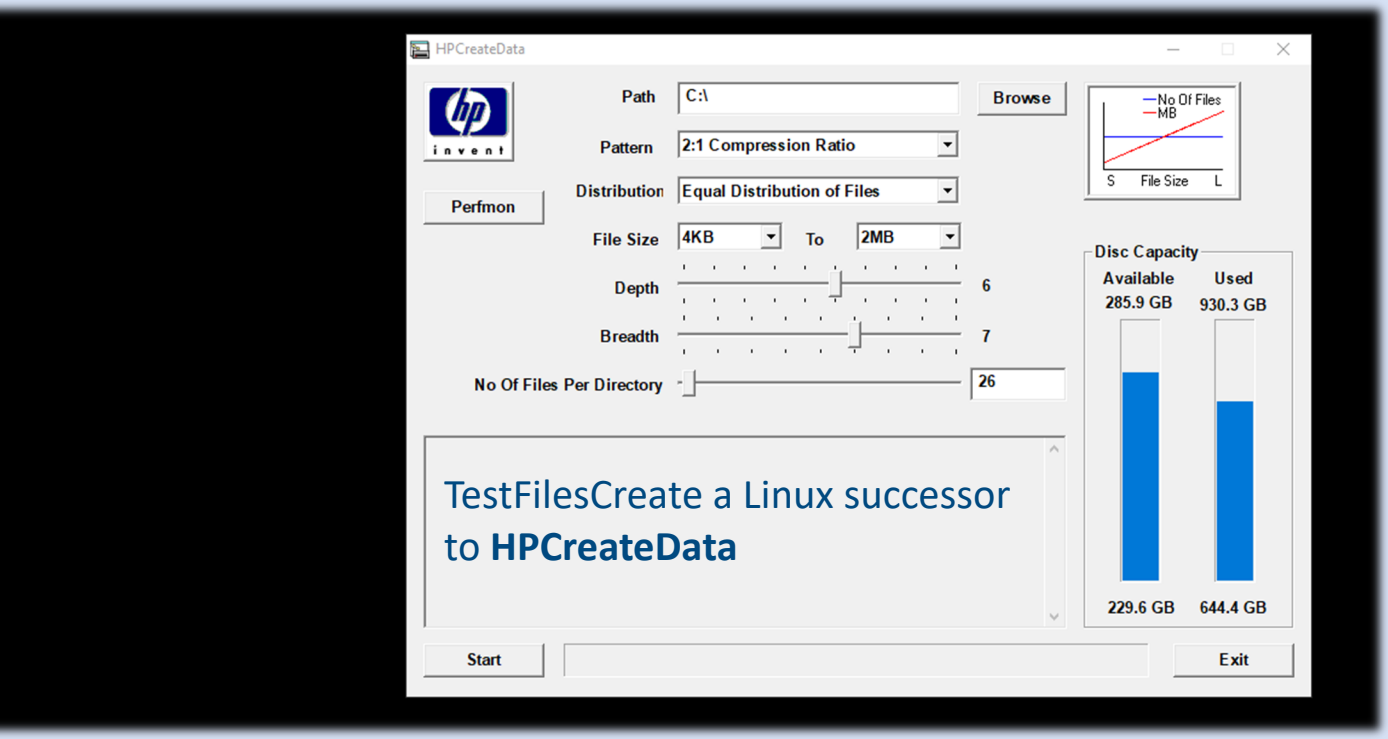
TestFilesCreate

Creates test data files in a single directory or a tree of directories, the tree dimensions and files are limited only by system resources. It is a tool for creating data to test data storage using hard drives and tape, it also can be used evaluating storage compression and deduplication capabilities. Comparative timings of compression software can be performed.

TestFilesCreate can set a benchmark for storage products by creating consistent test data to measure storage efficiency of data compression and data deduplication both at rest in storage systems and inflight during network transmission.

Data is created locally when required. It is not necessary to store test data and transmit between test sites for remote testing.

The complexity of test data is selected from a scale of 1 – 95. A complexity of one has only one printable character repeated, the upper limit is filled with randomized 95 printable characters. The more complex the data is, the more difficult it is to compress.



./TestFilesCreate

```
./TestFilesCreate -P 20 -d 6 -w 7 -s 4K -l 2M -n 26 -o /tmp

DIRECTORTY TREE:
Each directory contains 7 directories and 26 files
The tree is 6 levels deep

Output: /tmp/tfc_250518-1136-43

File contents individually generated for each file
Files created in a size range 4K to 2M
Storage used..... 995.72G (max potential)
File Contents..... printable, data complexity of 20
Total data directories.....19607
Total data files.....509808
```

Data creation options

Selectable data complexity range of 1-95.

Files are human readable and verifiable.

Individual file contents can be unique.

File size can be random, within a size range.

File size can be fixed, minimum two bytes.

All files can be identical.

Create a single file or millions.

Output to a single directory or a directory tree.

Filling files with random binary is available.

Sparse files are not available.

Upper limits determined by system configuration and capacity.

Calculator mode

```
./TestFilesCreate -C

File size requires units of B, K, M or G, the number must >1
decimals not permitted i.e. 750K 34M 2G and 10B (10 bytes)

NOTES:
 Two bytes (2B) file size is the minimum to build a tree
 One byte is permitted here for information only
 SINGLE DIRECTORY only, set Depth = 1

 Data tree directory depth (-d): 6
 Data tree directory width (-w): 7
 Files per directory       (-n): 26
 Size per file       (-f or -l): 2M

 Total number of directories :      19607
 Total number of files       :     509808
 Total file storage usage    :     995.72G

Top Level directory (tree depth = 1) total file usage 52.00M
  This directory contains 26 files, each 2.00M
  Content counts and storage used by this top level is constant
  and unaffected by subdirectory count (tree width)

            Directory count for each tree
Tree Depth        2        3        4        5        6
          ------------------------------------------------
Width   1 |        1        2        3        4        5
Width   2 |        2        6       14       30       62
Width   3 |        3       12       39      120      363
Width   4 |        4       20       84      340     1364
Width   5 |        5       30      155      780     3905
Width   6 |        6       42      258     1554     9330
Width   7 |        7       56      399     2800    19607

            File count for each tree
Tree Depth        2        3        4        5        6
          ------------------------------------------------
Width   1 |       52       78      104      130      156
Width   2 |       78      182      390      806     1638
Width   3 |      104      338     1040     3146     9464
Width   4 |      130      546     2210     8866    35490
Width   5 |      156      806     4056    20306   101556
Width   6 |      182     1118     6734    40430   242606
Width   7 |      208     1482    10400    72826   509808

            File storage usage for each tree
Tree Depth        2        3        4        5        6
          ------------------------------------------------
Width   1 |   104.00M   156.00M   208.00M   260.00M   312.00M
Width   2 |   156.00M   364.00M   780.00M     1.57G     3.20G
Width   3 |   208.00M   676.00M     2.03G     6.14G    18.48G
Width   4 |   260.00M     1.07G     4.32G    17.32G    69.32G
Width   5 |   312.00M     1.57G     7.92G    39.66G   198.35G
Width   6 |   364.00M     2.18G    13.15G    78.96G   473.84G
Width   7 |   416.00M     2.89G    20.31G   142.24G   995.72G
```

A Benchmark tool for Data Compression and Deduplication

This provides a simple method of comparing data compression or data deduplication capabilities of storage software and appliances while at rest or inflight.

Many applications and devices have purpose-built compression techniques targeting their unique data, like video and audio, but for every-day data that relies upon storage techniques to compress data there appears to be no recognised method or standard to compare the storage reduction techniques. Compression testers have their own unpublished methods and data sets to compare storage and networking products. The method that TestFilesCreate provides is a simple reproducible standard method generating data of varying compressibility.

Benchmarks have been published, the Calgary Corpus and the Canterbury Corpus* were used for benchmarking compression in the 1990s. In the mid-2000s data deduplication technology become commercially available and made some test tools obsolete like the *HPCreateData* tool which was not suitable for testing data deduplication**.**

Test Data and Data Complexity

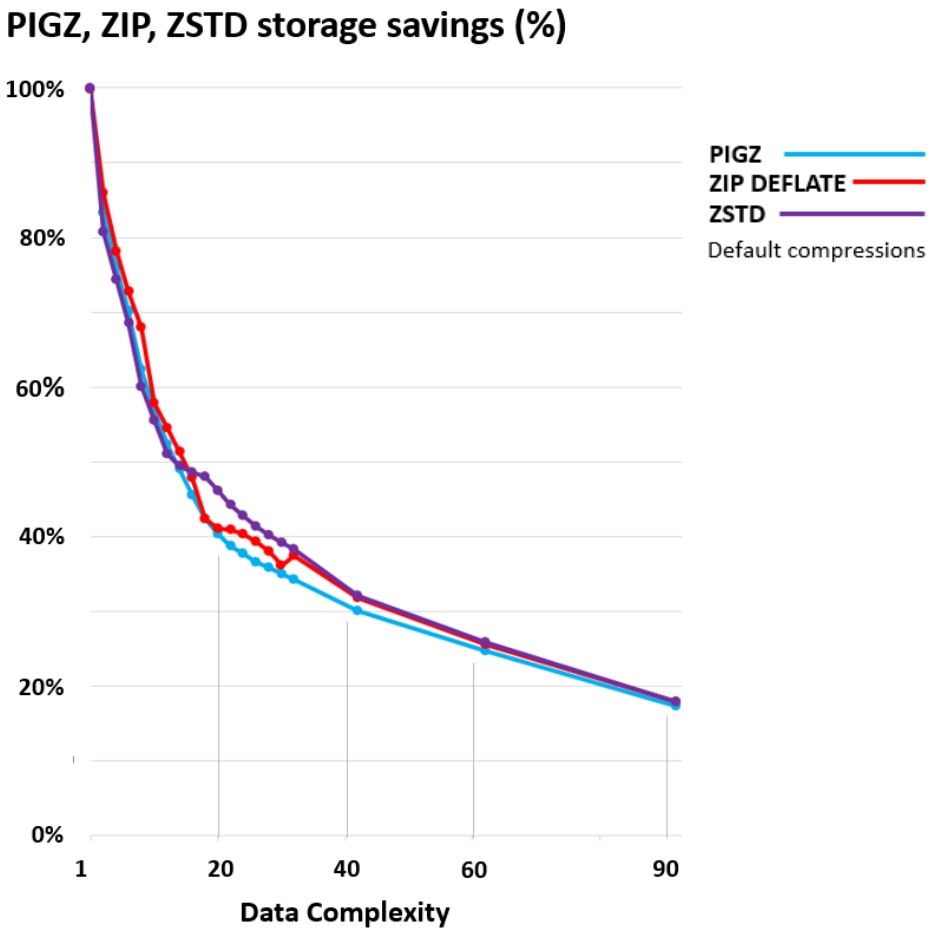
Data for testing compression and deduplication needs test files that contain data that is a challenge to compress. Test data that is too simple or too complex will not produce meaningful results. TestFilesCreate is able to produce data of selectable complexities of 1 to 95, a spectrum of complexity which sufficient for most testing requirements.

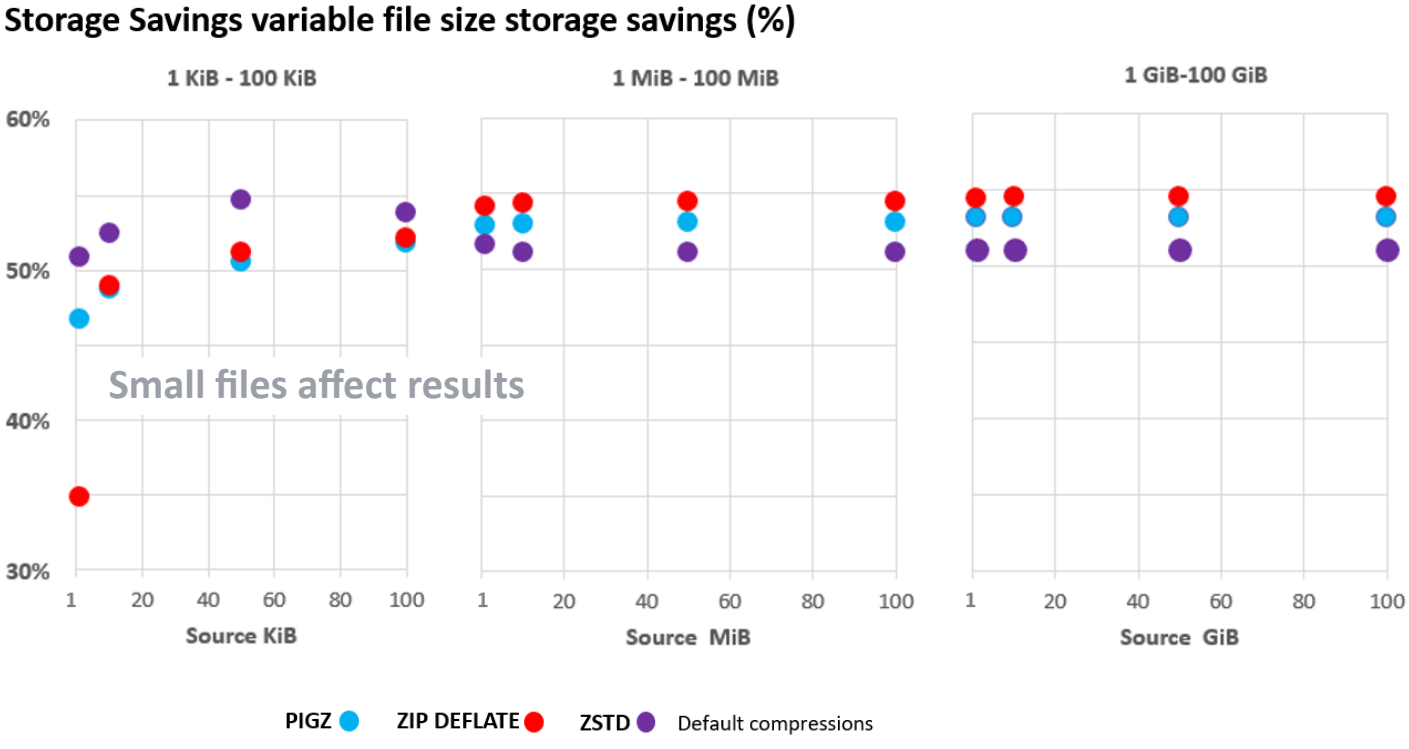
The files are filled with randomized printable characters of the ASCI character set or of random binary data. The test data is generated in a directory tree of user defined dimensions.

	Complexity	File Contents
Digits only (D)	1	Only zeros ‘0’
	2-10	Random digits ‘0123456789’
Printable ASCI character set (P)	1	Only uppercase ‘A’
	2-26	Only lowercase Latin alphabet
	27-95	The Printable ASCI characters set
Examples	P 10	Randomised selection from abcdefghij
	P 30	Randomised selection from !"#$%&'()*+,-./0123456789:;<=>
	D 8	Randomised selection from ‘12345678’
	D 1	00000000000000000000000000000000000000000000000000

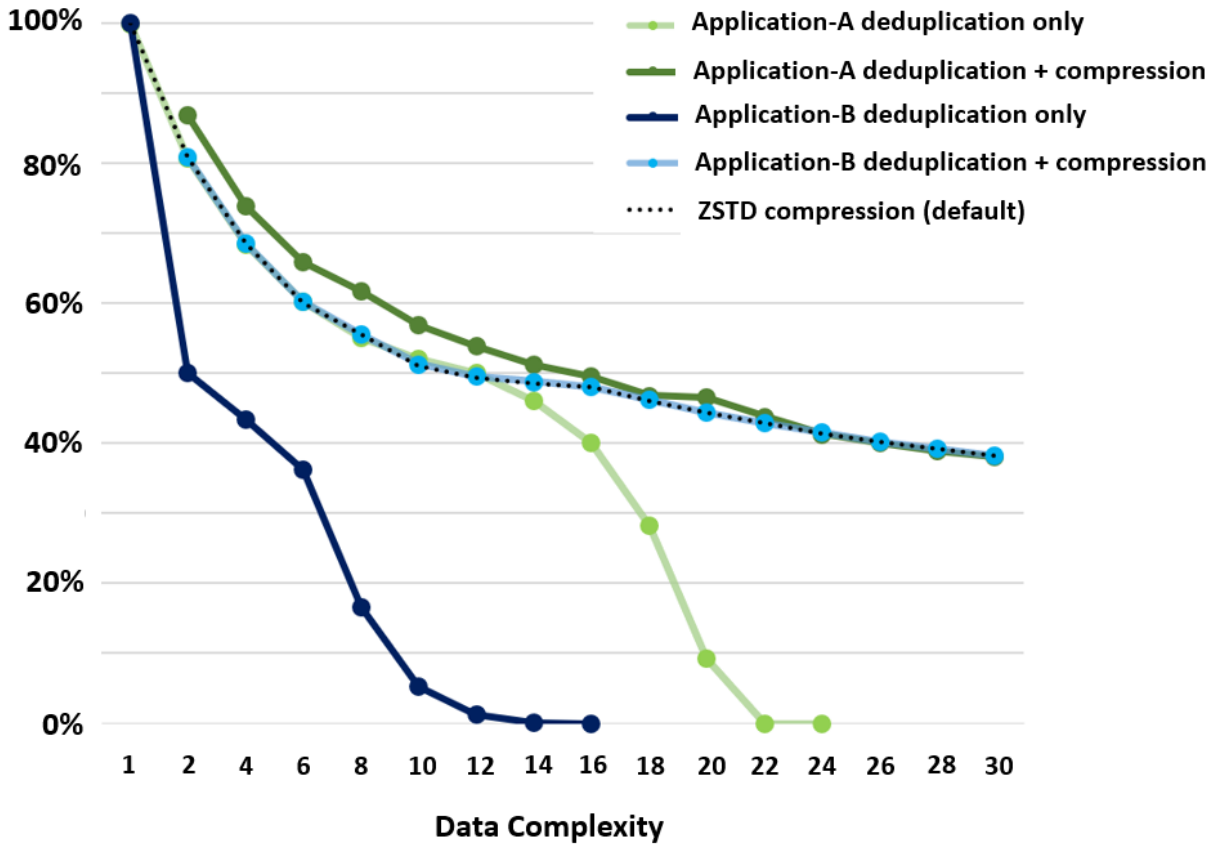
*Calgary Corpus & Canterbury Corpus: https://corpus.canterbury.ac.nz/index.html

Benchmark examples

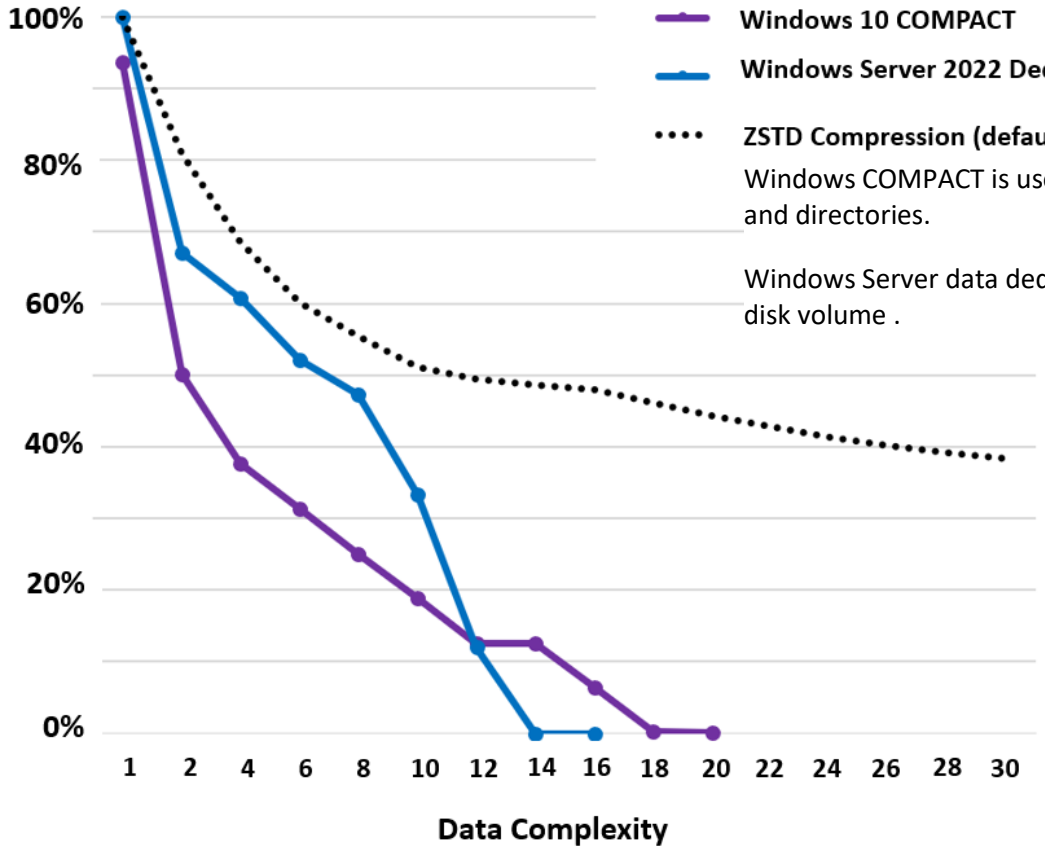




Backup Application storage savings (%)



Storage Device storage savings (%)



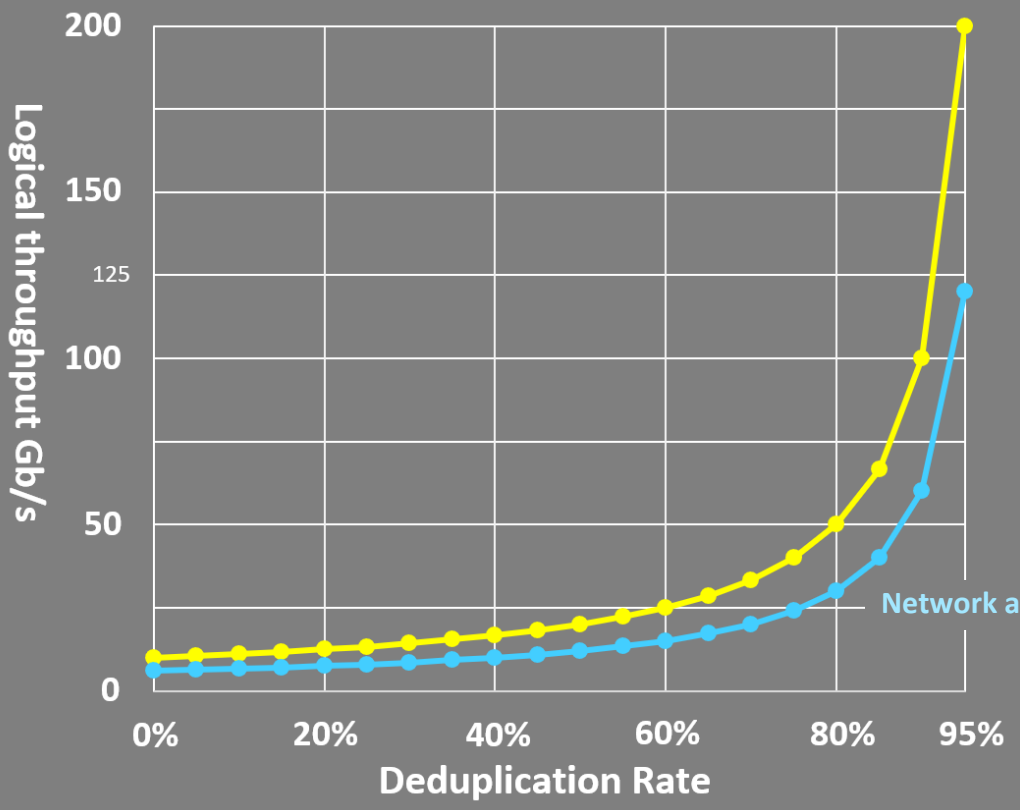
Windows COMPACT is used to compress drives and directories.

Windows Server data deduplication is set on the disk volume .

Testing the IP network performance of deduplication.

Some storage appliances and applications offload data deduplicated to the source device resulting substantial network throughput improvement. During transmission only unique data chunks and the dedupe signatures of repeated data chunks are transmitted.

Deduplication Rate and Logical Network Throughput



10Gb/s Throughput

Deduplication Rate	TiBs per hour
70%	14
80%	22
90%	44
95%	88

The IP network can be throttled by applications and inefficiency.

Notes.

Storage savings from compression and deduplication is only one factor, the importance of efficiently and quickly producing these savings are often more import in selecting data reduction techniques.

Storage that uses network enabled deduplication may come with guidelines regarding its use because some network devices use deduplication to improve efficiency across WAN and other networks.

The PIGZ and ZSTD **—rsyncable** option is used in PIGZ and ZSTD to create rsync friendly compressed files. The use of the rsyncable option has been found to be beneficial in some deduplication applications and may significantly influence deduplication test results. The rsyncable option in PIGZ and ZSTD has little impact on compressed file size.

Test data for examples.

PIGZ, ZIP, ZSTD, Backup Applications and Device Storage

Each data point is a minimum of two tests using 99.6 GiB directory trees containing 6,800 15 MiB files in 340 directories. If the two tests agreed no further tests was done.

PIGZ, ZIP, ZSTD Variable File Size

Each data point is three tests using a data complexity of 10 i.e. files were filed with a random sequence of `abcdefghij` characters.

TestFilesCreate available from https://github.com/Jim-JMCD

TestFilesCreate is a Linux only bash script protected by a *shc* generated executable wrapper.

Jim McDonald May 2025