dt "Zero Block" Data Corruptions

1. Overview

This document is to help with "*Zero Block*" corruptions, which are quite often seen. The name states the obvious, the corruption is *always* a set of zero blocks, simple enough, eh?

The purpose of this document is to help others recognize the "*corruption footprint*", since it's nearly always the same.

Note: While I have dt logs with *real* data corruptions, I cannot use these without permission (thus my *fake* corruption).

2. dt Workload

There are a number of predefined workloads, and a good starting point may be the longevity workloads:

longevity_common: Longevity Common Options (template)
    min=8k max=1m incr=vary **enable=raw,reread** enable=syslog **history=5 history_data=152 enable=history_timing** logprefix='%seq %nos %et %prog (j:%job t:%thread): ' keepalivet=5m runtime=-1 maxbad=1m onerr=abort noprogt=30s noprogtt=5m

l**ongevity_file_system**: Longevity File System Workload
    workload=longevity_common workload=high_validation min_limit=1m max_limit=2g incr_limit=vary dispose=keep **flags=direct** notime=close,fsync **oflags=trunc** maxdatap=75 threads=4

high_validation: Define Highest Data Validation Options (template)
    enable=btags pattern=iot prefix='%d@%h'

If you are new to dt, please use "*dt help*" for options, or refer to the dt Tool Overview document.

3. Corruption Footprint

First off, for all data corruptions, these are the key portions of the dt log that need to be included in corruption reports:

1. The dt Command Line
2. SCSI or NVMe Information
3. Extended Error Information
4. File Extent Map (for file systems supported)
5. History Information (when enabled)
6. Expected/Received Data
7. Corruption Analysis Summary
8. Block Header (Good and Bad)
9. Block Tag (Good and Bad)
10. Corrupted Data
11. Re-read Results
12. Total Statistics

While there are many I/O tools, and some are more advanced than dt, very few provide this level of error reporting! 🙂

One of the other keys is if file trim operations are enabled on NTFS, since deleting or truncating files create file trim operations (thus SCSI UNMAPs) by between multiple passes. These UNMAPs often contribute to the "zero blocks", where an array caching or logic error causes incorrect data to be returned. On Linux, file trims are enabled via a mount option.

Please Note: On Windows, you must run as Administrator for SCSI/NVMe information to be reported. Also on Windows, the relative file offset to physical LBA mapping requires a drive letter.

FYI: The example corruption information shown below was created by using these commands:

- `dt of=dt.data bs=random workload=high_validation limit=25m dispose=keep`
- `dt of=dt.data offset=10m pattern=0 count=3 disable=stats`
- `dt if=dt.data bs=random workload=high_validation limit=25m`

Note: The options to bypass the host buffer cache were omitted above, so here are options to consider:
- `flags=direct`
- `bufmodes={buffered,unbuffered,cachereads,cachewrites}`

3.1. SCSI Information

Since my system disk is an NVMe SSD, this is the disk information:

```
dt.exe (j:1 t:1):
```

```
dt.exe (j:1 t:1): SCSI Information:
dt.exe (j:1 t:1):                SCSI Device Name: \\.\C:
dt.exe (j:1 t:1):          Vendor Identification: NVMe
dt.exe (j:1 t:1):         Product Identification: SAMSUNG MZVLB512
dt.exe (j:1 t:1):          Firmware Revision Level: EXA7
dt.exe (j:1 t:1):       Target Port Group Support: 0 (ALUA not supported)
dt.exe (j:1 t:1):                    Block Length: 512
dt.exe (j:1 t:1):                Maximum Capacity: 1000215216 (488386.336 Mbytes,
476.940 Gbytes)
dt.exe (j:1 t:1):         Provisioning Management: Full Provisioned
dt.exe (j:1 t:1):            Device Serial Number: 0025_3881_8100_317A.
dt.exe (j:1 t:1):
```

For those who have dt with vendor specific extensions, additional information would be reported next.

3.1. Extended Error Information / File Extent Map

```
dt.exe (j:1 t:1):
dt.exe (j:1 t:1): ERROR: Error number 1 occurred on Thu Nov 17 18:37:05 2022
dt.exe (j:1 t:1):
dt.exe (j:1 t:1):                    Error Number: 1
dt.exe (j:1 t:1):           Time of Current Error: Thu Nov 17 18:37:05 2022
dt.exe (j:1 t:1):          Read Pass Start Time: Thu Nov 17 18:37:05 2022
dt.exe (j:1 t:1):                    Pass Number: 1
dt.exe (j:1 t:1):             Pass Elapsed Time: 00m00.00s
dt.exe (j:1 t:1):             Test Elapsed Time: 00m00.00s
dt.exe (j:1 t:1):                      File Name: dt.data
dt.exe (j:1 t:1):                        File ID: 21955048183435177 (0x4e000000000fa9)
dt.exe (j:1 t:1):                      File Size: 26214400 (0x1900000)
dt.exe (j:1 t:1):                      Operation: miscompare
dt.exe (j:1 t:1):                  Record Number: 20
dt.exe (j:1 t:1):                   Request Size: 196096 (0x2fe00)
dt.exe (j:1 t:1):                   Block Length: 383 (0x17f)
dt.exe (j:1 t:1):                       I/O Mode: read
dt.exe (j:1 t:1):                       I/O Type: sequential
dt.exe (j:1 t:1):                      File Type: input
dt.exe (j:1 t:1):                     Direct I/O: disabled (caching data)
dt.exe (j:1 t:1):           Device Serial Number: 0025_3881_8100_317A.
dt.exe (j:1 t:1):                    Device Size: 512 (0x200)
dt.exe (j:1 t:1):           Starting File Offset: 10327552 (0x9d9600)
dt.exe (j:1 t:1):          Starting Physical LBA: 544396171 (0x2072d38b)
dt.exe (j:1 t:1):             Ending File Offset: 10523648 (0xa09400)
dt.exe (j:1 t:1):           Ending Physical LBA: 554456553 (0x210c55e9)
dt.exe (j:1 t:1):             Error File Offset: 10485760 (0xa00000)
dt.exe (j:1 t:1):          Error Offset Modulos: %8 = 0, %512 = 0, %4096 = 0
dt.exe (j:1 t:1):     Starting Relative Error LBA: 20480 (0x5000)
dt.exe (j:1 t:1):     Starting Physical Error LBA: 554456480 (0x210c55a0)
dt.exe (j:1 t:1):       Physical Error LBA Offset: 283881717760 (0x4218ab4000)
dt.exe (j:1 t:1):    Physical 4096 byte Error LBA: 69307060 (0x4218ab4)
dt.exe (j:1 t:1):         Corruption Buffer Index: 158208 (byte index into read buffer)
dt.exe (j:1 t:1):          Corruption Block Index: 0 (byte index in miscompare block)
dt.exe (j:1 t:1):                    Prefix String: dt.data@DESKTOP-SBC6MG3
dt.exe (j:1 t:1):                    Prefix Length: 24 bytes (0x18) plus 1 zero bytes
dt.exe (j:1 t:1):
dt.exe (j:1 t:1):
dt.exe (j:1 t:1): Note: Reporting file map for current record only! Please use
'showfsmap' for full file extent map.
dt.exe (j:1 t:1):
dt.exe (j:1 t:1): File: dt.data, LBA Size: 512 bytes
dt.exe (j:1 t:1): Physical Disk: \\.\PhysicalDrive0, Cluster Size: 4096 on \\.\C:
[NTFS]
dt.exe (j:1 t:1):
dt.exe (j:1 t:1):    File Offset    Start LBA      End LBA      Blocks      VCN
LCN
dt.exe (j:1 t:1):      10327552    544396171    544396480         309     2304
67978392
```

```
dt.exe (j:1 t:1):          10485760    554456480    554456554         74     2560
69236148
dt.exe (j:1 t:1):
```

3.2. Expected/Received Data

The important data here, is the received data, indicating the initial corrupted block contains zeros:

```
dt.exe (j:1 t:1):
dt.exe (j:1 t:1): The incorrect data starts at memory address 0x000000000256aa00 (for
Robin's debug! :)
dt.exe (j:1 t:1): The incorrect data starts at file offset 000000000010327552 (marked
by asterisk '*')
dt.exe (j:1 t:1): Dumping Data File offsets (base = 10327552, mismatch offset = 0,
limit = 512 bytes):
dt.exe (j:1 t:1):                            / Block
dt.exe (j:1 t:1):          File Offset / Index
dt.exe (j:1 t:1): 000000000010327552/     0 |*00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327568/    16 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327584/    32 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327600/    48 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327616/    64 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327632/    80 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327648/    96 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327664/   112 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327680/   128 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327696/   144 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327712/   160 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327728/   176 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327744/   192 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327760/   208 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327776/   224 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327792/   240 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327808/   256 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327824/   272 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327840/   288 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327856/   304 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327872/   320 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327888/   336 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327904/   352 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327920/   368 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
```

```
dt.exe (j:1 t:1): 000000000010327936/    384 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327952/    400 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327968/    416 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010327984/    432 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010328000/    448 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010328016/    464 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010328032/    480 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1): 000000000010328048/    496 | 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 "                "
dt.exe (j:1 t:1):
```

3.3. Corruption Analysis

This is a key section for "zero blocks", since the analysis includes detecting the number of zero blocks:

```
dt.exe (j:1 t:1):
dt.exe (j:1 t:1): Analyzing IOT Record Data: (Note: Block #'s are relative to start of
record!)
dt.exe (j:1 t:1):
dt.exe (j:1 t:1):                        IOT block size: 512
dt.exe (j:1 t:1):              Total number of blocks: 383 (196096 bytes)
dt.exe (j:1 t:1):               Current IOT seed value: 0x01010101 (pass 1)
dt.exe (j:1 t:1):                 Range of good blocks: 0 - 308
dt.exe (j:1 t:1):                Length of good blocks: 309 (158208 bytes)
dt.exe (j:1 t:1):             Good blocks file offset: 10327552 (Relative LBA 20171,
Physical LBA 544396171)
dt.exe (j:1 t:1):            Range of corrupted blocks: 309 - 311
dt.exe (j:1 t:1):           Length of corrupted blocks: 3 (1536 bytes)
dt.exe (j:1 t:1):        Corrupted blocks file offset: 10485760 (Relative LBA 20480,
Physical LBA 554456480)
dt.exe (j:1 t:1):                 Range of good blocks: 312 - 382
dt.exe (j:1 t:1):                Length of good blocks: 71 (36352 bytes)
dt.exe (j:1 t:1):             Good blocks file offset: 10487296 (Relative LBA 20483,
Physical LBA 554456483)
dt.exe (j:1 t:1):          Number of corrupted blocks: 3
dt.exe (j:1 t:1):         Number of good blocks found: 380
dt.exe (j:1 t:1):         Number of zero blocks found: 3
dt.exe (j:1 t:1):
dt.exe (j:1 t:1):                             Record #: 20
dt.exe (j:1 t:1):               Starting Record Offset: 10327552
dt.exe (j:1 t:1):                       Transfer Count: 196096 (0x2fe00)
dt.exe (j:1 t:1):                 Ending Record Offset: 10523648
dt.exe (j:1 t:1):                 Starting Physical LBA: 544396171 (0x2072d38b)
dt.exe (j:1 t:1):                   Ending Physical LBA: 554456553 (0x210c55e9)
dt.exe (j:1 t:1):            Relative Record Block Range: 20171 - 20553
dt.exe (j:1 t:1):                  Read Buffer Address: 0x2544000
dt.exe (j:1 t:1):                 Pattern Base Address: 0x2432000
dt.exe (j:1 t:1):                        Prefix String: dt.data@DESKTOP-SBC6MG3
dt.exe (j:1 t:1):                        Prefix length: 24 bytes (0x18) plus 1 zero bytes
dt.exe (j:1 t:1):                             Note: Incorrect data is marked with
asterisk '*'
dt.exe (j:1 t:1):
```

3.4. Block Header

When possible, dt will report a good data block prior to each bad block. When block tags are enabled, the good block provides information that can be useful during triage:

3.4.1 Good Data Header

Here's an example of a good data block header:

```
dt.exe (j:1 t:1):
dt.exe (j:1 t:1):                        Record Block: 308 (GOOD data)
dt.exe (j:1 t:1):                 Record Block Offset: 10485248 (Relative LBA 20479,
Physical LBA 544396479)
dt.exe (j:1 t:1):                 Record Buffer Index: 157696 (0x26800)
dt.exe (j:1 t:1):               Prefix String Compare: correct
dt.exe (j:1 t:1):                Prefix String Offset: 152 (0x98)
dt.exe (j:1 t:1):             Expected IOT Data Offset: 176 (0xb0)
dt.exe (j:1 t:1):               Expected Block Number: 20479 (0x00004fff)
dt.exe (j:1 t:1):               Received Block Number: 20479 (0x00004fff)
dt.exe (j:1 t:1):
```

3.4.1 Bad Data Header

```
dt.exe (j:1 t:1):
dt.exe (j:1 t:1):                        Record Block: 309 (BAD data)
dt.exe (j:1 t:1):                 Record Block Offset: 10485760 (Relative LBA 20480,
Physical LBA 554456480)
dt.exe (j:1 t:1):                 Record Buffer Index: 158208 (0x26a00)
dt.exe (j:1 t:1):               Prefix String Compare: incorrect
dt.exe (j:1 t:1):                Prefix String Offset: 152 (0x98)
dt.exe (j:1 t:1):               Expected Prefix String: dt.data@DESKTOP-SBC6MG3
dt.exe (j:1 t:1):               Received Prefix String: <non-printable string>
dt.exe (j:1 t:1):               Expected Prefix Length: 24
dt.exe (j:1 t:1):               Received Prefix Length: 0
dt.exe (j:1 t:1):             Expected IOT Data Offset: 176 (0xb0)
dt.exe (j:1 t:1):               Expected Block Number: 20480 (0x00005000)
dt.exe (j:1 t:1):               Received Block Number: 0 (0x00000000)
dt.exe (j:1 t:1):               Received Block Offset: 0
dt.exe (j:1 t:1):               Seed Detected at Offset: 156 (0x9c) (word index 1)
dt.exe (j:1 t:1):               Data Written During Pass: 0
dt.exe (j:1 t:1):               Calculated Block Number: 0 (0x00000000)
dt.exe (j:1 t:1):             Expected Data is for Seed: 0x01010101 (pass 1)
dt.exe (j:1 t:1):           Received Data is from Seed: 0x00000000 (wrong data)
dt.exe (j:1 t:1):
```

3.5. Block Tag

The block tag, which exists at the start of each disk sized block, shows the expected and received fields.

3.5.1 Good Block Tag

```
dt.exe (j:1 t:1):
dt.exe (j:1 t:1): Block Tag (btag) @ 0x000000000256a800 (152 bytes):
dt.exe (j:1 t:1):
dt.exe (j:1 t:1):                      File Offset (  0): 10485248 (0x9ffe00)
dt.exe (j:1 t:1):                      Physical LBA: 544396479 (0x2072d4bf)
dt.exe (j:1 t:1):                      Relative LBA: 20479 (0x4fff)
dt.exe (j:1 t:1):                      File ID (  8): 21955048183435177 (0x4e000000000fa9)
dt.exe (j:1 t:1):                      Host Name ( 52): DESKTOP-SBC6MG3
dt.exe (j:1 t:1):                      Signature ( 76): 0xbadcafee
```

```
dt.exe (j:1 t:1):                        Version ( 80): 1
dt.exe (j:1 t:1):                   Pattern Type ( 81): 1 (IOT)
dt.exe (j:1 t:1):                          Flags ( 82): 0x5 (file,prefix,sequential,forward)
dt.exe (j:1 t:1): Write Pass Start (secs) ( 84): 0x63767f1c => Thu Nov 17 18:36:12
2022
dt.exe (j:1 t:1):    Write Timestamp (secs) ( 88): 0x63767f1c => Thu Nov 17 18:36:12
2022
dt.exe (j:1 t:1):   Write Timestamp (usecs) ( 92): 0x000bfdda
dt.exe (j:1 t:1):                       IOT Seed ( 96): 0x01010101
dt.exe (j:1 t:1):                     Generation (100): 1 (0x00000001)
dt.exe (j:1 t:1):                     Process ID (104): 12444 (0x0000309c)
dt.exe (j:1 t:1):                         Job ID (108): 1 (0x00000001)
dt.exe (j:1 t:1):                  Thread Number (112): 1 (0x00000001)
dt.exe (j:1 t:1):                    Device Size (116): 512 (0x00000200)
dt.exe (j:1 t:1):                   Record Index (120): 355328 (0x00056c00)
dt.exe (j:1 t:1):                    Record Size (124): 325120 (0x0004f600)
dt.exe (j:1 t:1):                  Record Number (128): 20 (0x00000014)
dt.exe (j:1 t:1):                    Step Offset (136): 0 (0x0)
dt.exe (j:1 t:1):                Opaque Data Type (144): 0 (No Data Type)
dt.exe (j:1 t:1):                Opaque Data Size (146): 0 (0x0000)
dt.exe (j:1 t:1):                         CRC-32 (148): 0xa25864e9
dt.exe (j:1 t:1):
```

3.5.2 Bad Block Tag

```
dt.exe (j:1 t:1):
dt.exe (j:1 t:1): Block Tag (btag) @ 0x000000000256aa00 (152 bytes):
dt.exe (j:1 t:1):
dt.exe (j:1 t:1):                    File Offset (  0): incorrect
dt.exe (j:1 t:1):                       Expected: 10485760 (0xa00000)
dt.exe (j:1 t:1):                   Physical LBA: 554456480 (0x210c55a0)
dt.exe (j:1 t:1):                   Relative LBA: 20480 (0x5000)
dt.exe (j:1 t:1):                       Received: 0 (0x0)
dt.exe (j:1 t:1):                   Physical LBA: 118902112 (0x7164d60)
dt.exe (j:1 t:1):                   Relative LBA: 0 (0x0)
dt.exe (j:1 t:1):                       File ID (  8): incorrect
dt.exe (j:1 t:1):                       Expected: 21955048183435177 (0x4e000000000fa9)
dt.exe (j:1 t:1):                       Received: 0 (0x0)
dt.exe (j:1 t:1):                    Host Name ( 52): incorrect
dt.exe (j:1 t:1):                       Expected: DESKTOP-SBC6MG3
dt.exe (j:1 t:1):                       Received: 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00
dt.exe (j:1 t:1):                      Signature ( 76): incorrect
dt.exe (j:1 t:1):                       Expected: 0xbadcafee
dt.exe (j:1 t:1):                       Received: 0x00000000
dt.exe (j:1 t:1):                        Version ( 80): incorrect
dt.exe (j:1 t:1):                       Expected: 1
dt.exe (j:1 t:1):                       Received: 0
dt.exe (j:1 t:1):                   Pattern Type ( 81): incorrect
dt.exe (j:1 t:1):                       Expected: 1 (IOT)
dt.exe (j:1 t:1):                       Received: 0 (UNKNOWN)
dt.exe (j:1 t:1):                          Flags ( 82): 0x0 (disk,sequential,forward)
dt.exe (j:1 t:1): Write Pass Start (secs) ( 84): 0x00000000 => <invalid time value>
dt.exe (j:1 t:1):   Write Timestamp (secs) ( 88): 0x00000000 => <invalid time value>
dt.exe (j:1 t:1):  Write Timestamp (usecs) ( 92): 0x00000000
dt.exe (j:1 t:1):                       IOT Seed ( 96): incorrect
dt.exe (j:1 t:1):                       Expected: 0x01010101
dt.exe (j:1 t:1):                       Received: 0x00000000
dt.exe (j:1 t:1):                     Generation (100): 0 (0x00000000)
dt.exe (j:1 t:1):                     Process ID (104): 0 (0x00000000)
dt.exe (j:1 t:1):                         Job ID (108): 0 (0x00000000)
dt.exe (j:1 t:1):                  Thread Number (112): 0 (0x00000000)
dt.exe (j:1 t:1):                    Device Size (116): incorrect
dt.exe (j:1 t:1):                       Expected: 512 (0x00000200)
dt.exe (j:1 t:1):                       Received: 0 (0x00000000)
dt.exe (j:1 t:1):                   Record Index (120): 0 (0x00000000)
dt.exe (j:1 t:1):                    Record Size (124): 0 (0x00000000)
dt.exe (j:1 t:1):                  Record Number (128): 0 (0x00000000)
dt.exe (j:1 t:1):                    Step Offset (136): 0 (0x0)
```

```
dt.exe (j:1 t:1):              Opaque Data Type (144): 0 (No Data Type)
dt.exe (j:1 t:1):              Opaque Data Size (146): 0 (0x0000)
dt.exe (j:1 t:1):                      CRC-32 (148): incorrect
dt.exe (j:1 t:1):                          Expected: 0xb2aa7578
dt.exe (j:1 t:1):                          Received: 0x00000000
dt.exe (j:1 t:1):                       Btag Errors: 9
dt.exe (j:1 t:1):
```

Of course, in this case with all zero data, the majority of tag fields are flagged as incorrect!

3.6. Corrupted Data

This section reports a side by side of the good data on the left, and incorrect (bad data) on the right (all zeros):

```
dt.exe (j:1 t:1):
dt.exe (j:1 t:1): Byte Expected: address 0x2458a00           Received: address
0x256aa00
dt.exe (j:1 t:1): 0000 00a00000 00000000 00000fa9 004e0000 * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 0010 00000000 00000000 00000000 00000000   00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 0020 00000000 00000000 00000000 00000000   00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 0030 00000000 4b534544 2d504f54 36434253 * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 0040 0033474d 00000000 00000000 badcafee * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 0050 00050101 00000000 00000000 00000000 * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 0060 01010101 00000001 00005e5c 00000001 * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 0070 00000001 00000200 00026a00 00009400 * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 0080 00000014 00000000 00000000 00000000 * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 0090 00000000 b2aa7578 642e7464 40617461 * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 00a0 4b534544 2d504f54 36434253 0033474d * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1):        K S E D  - P O T  6 C B S   3 G M
dt.exe (j:1 t:1): 00b0 00005000 01015101 02025202 03035303 * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 00c0 04045404 05055505 06065606 07075707 * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 00d0 08085808 09095909 0a0a5a0a 0b0b5b0b * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 00e0 0c0c5c0c 0d0d5d0d 0e0e5e0e 0f0f5f0f * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 00f0 10106010 11116111 12126212 13136313 * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 0100 14146414 15156515 16166616 17176717 * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 0110 18186818 19196919 1a1a6a1a 1b1b6b1b * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 0120 1c1c6c1c 1d1d6d1d 1e1e6e1e 1f1f6f1f * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 0130 20207020 21217121 22227222 23237323 * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 0140 24247424 25257525 26267626 27277727 * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 0150 28287828 29297929 2a2a7a2a 2b2b7b2b * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 0160 2c2c7c2c 2d2d7d2d 2e2e7e2e 2f2f7f2f * 00000000 00000000
00000000 00000000
```

```
dt.exe (j:1 t:1): 0170 30308030 31318131 32328232 33338333 * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 0180 34348434 35358535 36368636 37378737 * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 0190 38388838 39398939 3a3a8a3a 3b3b8b3b * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 01a0 3c3c8c3c 3d3d8d3d 3e3e8e3e 3f3f8f3f * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 01b0 40409040 41419141 42429242 43439343 * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 01c0 44449444 45459545 46469646 47479747 * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 01d0 48489848 49499949 4a4a9a4a 4b4b9b4b * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 01e0 4c4c9c4c 4d4d9d4d 4e4e9e4e 4f4f9f4f * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1): 01f0 5050a050 5151a151 5252a252 5353a353 * 00000000 00000000
00000000 00000000
dt.exe (j:1 t:1):
```

3.7. Re-Read Results

The purpose of the re-reads include:

1. Helps determine if there was a read or write failure.
   1. if none of the re-reads match the expected data, this may be a (*persistent*) write failure
   2. if the re-read match the expected data, this is considered a (transient) read failure
2. The expected, corrupted, and re-read data are written to files for further investigation.
3. The dt commands to re-read the corrupted record or file (from file start) are reported.

Please know, a later re-read of the same record data may report different results, since oftentimes stale data was read, which changes due to a caching issue (in this case). This is still considered a failure, of course.

Here's what you'll see during the re-reads:

```
dt.exe (j:1 t:1): Writing expected data to file dt.data-EXPECT0-j1t1, from buffer
0x2432000, 196096 bytes...
dt.exe (j:1 t:1): Writing corrupted data to file dt.data-CORRUPT0-j1t1, from buffer
0x2544000, 196096 bytes...
dt.exe (j:1 t:1): Rereading and verifying record data using Direct I/O...
dt.exe (j:1 t:1): Record #1 - Reading 196096 bytes (383 blocks) into buffer 0x52d000,
Physical LBA's 544396171, 554456553 (offset 10327552)
dt.exe (j:1 t:1): Reread data matches previous data read, possible write failure!
dt.exe (j:1 t:1): Writing reread data to file dt.data-REREAD0-j1t1, from buffer
0x52d000, 196096 bytes...
dt.exe (j:1 t:1): Command line to re-read the corrupted data:
dt.exe (j:1 t:1):     % C:\Tools\dt.exe if=dt.data bs=196096 count=1 offset=10327552
prefix="dt.data@DESKTOP-SBC6MG3" pattern=iot enable=btags
disable=retryDC,savecorrupted,trigdefaults
dt.exe (j:1 t:1):
dt.exe (j:1 t:1): Command line to re-read the data:
dt.exe (j:1 t:1):     % C:\Tools\dt.exe if=dt.data min=512 max=1048576 incr=vary
dsize=512 iotype=sequential iodir=forward limit=10523648 records=19
rseed=0x5e341a4c0a2 prefix="dt.data@DESKTOP-SBC6MG3" pattern=iot enable=btags
disable=retryDC,savecorrupted,trigdefaults
dt.exe (j:1 t:1):
```

3.7. Total Statistics

```
dt.exe (j:1 t:1):
dt.exe (j:1 t:1): Operating System Information:
dt.exe (j:1 t:1):                    Host name: DESKTOP-SBC6MG3 (192.168.50.31)
dt.exe (j:1 t:1):                    User name: robin
dt.exe (j:1 t:1):                   Process ID: 24156
dt.exe (j:1 t:1):               OS information: Windows 10 [10.0.19045 No Service
Pack]
dt.exe (j:1 t:1):
dt.exe (j:1 t:1): File System Information:
dt.exe (j:1 t:1):          Filesystem block size: 4096
dt.exe (j:1 t:1):          Filesystem free space: 225523331072 (215075.809 Mbytes,
210.035 Gbytes, 0.205 Tbytes)
dt.exe (j:1 t:1):         Filesystem total space: 510770802688 (487108.996 Mbytes,
475.692 Gbytes, 0.465 Tbytes)
dt.exe (j:1 t:1):              Volume path name: C:\
dt.exe (j:1 t:1):
dt.exe (j:1 t:1): SCSI Information:
dt.exe (j:1 t:1):             SCSI device name: \\.\C:
dt.exe (j:1 t:1):          Inquiry information: Vid=NVMe, Pid=SAMSUNG MZVLB512,
Rev=EXA7
dt.exe (j:1 t:1):         Capacity information: Block Length=512,
Capacity=1000215216 (488386.336 Mbytes)
dt.exe (j:1 t:1):       Provisioning management: Full Provisioned
dt.exe (j:1 t:1):         Device serial number: 0025_3881_8100_317A.
dt.exe (j:1 t:1):
dt.exe (j:1 t:1): Total Statistics:
dt.exe (j:1 t:1):         Input device/file name: dt.data (device type=regular)
dt.exe (j:1 t:1):         Type of I/O's performed: sequential (forward,
rseed=0x5e341a4c0a2)
dt.exe (j:1 t:1):         Job Information Reported: Job 1, Thread 1
dt.exe (j:1 t:1):         Data pattern prefix used: dt.data@DESKTOP-SBC6MG3
dt.exe (j:1 t:1):         Data pattern string used: 'IOT Pattern' (blocking is 512
bytes)
dt.exe (j:1 t:1):         Last IOT seed value used: 0x01010101
dt.exe (j:1 t:1):          Block tag verify flags: 0x0f8841ff
dt.exe (j:1 t:1):              Total records read: 20
dt.exe (j:1 t:1):               Total bytes read: 10523648 (10277.000 Kbytes, 10.036
Mbytes, 0.010 Gbytes)
dt.exe (j:1 t:1):          Total records written: 0
dt.exe (j:1 t:1):           Total bytes written: 0 (0.000 Kbytes, 0.000 Mbytes, 0.000
Gbytes)
dt.exe (j:1 t:1):         Total records processed: 20 with min=512, max=1048576,
incr=variable
dt.exe (j:1 t:1):         Total bytes transferred: 10523648 (10277.000 Kbytes, 10.036
Mbytes)
dt.exe (j:1 t:1):         Average transfer rates: 172938408 bytes/sec, 168885.164
Kbytes/sec, 164.927 Mbytes/sec
dt.exe (j:1 t:1):          Number I/O's per second: 328.666
dt.exe (j:1 t:1):          Number seconds per I/O: 0.0030 (3.04ms)
dt.exe (j:1 t:1):           Total passes completed: 1/1
dt.exe (j:1 t:1):            Total errors detected: 1/1
dt.exe (j:1 t:1):              Total elapsed time: 00m00.00s
dt.exe (j:1 t:1):                   Starting time: Thu Nov 17 18:37:05 2022
dt.exe (j:1 t:1):                     Ending time: Thu Nov 17 18:37:05 2022
dt.exe (j:1 t:1):
dt.exe (j:1 t:1): Command Line:
dt.exe (j:1 t:1):
dt.exe (j:1 t:1):     % C:\Tools\dt.exe if=dt.data bs=random workload=high_validation
limit=25m
dt.exe (j:1 t:1):
dt.exe (j:1 t:1):         --> Date: December 3rd, 2021, Version: 25.02, Author: Robin
T. Miller <--
dt.exe (j:1 t:1):
dt.exe (j:0 t:0): Program is exiting with status -1...
```