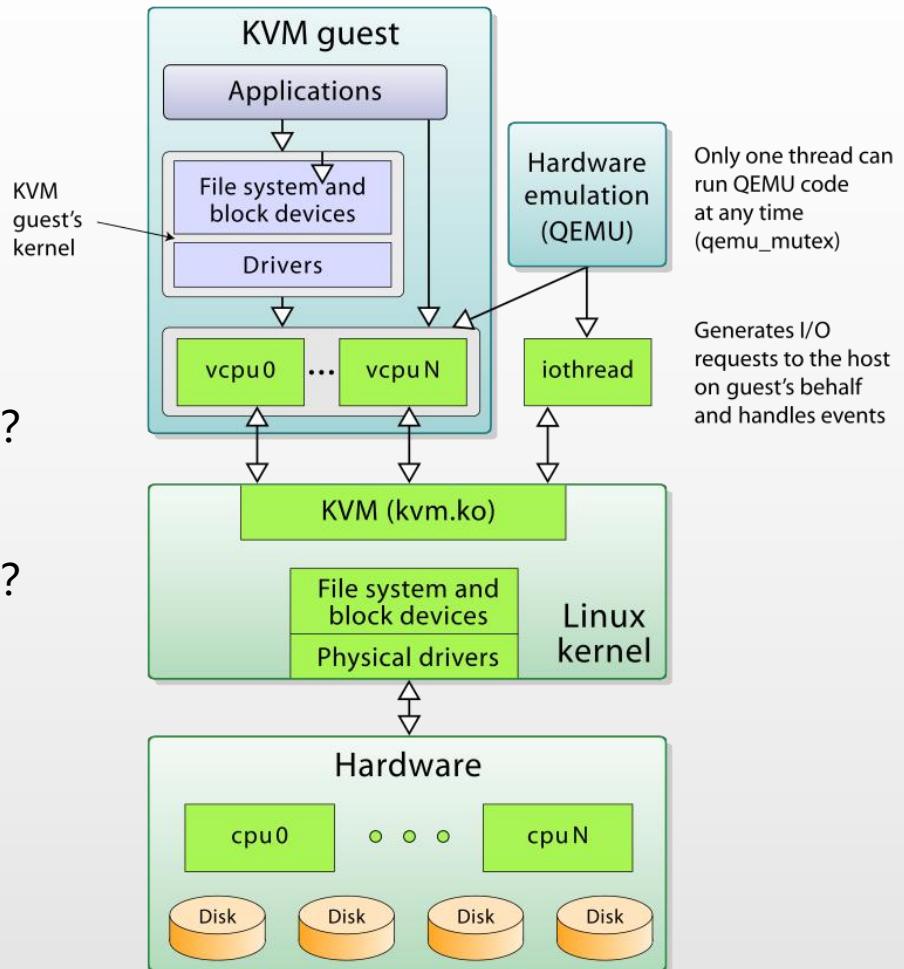
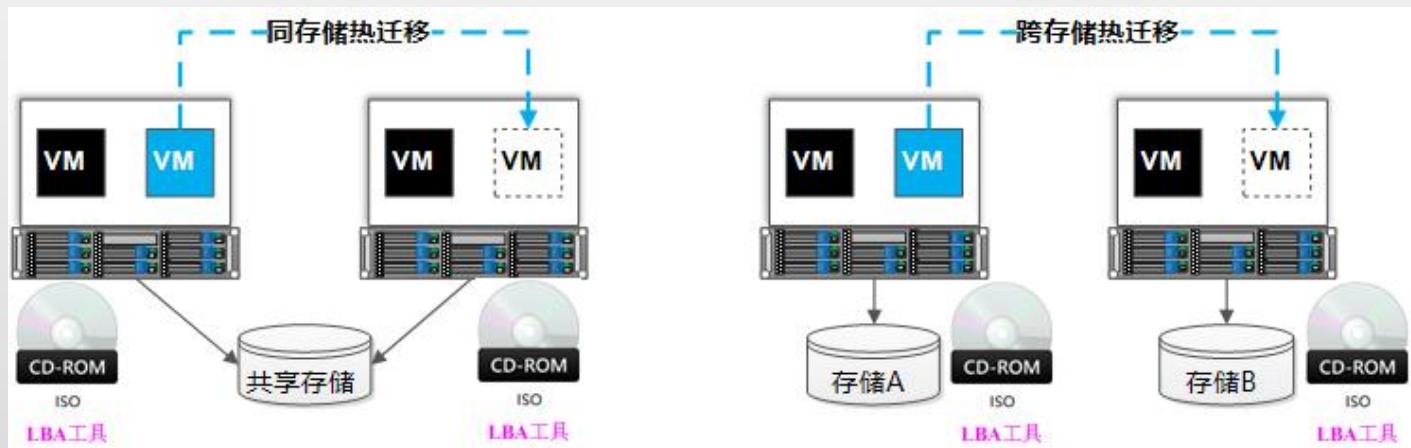


# LBA工具典型应用场景：云计算

## ➤ 虚拟机热迁移存储/内存数据一致性校验



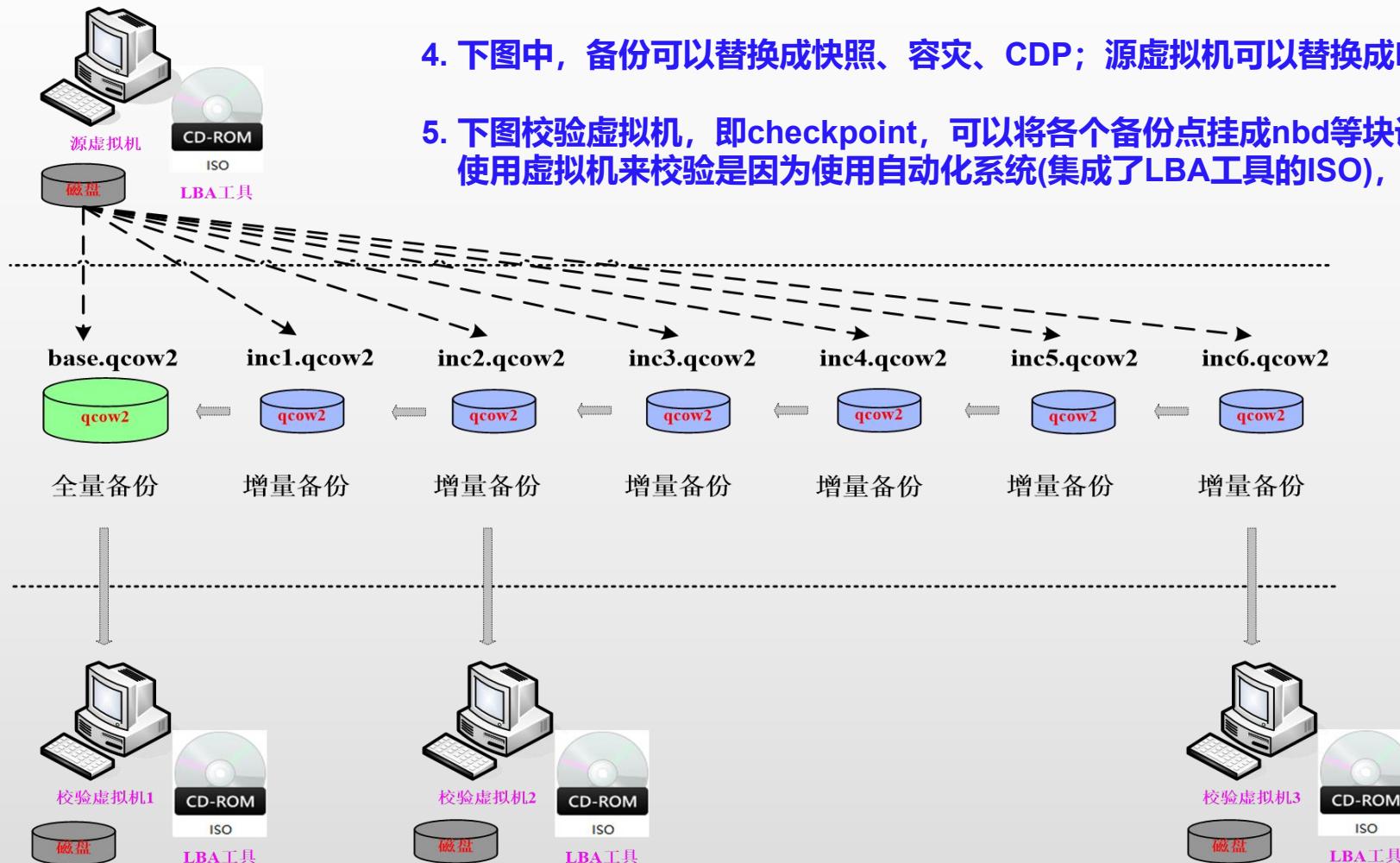
- (1) 虚拟机热迁移，怎么验证内存数据迁移到目标端虚拟机后，数据没有出错？
- (2) 虚拟机热迁移，怎么验证内存数据迁移，源端虚拟机没有漏迁数据？
  
- (3) 虚拟机热迁移，怎么验证磁盘数据迁移到目标端虚拟机后，数据没有出错？
- (4) 虚拟机热迁移，怎么验证磁盘数据迁移，源端虚拟机没有漏迁数据？



# LBA工具典型应用场景：快照、备份、容灾、CDP

## ➤ 校验快照、备份、容灾、CDP等数据一致性校验

1. 源虚拟机配置LBA自动化测试系统ISO和数据盘，LBA工具写磁盘模拟业务系统的IO数据；
2. 定期对虚拟机进行全量备份和增量备份；
3. 使用虚拟机备份创建新虚拟机，并且加载LBA自动化测试系统ISO，LBA工具自动校验新虚拟机数据盘中的数据一致性；



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# 存储稳定性测试与数据一致性校验自动化测试系统演示

➤ 自动化测试系统ISO，包括：[linux\\_x86](#) / [linux\\_arm](#) / [winPE](#) 三种版本

名称	修改日期	名称	修改日期	大小
hd_write_verify.with.stripe.split.64K.整体校验+批量校验.x86_64.V10.iso	2024/3/22 0:41	hd_write_verify.with.stripe.split.64K.整体校验+批量校验.aarch64.V10.iso	2024/3/25 0:56	64,486 KB
hd_write_verify.with.stripe.split.128K.整体校验+批量校验.x86_64.V10.iso	2024/3/22 0:41	hd_write_verify.with.stripe.split.128K.整体校验+批量校验.aarch64.V10.iso	2024/3/25 0:55	64,486 KB
hd_write_verify.with.stripe.split.256K.整体校验+批量校验.x86_64.V10.iso	2024/3/22 0:40	hd_write_verify.with.stripe.split.256K.整体校验+批量校验.aarch64.V10.iso	2024/3/25 0:54	64,486 KB
hd_write_verify.with.stripe.split.512K.整体校验+批量校验.x86_64.V10.iso	2024/3/22 0:40	hd_write_verify.with.stripe.split.512K.整体校验+批量校验.aarch64.V10.iso	2024/3/25 0:53	64,486 KB
hd_write_verify.with.stripe.split.1M.整体校验+批量校验.x86_64.V10.iso	2024/3/22 0:40	hd_write_verify.with.stripe.split.1M.整体校验+批量校验.aarch64.V10.iso	2024/3/25 0:51	64,486 KB
hd_write_verify.with.stripe.robin.1K.整体校验+批量校验.x86_64.V10.iso	2024/3/22 0:39	hd_write_verify.with.stripe.robin.1K.整体校验+批量校验.aarch64.V10.iso	2024/3/25 0:51	64,486 KB
hd_write_verify.with.stripe.robin.4K.整体校验+批量校验.x86_64.V10.iso	2024/3/22 0:39	hd_write_verify.with.stripe.robin.4K.整体校验+批量校验.aarch64.V10.iso	2024/3/25 0:49	64,486 KB
hd_write_verify.with.stripe.robin.8K.整体校验+批量校验.x86_64.V10.iso	2024/3/22 0:38	hd_write_verify.with.stripe.robin.8K.整体校验+批量校验.aarch64.V10.iso	2024/3/25 0:48	64,486 KB
hd_write_verify.with.stripe.robin.16K.整体校验+批量校验.x86_64.V10.iso	2024/3/22 0:38	hd_write_verify.with.stripe.robin.16K.整体校验+批量校验.aarch64.V10.iso	2024/3/25 0:47	64,486 KB
hd_write_verify.with.stripe.robin.64K.整体校验+批量校验.x86_64.V10.iso	2024/3/22 0:38	hd_write_verify.with.stripe.robin.64K.整体校验+批量校验.aarch64.V10.iso	2024/3/25 0:46	64,486 KB
hd_write_verify.with.stripe.robin.128K.整体校验+批量校验.x86_64.V10.iso	2024/3/22 0:37	hd_write_verify.with.stripe.robin.128K.整体校验+批量校验.aarch64.V10.iso	2024/3/25 0:45	64,486 KB
hd_write_verify.with.stripe.robin.256K.整体校验+批量校验.x86_64.V10.iso	2024/3/22 0:37	hd_write_verify.with.stripe.robin.256K.整体校验+批量校验.aarch64.V10.iso	2024/3/25 0:44	64,486 KB
hd_write_verify.with.stripe.robin.512K.整体校验+批量校验.x86_64.V10.iso	2024/3/22 0:37	hd_write_verify.with.stripe.robin.512K.整体校验+批量校验.aarch64.V10.iso	2024/3/25 0:43	64,486 KB
hd_write_verify.with.stripe.robin.1M.整体校验+批量校验.x86_64.V10.iso	2024/3/22 0:37	hd_write_verify.with.stripe.robin.1M.整体校验+批量校验.aarch64.V10.iso	2024/3/25 0:41	64,486 KB
hd_write_verify.disk_lba_check_only.with.stripe.split.x86_64.V10.iso	2024/3/22 0:36	hd_write_verify.disk_lba_check_only.with.stripe.split.aarch64.V10.iso	2024/3/25 0:40	64,486 KB
hd_write_verify.disk_lba_check_only.with.stripe.robin.x86_64.V10.iso	2024/3/22 0:36	hd_write_verify.disk_lba_check_only.with.stripe.robin.aarch64.V10.iso	2024/3/25 0:39	64,488 KB
hd_write_verify.mem_lba.with.stripe.robin.1M.x86_64.V10.iso	2024/3/22 0:36	hd_write_verify.mem_lba.with.stripe.robin.1M.aarch64.V10.iso	2024/3/25 0:38	64,486 KB
hd_write_verify.mem_disk_lba.with.stripe.robin.1M.x86_64.V10.iso	2024/3/22 0:36	hd_write_verify.mem_disk_lba.with.stripe.robin.1M.aarch64.V10.iso	2024/3/25 0:35	64,490 KB

# 存储稳定性测试与数据一致性校验自动化测试系统演示

- 1.虚拟机添加hd\_write\_verify.mem\_disk\_lba.with.stripe.robin.1M.x86\_64.V10.iso，作为启动盘；
- 2.添加数据盘，最多可以添加64个数据盘（一般只需要添加一个数据盘进行测试即可）；
- 3.运行虚拟机，稳定性自动化测试就跑起来了。（可以对虚拟机注入各种故障：断电，断网，存储IO错误等）；
- 4.如果虚拟机内部运行的LBA工具，报出了“BUG”关键字输出（鲜红色），即测试出了LBA问题（出现数据一致性错误）；



BUG 001[1]: [Thread: 1] RANDOM VERIFY DIFFER FLAGS | ERROR LBA: 0x794400  
BUG 001[2]: [Thread: 3] RANDOM VERIFY DIFFER LBA\_LIST | ERROR LBA: 0x28c00  
BUG 001[3]: [Thread: 1] BATCH VERIFY DIFFER FLAGS | ERROR LBA: 0x4f5000  
BUG 001[4]: [Thread: 9] BATCH VERIFY DIFFER LBA\_LIST | ERROR LBA: 0x404800  
BUG 002[1]: [Thread: 5] RANDOM VERIFY SECTOR[647] DIFFER: 1  
| CORRECT LBA[0]: 0x63f400 | ERROR LBA[647]: 0x63f687 | filename: lba.raw  
BUG 002[2]: [Thread: 2] RANDOM VERIFY ZERO SECTOR[63] DIFFER: 1  
| CORRECT LBA[0]: 0x57ef00 | ERROR LBA[63]: 0x57ef3f | filename: lba.raw  
BUG 002[3]: [Thread: 3] VERIFY SECTOR[306] DIFFER: 1  
| CORRECT LBA[0]: 0xb2a000 | ERROR LBA[306]: 0xb2a132 | filename: lba.raw  
BUG 002[4]: [Thread: 1] VERIFY ZERO SECTOR[970] DIFFER: 54  
| CORRECT LBA[0]: 0x7e9800 | ERROR LBA[970]: 0x7e9bca  
BUG 003: [Thread: 3] WRITE PART SECTOR | read[83]  
BUG 004 [Thread: 5] DATA LOST  
PREV LBA: 0x4a5100 | LOST LBA: 0x35480 | NEXT LBA: 0x1c93780  
BUG 005: [Thread: 0] VERIFY HD\_FLAG ERROR | HF: 0x0400ffff|0x04001270  
BUG 006: [Thread: 5] VERIFY DIFFER FLAGS | read[248], write[709]  
BUG 007[1] : [Thread: 9] VERIFY SECTOR[271] DIFFER: 1 | read[241]  
BUG 007[2] : [Thread: 8] VERIFY ZERO SECTOR[853] DIFFER: 1 | read[259]  
BUG 007[3]: [Thread: 7] VERIFY SECTOR[310] DIFFER: 11 | read[498]  
BUG 007[4]: [Thread: 1] VERIFY ZERO SECTOR[970] DIFFER: 54 | read[534]

# 存储稳定性测试与数据一致性校验自动化测试系统演示

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- (1) 磁盘数据一致性测试与校验 (默认: alt + F1)
- (2) 内存数据一致性测试与校验 (tty2: alt + F2)
- (3) iostat查看IO性能及精准限速(比较稳定的负载) (tty3: alt + F3, iostat -x 3)
- (4) 查看内存变脏速度(适用于虚拟机热迁移场景) (tty4: alt + F4, tailf /var/log/mem\_dirty\_speed.log)
- (5) 自动化测试简单演示([录屏](#))



LBA\_iso.gif

# 存储稳定性测试与数据一致性校验自动化测试系统演示

## ➤ 磁盘数据一致性测试与校验

1. 多磁盘条带测试：校验磁盘组快照、备份等数据一致性

2. 虚拟机热迁移：磁盘数据一致性测试

```
Welcome to the YOUPlus's LBA TESTING SYSTEM
https://github.com/zhangyoujia/
-----  
  
YOUPlus login: root (automatic login)
echo never > /sys/kernel/mm/transparent_hugepage/enabled  
  
hd_write_verify -c -D -K -R 33 -w on -S 2048 -V all -T 10 -L 102400 -P robin -I /dev/vda -I /dev/vdb
Device Topology:
Disk: /dev/vda
Logical block size: 512
Physical block size: 512
Minimum I/O size: 512
Optimal I/O size: 0 (0: unknown)
Alignment offset: 0
Disk Size: 10737418240 / 10240M / 10.00G  
  
Device Topology:
Disk: /dev/vdb
Logical block size: 512
Physical block size: 512
Minimum I/O size: 512
Optimal I/O size: 0 (0: unknown)
Alignment offset: 0
Disk Size: 10737418240 / 10240M / 10.00G  
  
Disk: stripe | Thread: 10 | Total Sectors: 83886080 | Total Clusters: 20480 | Sectors of Cluster: 2048 | DIRECT IO & NO Flush | Verify: 6 | Notify: 0
Current Time: 2023-07-10 13:35:10
Thread 4 [tid: 1052]: Starting check disk ...
Thread 9 [tid: 1057]: Starting check disk ...
Thread 7 [tid: 1055]: Starting check disk ...
Thread 1 [tid: 1049]: Starting check disk ...
Thread 0 [tid: 1047]: Starting check disk ...
Thread 3 [tid: 1051]: Starting check disk ...
Thread 5 [tid: 1053]: Starting check disk ...
Thread 8 [tid: 1056]: Starting check disk ...
Thread 2 [tid: 1050]: Starting check disk ...
Thread 6 [tid: 1054]: Starting check disk ...  
  
-----  
Starting write disk: Thread ID | Read MB - Write MB |
KEY: <P> = pause, KEY: <S> = start, KEY: <Q> = quit  
  
Loop 1: .
Current Time: 2023-07-10 13:35:10
2283, 1629 | 2288, 1635 | 2280, 1633 | 2326, 1656 | 2303, 1643 | 2296, 1637 | 2267, 1645 | 2281, 1631 | 2267, 1645 | 2273, 1640 |
```

# 存储稳定性测试与数据一致性校验自动化测试系统演示

## ➤ iostat查看IO性能及精准限速(比较稳定的负载)

```
Welcome to the YOUPlus's LBA TESTING SYSTEM
https://github.com/zhangyoujia/
[REDACTED]

YOUPlus login: root (automatic login)
Last login: Mon Jul 10 13:35:10 GMT-8 2023 on tty2
root@YOUPlus /var/iso/tools # lsblk
NAME  MAJ:MIN RM  SIZE RO TYPE MOUNTPOINT
loop1   7:1    0  3.2G  0 loop
vdb   253:16   0   10G  0 disk
sr0   11:0    1  64.6M 0 rom  /var/iso
vda   253:0    0   10G  0 disk
root@YOUPlus /var/iso/tools # iostat -x 3
Linux 4.18.0 (YOUPlus) 07/10/23      _x86_64_        (2 CPU)

avg-cpu: %user  %nice %system %iowait  %steal  %idle
        4.20     0.00   17.05   36.29     0.36   42.11

Device:    rrqm/s   wrqm/s     r/s     w/s    rkB/s    wkB/s   avgrrq-sz  avgqu-sz   await  r_await  w_await  svctm  %util
vda       0.00     0.00   38.61   41.95  39073.19  26445.41    0.79     11.82    14.84     9.03    7.49   60.38
vdb       0.00     0.00   20.14   23.18  20153.62  14441.90    0.37     10.51    14.65     6.91    9.37   40.58
sr0       0.00     0.00    0.36     0.00     1.34     0.00     7.40     0.00     0.40     0.40     0.00    1.01   0.04
loop1     0.00     0.00  217.16  264.27 110050.83  83074.29    0.25     1.50     1.46     1.52     0.88   42.24

avg-cpu: %user  %nice %system %iowait  %steal  %idle
        5.30     0.00   12.58   41.72     0.17   40.23

Device:    rrqm/s   wrqm/s     r/s     w/s    rkB/s    wkB/s   avgrrq-sz  avgqu-sz   await  r_await  w_await  svctm  %util
vda       0.00     0.00   34.00   33.67  34816.00  22186.67    0.61     10.85    17.30     4.34    8.93   60.40
vdb       0.00     0.00   25.83   31.67  25941.33  19235.67    0.43     9.31    16.03     3.94    8.09   46.13
sr0       0.00     0.00    0.33     0.00     0.67     0.00     4.00     0.00     1.00     1.00     0.00    8.00   0.27
loop1     0.00     0.00  200.00  332.00 102400.00 102400.00    0.10     0.96     0.93     0.98     0.68   36.13

avg-cpu: %user  %nice %system %iowait  %steal  %idle
        3.20     0.00   13.13   36.70     0.34   46.63

Device:    rrqm/s   wrqm/s     r/s     w/s    rkB/s    wkB/s   avgrrq-sz  avgqu-sz   await  r_await  w_await  svctm  %util
vda       0.00     0.00   40.33   20.00  41301.33  11946.67    0.53     10.78    14.02     4.23    7.73   46.67
vdb       0.00     0.00   33.33   25.33  34133.33  15018.67    0.42     9.19    13.82     3.11    8.45   49.60
sr0       0.00     0.00    0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00     0.00    0.00   0.00
loop1     0.00     0.00  200.00  319.33 102400.00 102400.00    0.12     1.04     1.01     1.05     0.70   36.27
```

# 存储稳定性测试与数据一致性校验自动化测试系统演示

## ➤ 内存数据一致性测试与校验

### 1. 虚拟机热迁移：内存数据一致性测试(tmpfs + loop设备)

```
Welcome to the YOUPlus's LBA TESTING SYSTEM
https://github.com/zhangyoujia/

YOUPlus login: root (automatic login)
Last login: Mon Jul 10 14:06:03 GMT-8 2023 on ttys1
hd_write_verify -c -D -K -R 33 -w on -S 1024 -V once -T 10 -L 204800 /dev/loop1
Device Topology:
Disk: /dev/loop1
Logical block size: 512
Physical block size: 512
Minimum I/O size: 512
Optimal I/O size: 0 (0: unknown)
Alignment offset: 0
Disk Size: 3387949056 / 3231M / 3.16G

Disk: /dev/loop1 | Thread: 10 | Total Sectors: 6617088 | Total Clusters: 6462 | Sectors of Cluster: 1024 | DIRECT IO & NO Flush | Verify: 2 | Notify: 0

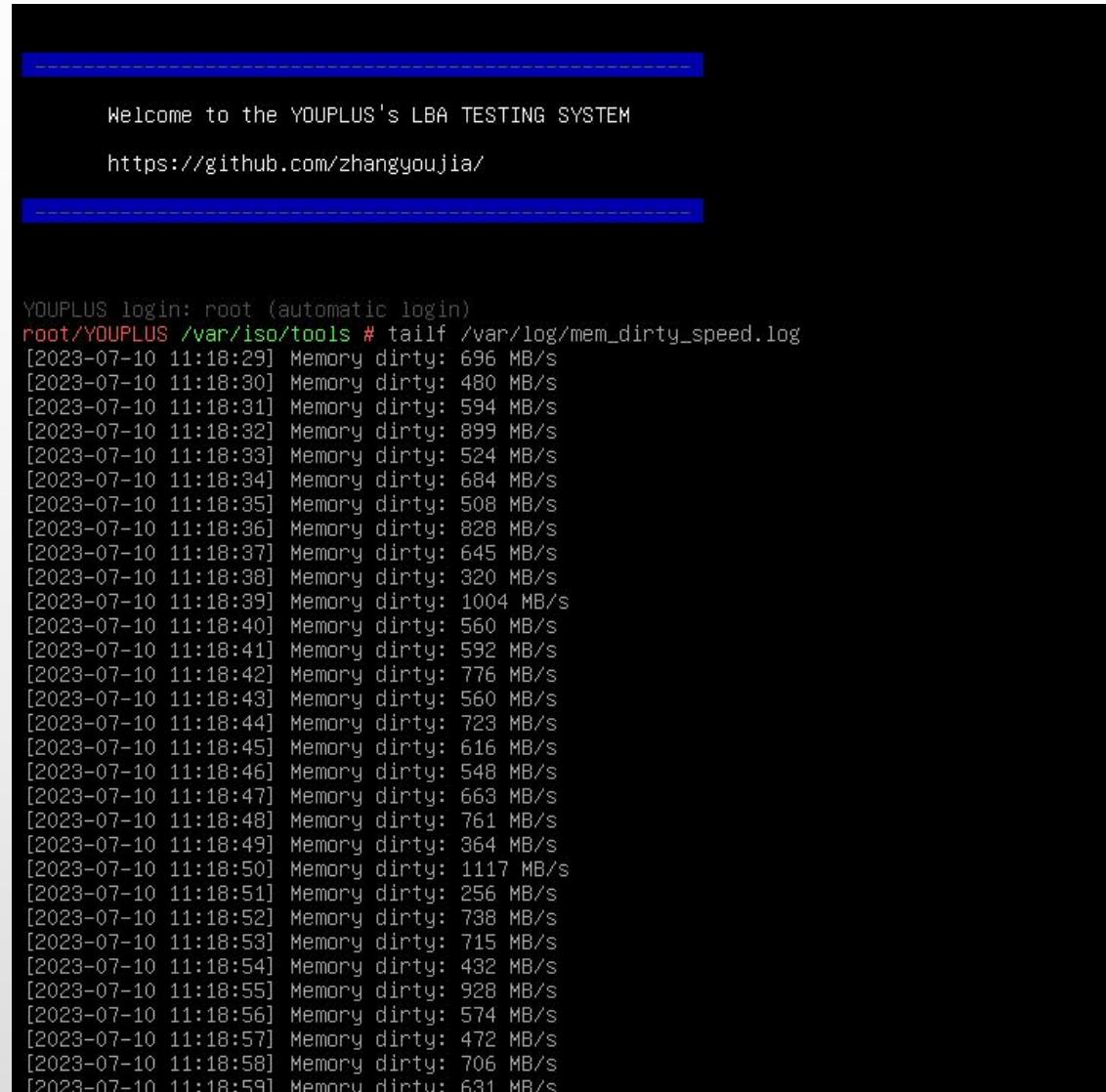
Current Time: 2023-07-10 14:06:05
Thread 5 [tid: 1122]: Starting check disk ...
Thread 6 [tid: 1123]: Starting check disk ...
Thread 1 [tid: 1118]: Starting check disk ...
Thread 9 [tid: 1126]: Starting check disk ...
Thread 4 [tid: 1121]: Starting check disk ...
Thread 2 [tid: 1119]: Starting check disk ...
Thread 3 [tid: 1120]: Starting check disk ...
Thread 8 [tid: 1125]: Starting check disk ...
Thread 0 [tid: 1117]: Starting check disk ...
Thread 7 [tid: 1124]: Starting check disk ...

-----
Starting write disk: Thread ID | Read MB - Write MB |
KEY: <P> = pause, KEY: <S> = start, KEY: <Q> = quit
Loop 1: .
Current Time: 2023-07-10 14:06:06
371, 298 | 369, 301 | 372, 299 | 375, 302 | 388, 309 | 378, 303 | 376, 301 | 372, 298 | 380, 304 | 362, 308 |
sysfs on /sys type sysfs (rw,nosuid,nodev,noexec,relatime)
tmpfs on /dev type tmpfs (rw,relatime,size=32768k,mode=755) Current Time: 2023-07-10 14:06:39
/dev/sr0 on /var/iso type iso9660 (ro,relatime,norock,check=)
tmpfs on /var/mem type tmpfs (rw,relatime,size=3329024k) Thread 8 [tid: 1125]: Starting check disk ...
root/YOUPlus /var/iso/tools # Thread 4 [tid: 1121]: Starting check disk ...
root/YOUPlus /var/iso/tools # losetup -a Thread 9 [tid: 1126]: Starting check disk ...
/dev/loop1: [0018]:19412 (/var/mem/mem_test.raw) Thread 2 [tid: 1119]: Starting check disk ...
root/YOUPlus /var/iso/tools # Thread 5 [tid: 1122]: Starting check disk ...
Thread 6 [tid: 1123]: Starting check disk ...
```

# 存储稳定性测试与数据一致性校验自动化测试系统演示

- 查看内存变脏速度 (适用于虚拟机热迁移场景)

虚拟机热迁移性能优化：multifd / dirty-ring / 内存压缩 / VCPU节流策略等



Welcome to the YOUPlus's LBA TESTING SYSTEM  
<https://github.com/zhangyoujia/>

```
YOUPlus login: root (automatic login)
root@YOUPlus /var/iso/tools # tailf /var/log/mem_dirty_speed.log
[2023-07-10 11:18:29] Memory dirty: 696 MB/s
[2023-07-10 11:18:30] Memory dirty: 480 MB/s
[2023-07-10 11:18:31] Memory dirty: 594 MB/s
[2023-07-10 11:18:32] Memory dirty: 899 MB/s
[2023-07-10 11:18:33] Memory dirty: 524 MB/s
[2023-07-10 11:18:34] Memory dirty: 684 MB/s
[2023-07-10 11:18:35] Memory dirty: 508 MB/s
[2023-07-10 11:18:36] Memory dirty: 828 MB/s
[2023-07-10 11:18:37] Memory dirty: 645 MB/s
[2023-07-10 11:18:38] Memory dirty: 320 MB/s
[2023-07-10 11:18:39] Memory dirty: 1004 MB/s
[2023-07-10 11:18:40] Memory dirty: 560 MB/s
[2023-07-10 11:18:41] Memory dirty: 592 MB/s
[2023-07-10 11:18:42] Memory dirty: 776 MB/s
[2023-07-10 11:18:43] Memory dirty: 560 MB/s
[2023-07-10 11:18:44] Memory dirty: 723 MB/s
[2023-07-10 11:18:45] Memory dirty: 616 MB/s
[2023-07-10 11:18:46] Memory dirty: 548 MB/s
[2023-07-10 11:18:47] Memory dirty: 663 MB/s
[2023-07-10 11:18:48] Memory dirty: 761 MB/s
[2023-07-10 11:18:49] Memory dirty: 364 MB/s
[2023-07-10 11:18:50] Memory dirty: 1117 MB/s
[2023-07-10 11:18:51] Memory dirty: 256 MB/s
[2023-07-10 11:18:52] Memory dirty: 738 MB/s
[2023-07-10 11:18:53] Memory dirty: 715 MB/s
[2023-07-10 11:18:54] Memory dirty: 432 MB/s
[2023-07-10 11:18:55] Memory dirty: 928 MB/s
[2023-07-10 11:18:56] Memory dirty: 574 MB/s
[2023-07-10 11:18:57] Memory dirty: 472 MB/s
[2023-07-10 11:18:58] Memory dirty: 706 MB/s
[2023-07-10 11:18:59] Memory dirty: 631 MB/s
```

# 存储稳定性测试与数据一致性校验自动化测试系统演示

## ➤ 自动化测试简单演示(录屏)



# 存储稳定性测试与数据一致性校验自动化测试脚本

The screenshot shows a file manager interface with the following details:

- Left Panel:** Shows a tree view of files and folders under 'master'. The 'scripts' folder is expanded, showing sub-scripts like date.sh, disk\_lba\_robin.check.sh, etc.
- Middle Panel:** Shows the contents of the 'scripts' folder under 'hd\_write\_verify'. The files are categorized into groups:
  - Red Box:** disk\_lba\_robin.check.sh, disk\_lba\_robin.sh, disk\_lba\_robin\_bsrangle.sh, disk\_lba\_robin\_trim.sh, disk\_lba\_split.check.sh, disk\_lba\_split.sh, disk\_lba\_split\_bsrangle.sh, disk\_lba\_split\_trim.sh
  - Yellow Box:** file\_lba\_test.sh, file\_lba\_test\_bg.sh, file\_lba\_test\_bg\_bsrangle.sh, file\_lba\_test\_bg\_trim.sh, file\_lba\_test\_bsrangle.sh, file\_lba\_test\_trim.sh
  - Blue Box:** mem\_loop\_lba\_test.sh, mem\_loop\_lba\_test\_trim.sh
  - Green Box:** readme.txt
- Right Panel:** A text editor window titled 'readme.txt' containing the following content:

```
【scripts自动化测试脚本使用说明】
1. 把LBA工具(hd_write_verify和hd_write_verify_dump)放到/usr/sbin/目录下;
2. 给LBA工具加上可执行权限(chmod +x hd_write_verify hd_write_verify_dump);
3. 把scripts自动化测试脚本放到/root/目录下;
4. 给scripts自动化测试脚本加上可执行权限(dos2unix /root/scripts/*; chmod +x /root/scripts/*);
5. 自动化测试, 实例:
   测试块存储:
     (1) 测试磁盘组: /root/scripts/disk_lba_robin.sh
                           /root/scripts/disk_lba_robin.sh 16
                           /root/scripts/disk_lba_robin.sh 512 204800
                           /root/scripts/disk_lba_split.sh
                           /root/scripts/disk_lba_split.sh 128
                           /root/scripts/disk_lba_split.sh 1024 102400
     (2) 测试单个指定磁盘: /root/scripts/disk_lba_robin.sh /dev/sda
                           /root/scripts/disk_lba_robin.sh /dev/sda 64
                           /root/scripts/disk_lba_robin.sh /dev/sda 512 102400
     (3) 测试单个指定分区: /root/scripts/disk_lba_robin.sh /dev/sdal
                           /root/scripts/disk_lba_robin.sh /dev/sdal 128
                           /root/scripts/disk_lba_robin.sh /dev/sdal 1024 51200
   只读全盘校验块存储数据一致性:
     (1) 校验磁盘组: /root/scripts/disk_lba_robin.check.sh 或者
                           /root/scripts/disk_lba_split.check.sh
     (2) 校验单个指定磁盘: /root/scripts/disk_lba_robin.check.sh /dev/sda
     (3) 校验单个指定分区: /root/scripts/disk_lba_robin.check.sh /dev/sdal
   测试文件存储:
     (1) LBA工具前端测试: /root/scripts/file_lba_test.sh      /path/lba_test.raw
                           /root/scripts/file_lba_test.sh      /path/lba_test.raw 1024
                           /root/scripts/file_lba_test.sh      /path/lba_test.raw 2048 204800
     (2) LBA工具后端测试: /root/scripts/file_lba_test_bg.sh /path/lba_test.raw
                           /root/scripts/file_lba_test_bg.sh /path/lba_test.raw 2048
                           /root/scripts/file_lba_test_bg.sh /path/lba_test.raw 1024 409600
   测试内存(通过tmpfs的方式, 主要用于虚拟机热迁移场景, 验证虚拟机内存热迁移前后的数据一致性):
     (1) 通过loop设备测试内存: /root/scripts/mem_loop_lba_test.sh
     (2) 查看内存变脏速度: tail -f /var/log/mem_dirty_speed.log
```

# 物理存储稳定性测试与数据一致性校验方案

## pynvme

2015年Intel开源了SPDK，为数据中心存储提供一系列软件支持，其中包括了NVMe驱动。SPDK的整体架构非常清晰，NVMe驱动模块的接口完整，实现了大部分NVMe设备的功能。SPDK也经过数据中心的实践检验，有稳定性的保障。但另一方面，SPDK毕竟是以数据中心存储系统为设计目标，会缺少一些SSD测试所需要的功能，譬如：

1. SPDK采用轮询，不支持中断；
2. SPDK只提供C语言的接口，直接在SPDK上面开发测试程序的成本高，并且容易引入bug；
3. 没有提供cmdlog等专门用于测试和调试的功能，测试过程中遇到问题不容易分析；
4. NVMe的SQ和CQ被绑定为1:1的Qpair；
5. 只支持NVMe协议。

但是作为一个Intel的开源项目，SPDK的文档和代码非常规范，模块之间高度解耦。我们以SPDK的NVMe驱动为起点，开发了NVMe设备的测试驱动。这就是pynvme的缘起。

在SPDK的基础上，我们在pynvme中实现了这些功能：

1. 支持MSIx中断：通过软件实现的中断控制器，提供中断相关的测试接口；
2. 通过Cython的封装，为SPDK的NVMe驱动提供了Python接口，抽象出controller, namespace, qpair, buffer, ioworker等对象和方法；
3. 实现了cmdlog：将NVMe测试驱动最近发送的若干条NVMe command及其completion结构记录到cmdlog中；
4. 提供通用化的命令接口，可以发送任何NVMe command，包括VS command，甚至是不符合NVMe协议要求的命令；
5. 结合pytest及其fixture，进一步简化测试脚本的开发和执行；
6. 通过vscode及其插件，在IDE中开发和调试测试脚本，并能查看测试过程中寄存器、Qpair以及cmdlog的数据；
7. 通过S3/standby模式实现SSD设备的电源控制，无需任何额外设备就可以在普通PC上实现部分上下电测试；
8. 实现ioworker，以多进程的方式对同一个SSD设备进行并发读写操作，加大测试压力；
9. 自动计算、记录、校验每个LBA的CRC，实现数据完整性的测试；
10. 自动在每个LBA数据中插入LBA地址等信息，以发现其他数据一致性问题；
11. 可以读写PCI配置空间，以及BAR空间。

pynvme实现了众多NVMe SSD测试所需的功能，并通过Python提供一致的脚本接口。就像美味的煎饼果子，用煎饼包裹各种不同的食材，呈现统一而诱人的风味。pynvme就是专为NVMe SSD测试而生的煎饼大侠！:)

<https://github-wiki-see.page/m/pynvme/pynvme/wiki/初探pynvme>

<https://github-wiki-see.page/m/pynvme/pynvme/wiki/实战pynvme>

## SSD盘可以参考pynvme测试方案：

1.LBA工具侧重于左下图红框中的三项测试功能；

2.LBA工具支持磁盘组(多盘条带)测试；(见前页)

disk\_lba\_robin.sh (搜索所有空闲盘，以robin条带策略，IO大小：1MB 测试)  
disk\_lba\_robin.sh 16 (同上，IO大小：8KB 测试)  
disk\_lba\_robin.sh 512 204800 (同上，IO大小：256KB 测试，同时限速：200MB/s)

disk\_lba\_split.sh (搜索所有空闲盘，以split条带策略，IO大小：1MB 测试)  
disk\_lba\_split.sh 128 (同上，IO大小：64KB 测试)  
disk\_lba\_split.sh 1024 102400 (同上，IO大小：512KB 测试，同时限速：100MB/s)

3.LBA工具支持全盘数据的trim-all测试和每个IO的discard测试等高级功能；

4.LBA工具支持bsrange测试；

```
[root@linux lba]# hd_write_verify_dump -c -D -L 0 /dev/sdb
-----
Device Topology:
Disk: /dev/sdb
Logical block size: 512
Physical block size: 4096
Minimum I/O size: 262144
Optimal I/O size: 0 (0: unknown)
Alignment offset: 262144
Max Sectors KB: 256
Disk Size: 479559942144 / 457344M / 446.62G
```

右图：512e的ssd盘

# 文件存储稳定性测试与数据一致性校验方案



■ 技术/案例分享 ■ 原理解读

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## 如何支撑百亿级文件

Curve 文件系统的重要特点之一就是适用于海量文件存储，那么 Curve 文件系统如何保证可以支撑百亿级规模？如何保证在百亿级规模下的性能？从理论上来讲：

- 规模方面，Curve文件存储的元数据集群，每个节点存储一定范围的 inode(比如1~10000)和 dentry，如果文件数量增多，可以进行存储节点的扩充，所以理论上规模是没有上限的。
- 性能方面，当文件数量很多时，对于单个文件的操作是没有什么差别的，但对于一些需要元数据的聚合操作会出现性能问题，比如 du (计算当前文件系统的容量), ls (获取目录下所有文件信息)等操作，需要做一定的优化来保障性能。

那实际上 Curve 文件系统的表现如何呢？

首先介绍一下文件系统的几款通用测试工具。

1. pjdfstest[1]: posix 兼容性测试。有3600+个回归测试用例，覆盖 chmod, chown, link, mkdir, mkfifo, open, rename, rmdir, symlink, truncate, unlink 等
2. mdtest[2]: 元数据性能测试。对文件或者目录进行 open/stat/close 等操作，并返回报告
3. vdbench[3]: 数据一致性测试。Vdbench 是 Oracle 编写的一款应用广泛的存储性能测试工具，既支持块设备的性能测试，也支持文件系统性能测试，在做随机写的一致性测试很方便，能实时检查出哪一个扇区出现了数据不一致
4. fio[4]: 数据性能测试。

Curve 文件系统从v2.3版本以后提供了单独压测元数据集群的方式（数据集群一般使用 Curve 块存储和 S3，所以直接对这些组件进行性能测试即可）。

1. 通过 CurveAdm[5] 搭建文件系统，在准备客户端配置文件 client.yaml[6] 时新增配置项: s3.fakeS3=true[7]。
2. 使用 mdtest, vdbench, ImagerNet数据集[8]作为数据源，测试大小文件混合场景下文件系统的稳定性和性能。

<https://ask.opencurve.io/t/topic/115>

**可以参考网易OpenCurve测试方案：**

1. 使用pjdfstest测试兼容性；
2. 使用mdtest测试元数据；
3. 使用LBA工具测试 & 校验普通文件数据一致性和文件系统稳定性；  
(替代截图中的vdbench)

**可以用自动化脚本同时测试多个文件：**

```
file_lba_test.sh /path/lba_test1.raw  
file_lba_test.sh /path/lba_test2.raw  
.....  
file_lba_test.sh /path/lba_testN.raw
```

# 目 录



- 
- 01 LBA工具简介
  - 02 LBA工具实现原理
  - 03 LBA工具使用说明及基本功能演示
  - 04 LBA工具典型应用场景
  - 05 存储稳定性测试与数据一致性校验  
自动化测试系统演示
  - 06 展望
-

# 展望

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1. PPT篇幅有限，很多内容没有深入或者涉及，后续考虑录屏，现场演示和详细讲解LBA工具各项功能；
2. 制作多平台、集成LBA工具并可自动化测试的容器镜像；
3. 使用QT等制作图形界面版本LBA工具；
4. 开发基于spdk版本的LBA工具；
5. 对外推广：向qemu、ceph、spdk等开源社区和国内存储(OS)、云计算、备份/容灾等厂商推荐使用/试用；
6. 期望能成为存储(OS)、云计算、备份/容灾等产品稳定性测试与数据一致性校验首选工具或标准；
7. 期望能成为存储(OS)、云计算、备份/容灾等产品稳定性与数据一致性认证场景中使用的首选工具或标准；
8. 欢迎试用与合作(**培训授课、顾问咨询、LBA工具及自动化测试系统商业使用授权 + 技术支持**)

**github:**

[https://github.com/zhangyoujia/hd\\_write\\_verify](https://github.com/zhangyoujia/hd_write_verify)

**腾讯会议录屏:**

<https://cloud.tencent.com/developer/video/78756>

<https://www.bilibili.com/video/BV1aX4y1L78a>

**gitee:**

[https://gitee.com/youplus2024/hd\\_write\\_verify](https://gitee.com/youplus2024/hd_write_verify)

**下载链接:**

<https://pan.baidu.com/s/1hxM1idYhY1Z3UgqprXif6Q>

**提取码:** LBA1



zhangyoujia, 你好:

久等了, 您的项目检测报告已生成, 点击或复制链接查看:

[https://www.murphysec.com/console/report/1702199936857980928/1702199936933478400?  
allow=1&f=m](https://www.murphysec.com/console/report/1702199936857980928/1702199936933478400?allow=1&f=m)

报告概览:

项目名称:

2023-09-14 13:57:45

**zhangyoujia/hd\_write\_verify**

依赖开源组件数:

0

存在安全漏洞数:

0

高危及以上漏洞:

0

暂未发现相关安全风险, 点击报告中的安全徽章, 获取放置在您的项目主页, 彰显项目安全可靠:



点击快速检测, 检测您其它项目的安全风险:

快速检测

# Q & A



微信群已超200人，无法再生成新的二维码，有意请添加微信！

# Thanks