

DiskMark Performance Measurement

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Basic disk file operations

1. Create a binary file consisting of records that have a fixed structure (e.g. account number, customer name, and balance)
2. Sequential read of the binary file
3. Random read of the binary file

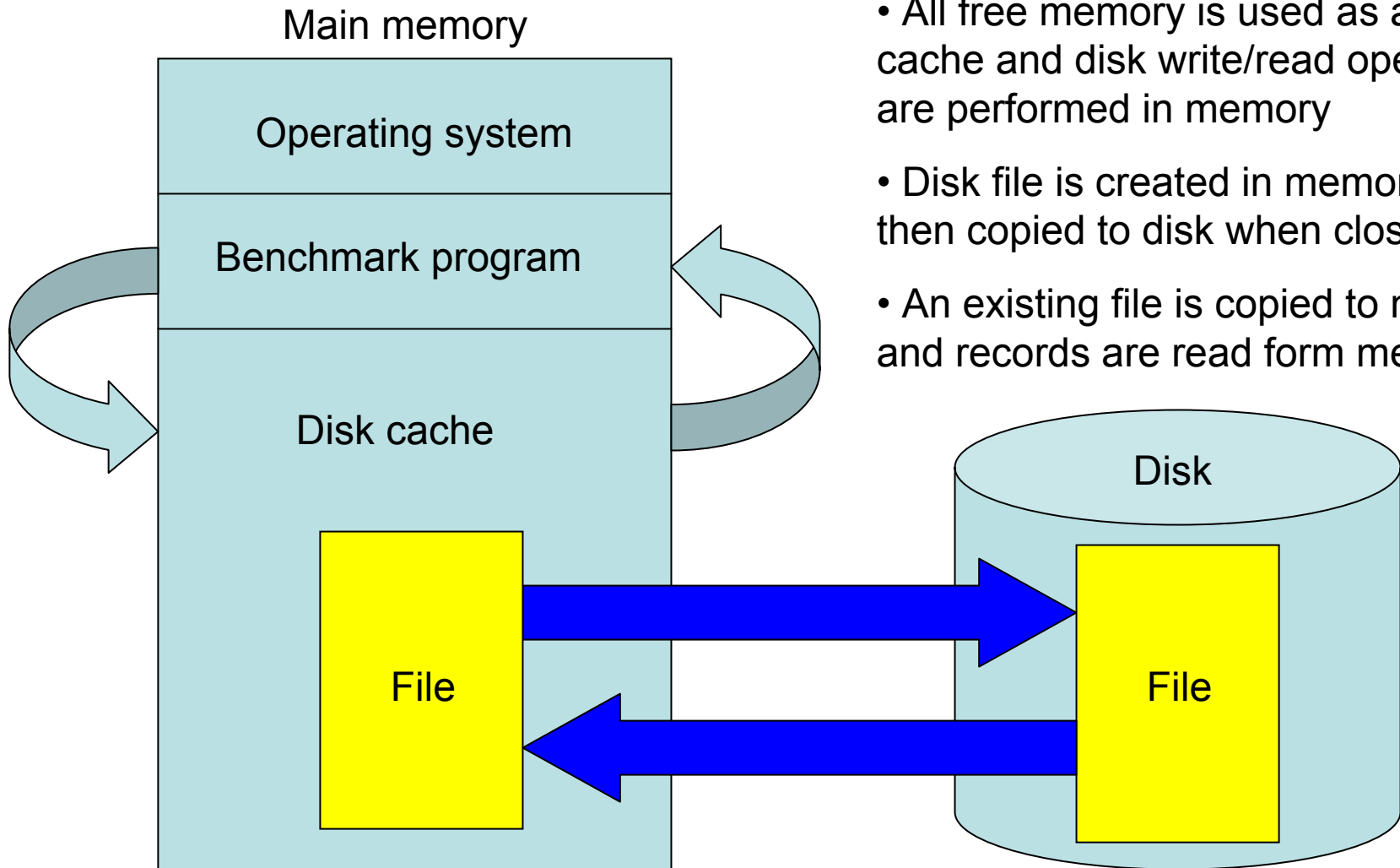
DiskMark

- Measured speed indicators:
 - V_{seqw} = disk sequential write speed
 - V_{seqr} = disk sequential read speed
 - V_{ranr} = disk random read speed
- DiskMark is defined as the mean speed of basic disk operations:
$$V_{disk} = 3 / (1/V_{seqw} + 1/V_{seqr} + 1/V_{ranr})$$

Parameters of the benchmark program

- Record size
 - Convenient size is a fraction of the 512 byte sector
 - E.g., $512/8=64$ bytes
- File size
 - File size can be determined using a fixed file create time
 - File size can be defined as a constant value (number of records)

Using main memory as a disk cache



- All free memory is used as a disk cache and disk write/read operations are performed in memory
- Disk file is created in memory and then copied to disk when closed
- An existing file is copied to memory and records are read from memory

Performance effects

- Using main memory as disk cache dramatically reduces the number of mechanical disk read and write operations
- For files that can fit in memory the importance of seek time and latency becomes negligible
- Performance of disk read/write operations depends primarily on the following:
 - Processor speed
 - Memory and bus speeds
 - Efficiency of cache data access and data buffering algorithms implemented in the file management part of the operating system

Example

- Rotational speed of disk = 7200 rpm
- Revolution time = $7200/60 = 120$ rev/sec
- Consequently the number of physical random accesses to disk is ≤ 120 [1/sec]
- Measured number of random accesses per second > 300000 [1/sec]
- Obviously, random accesses are performed in memory, not on disk

The structure of record

```
const int BytesPerRecord=64;
```

```
struct client
```

```
{
```

```
    int account;
```

```
    char name[BytesPerRecord-8];
```

```
    int balance;
```

```
};
```


File open command

- Open for writing:

```
ofstream OS(filename, ios::out | ios::binary);
```

- Open for sequential read:

```
ifstream IS(filename, ios::in | ios::binary);
```

- Open for random read:

```
ifstream IS(filename, ios::in | ios::out | ios::binary);
```

Sequential write

```
client c;
```

```
.....
```

```
while( condition )
```

```
{ // Create client record
```

```
    OS.write(reinterpret_cast< const char *>(&c),  
              sizeof(c)); // Write to cache
```

```
}
```

```
OS.close( ); // Write from cache to disk
```

Sequential read

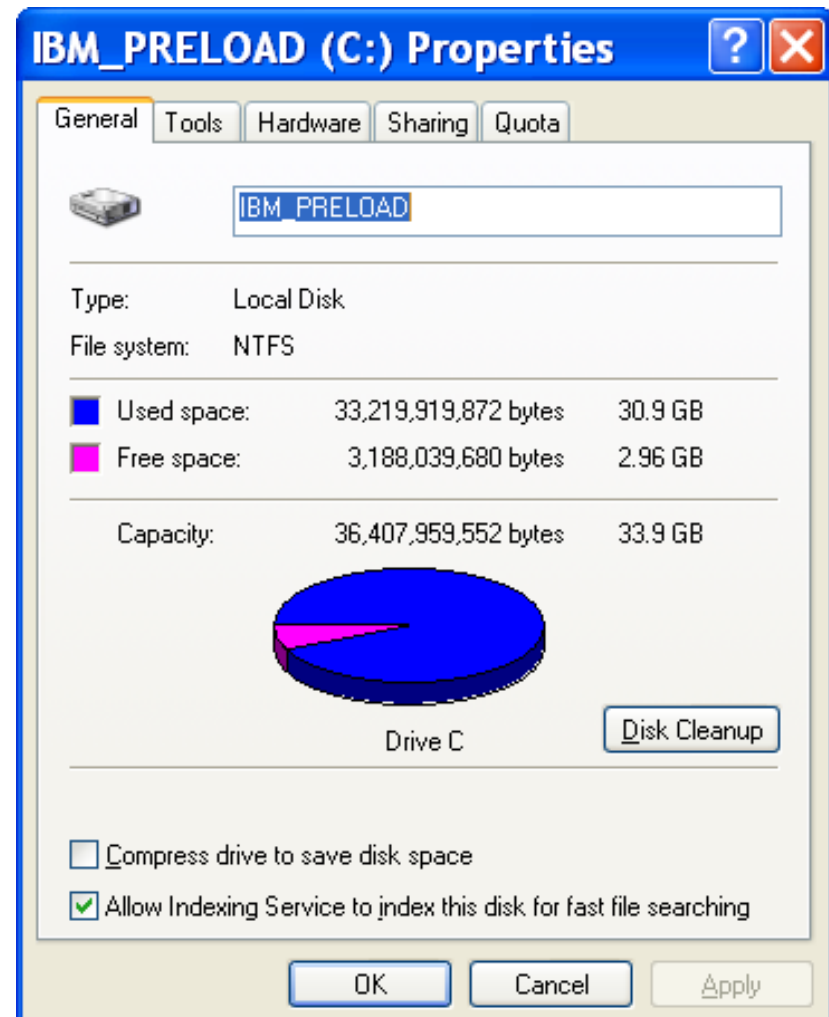
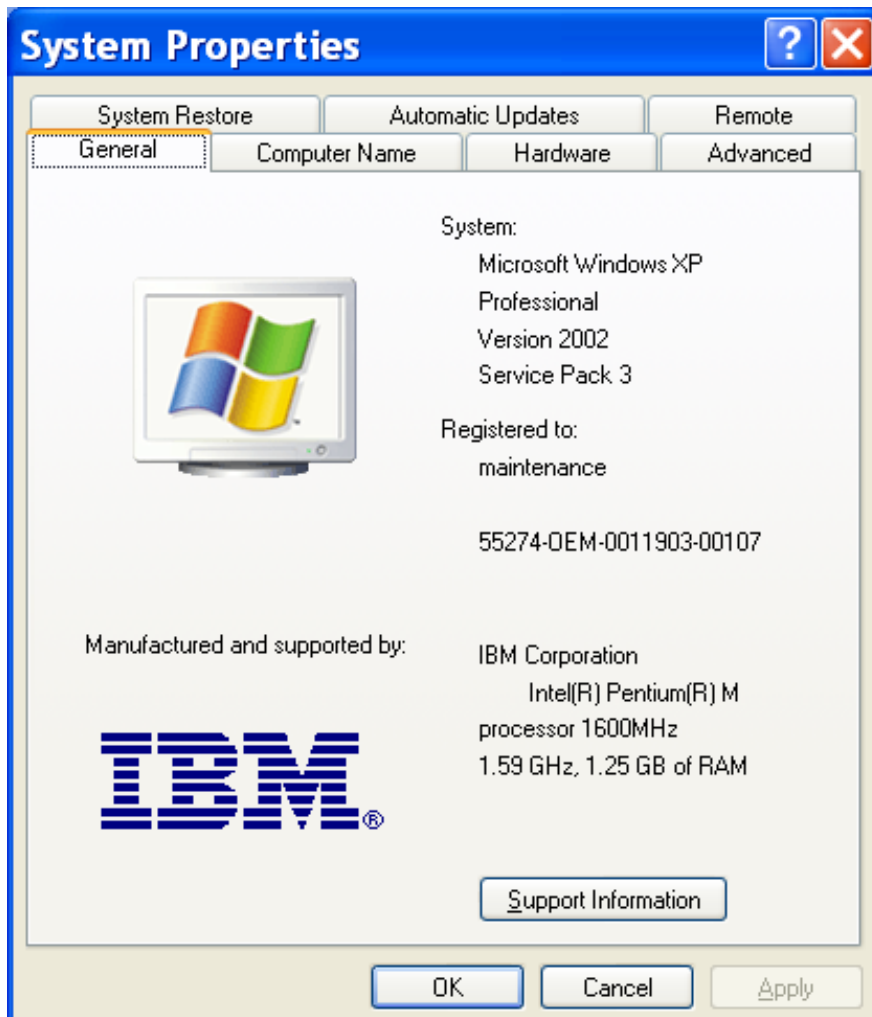
```
while(! IS.eof( ))  
{  
    IS.read(reinterpret_cast< char *>(&c),  
            sizeof(c)); // Read from cache  
    // process client record  
}  
IS.close();  
// Display results
```

Random read

```
while( condition )  
{  
    record = int((N-2.)*double(rand())/RAND_MAX)  
    IS.seekg(record*sizeof(c));  
    IS.read(reinterpret_cast< char *>(&c), sizeof(c));  
    // Process client record  
}  
IS.close( );
```

Experiments with a laptop computer

IBM T41, 1.25 GB, Pentium M, Windows XP



IBM T41 MS VCPP Debug mode Battery

```
C:\ "C:\Documents and Settings\jozo\Desk... - [X]
Sequential binary file DiskMark.dat created
-----
Time assigned for making file      = 10 sec
Time used for making file         = 10.014 sec
Time difference (copy to disk)    = 0.014 sec
Physical time reported by time()  = 10 sec
Number of records created         = 106087
File size [megabytes written]     = 6.47504 MB
Checksum (sum of all balances)    = 477388
Effective sequential write speed  = 0.646598 MB/sec
-----

Sequential read for the binary file DiskMark.dat
-----
Time used for reading the file     = 8.302 sec
Physical time reported by time()   = 8 sec
Number of records read/processed   = 106088
File size [megabytes processed]    = 6.4751 MB
Checksum (sum of all balances)     = 477395
Effective sequential read speed    = 0.779944 MB/sec
-----

Random read from binary file DiskMark.dat
-----
Time assigned for reading file     = 10 sec
Time used for reading file         = 10.004 sec
Time difference                    = 0.004 sec
Physical time reported by time()   = 10 sec
Number of records processed        = 104478
Random accesses per second         = 10443.6 [1/sec]
Megabytes processed                = 6.37683 MB
Checksum (sum of all balances)     = 471325
Effective random read speed        = 0.637428 MB/sec
-----

=====
DiskMark = 0.682205 MB/sec
=====

Press any key to continue . . .
```

IBM T41
MS VCPP
Debug mode
AC Power

```
"C:\Documents and Settings\jozo\Desktop..."
Sequential binary file DiskMark.dat created
-----
Time assigned for making file      = 10 sec
Time used for making file          = 10.004 sec
Time difference (copy to disk)     = 0.004 sec
Physical time reported by time()   = 10 sec
Number of records created          = 280028
File size [megabytes written]      = 17.0916 MB
Checksum (sum of all balances)     = 1260126
Effective sequential write speed    = 1.70847 MB/sec
-----

Sequential read for the binary file DiskMark.dat
-----
Time used for reading the file     = 7.991 sec
Physical time reported by time()   = 8 sec
Number of records read/processed   = 280029
File size [megabytes processed]    = 17.0916 MB
Checksum (sum of all balances)     = 1260134
Effective sequential read speed     = 2.13886 MB/sec
-----

Random read from binary file DiskMark.dat
-----
Time assigned for reading file     = 10 sec
Time used for reading file         = 10.004 sec
Time difference                     = 0.004 sec
Physical time reported by time()   = 10 sec
Number of records processed        = 271897
Random accesses per second         = 27178.8 [1/sec]
Megabytes processed                = 16.5953 MB
Checksum (sum of all balances)     = 1222888
Effective random read speed        = 1.65886 MB/sec
-----

=====
DiskMark = 1.81194 MB/sec
=====

Press any key to continue . . .
```

IBM T41 MS VCPP Release mode Battery

```
"C:\Documents and Settings\jozo\Desktop..."
Sequential binary file DiskMark.dat created
-----
Time assigned for making file      = 10 sec
Time used for making file          = 13.199 sec
Time difference (copy to disk)    = 3.199 sec
Physical time reported by time()  = 13 sec
Number of records created         = 904961
File size [megabytes written]     = 55.2344 MB
Checksum (sum of all balances)    = 4072321
Effective sequential write speed  = 4.18474 MB/sec
-----

Sequential read for the binary file DiskMark.dat
-----
Time used for reading the file     = 3.394 sec
Physical time reported by time()   = 3 sec
Number of records read/processed   = 904962
File size [megabytes processed]    = 55.2345 MB
Checksum (sum of all balances)     = 4072322
Effective sequential read speed    = 16.2742 MB/sec
-----

Random read from binary file DiskMark.dat
-----
Time assigned for reading file     = 10 sec
Time used for reading file         = 10.005 sec
Time difference                    = 0.005 sec
Physical time reported by time()   = 10 sec
Number of records processed        = 476724
Random accesses per second         = 47648.6 [1/sec]
Megabytes processed                = 29.0969 MB
Checksum (sum of all balances)     = 2143878
Effective random read speed        = 2.90824 MB/sec
-----

=====
DiskMark = 4.6565 MB/sec
=====

Press any key to continue . . .
```


IBM T41
MS VCPP
Release mode
AC Power

```
"C:\Documents and Settings\jozo\Desktop..."
Sequential binary file DiskMark.dat created
-----
Time assigned for making file      = 10 sec
Time used for making file         = 12.497 sec
Time difference (copy to disk)    = 2.497 sec
Physical time reported by time()  = 12 sec
Number of records created         = 855187
File size [megabytes written]     = 52.1965 MB
Checksum (sum of all balances)    = 3848338
Effective sequential write speed   = 4.17672 MB/sec
-----

Sequential read for the binary file DiskMark.dat
-----
Time used for reading the file     = 1.352 sec
Physical time reported by time()   = 2 sec
Number of records read/processed   = 855188
File size [megabytes processed]    = 52.1965 MB
Checksum (sum of all balances)     = 3848345
Effective sequential read speed    = 38.6069 MB/sec
-----

Random read from binary file DiskMark.dat
-----
Time assigned for reading file     = 10 sec
Time used for reading file         = 10.005 sec
Time difference                    = 0.005 sec
Physical time reported by time()   = 10 sec
Number of records processed        = 1111880
Random accesses per second         = 111132 [1/sec]
Megabytes processed                = 67.8638 MB
Checksum (sum of all balances)     = 5002298
Effective random read speed        = 6.78299 MB/sec
-----

=====
DiskMark = 7.26828 MB/sec
=====

Press any key to continue . . .
```

IBM T41

Dev C++

No optimize

AC Power

Note: Experiments with DEV C++ compiler showed no effects of optimization. The default no optimize version generated the best results.

Individual runs generate results that can differ for 10% depending on the available memory.

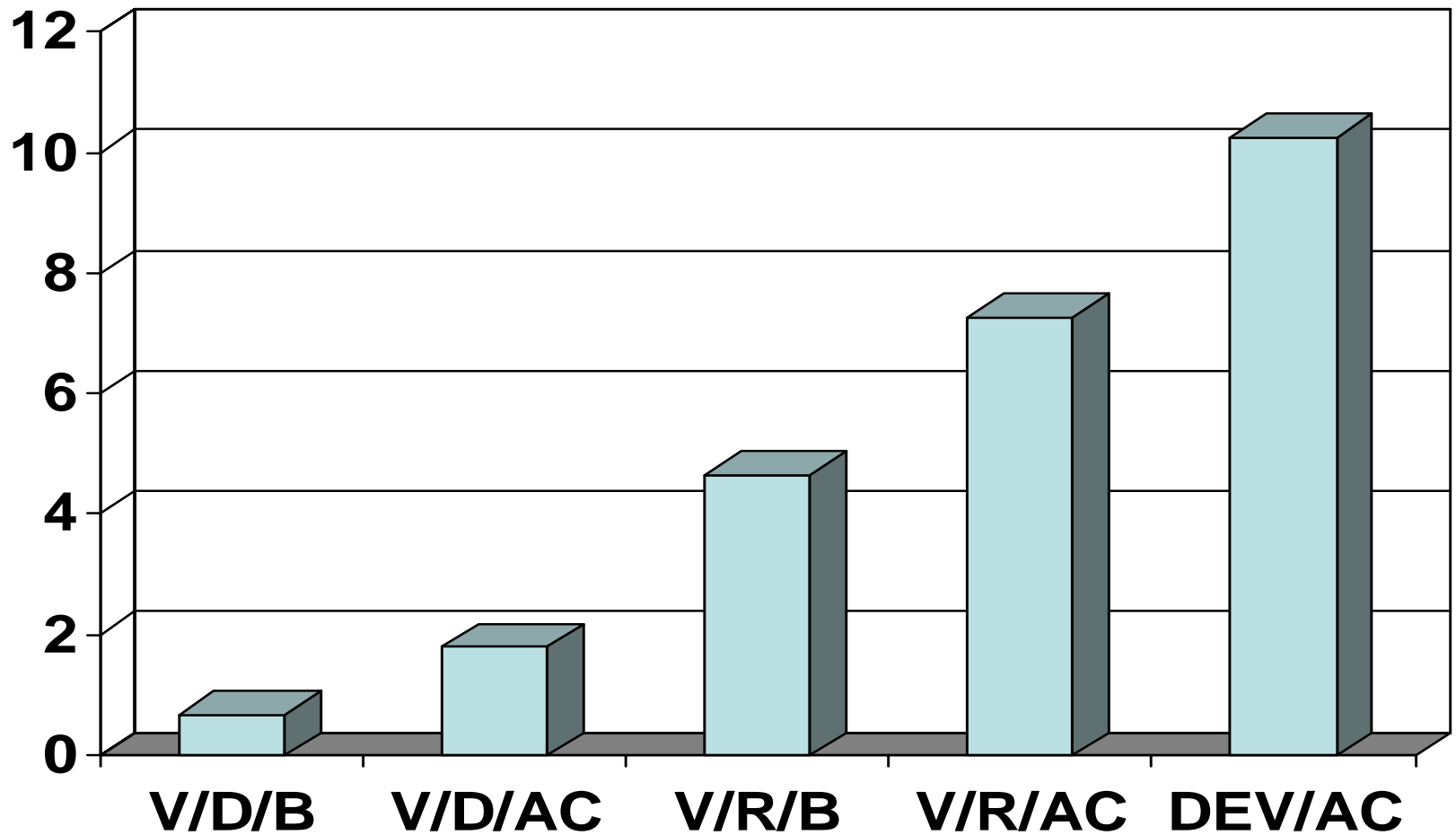
```
C:\Documents and Settings\jozo\Des...
Sequential binary file DiskMark.dat created
-----
Time assigned for making file      = 10 sec
Time used for making file         = 13.038 sec
Time difference (copy to disk)    = 3.038 sec
Physical time reported by time()  = 13 sec
Number of records created         = 961544
File size [megabytes written]     = 58.688 MB
Checksum (sum of all balances)    = 4326940
Effective sequential write speed  = 4.5013 MB/sec
-----

Sequential read for the binary file DiskMark.dat
-----
Time used for reading the file     = 1.002 sec
Physical time reported by time()   = 1 sec
Number of records read/processed  = 961545
File size [megabytes processed]    = 58.688 MB
Checksum (sum of all balances)     = 4326944
Effective sequential read speed    = 58.5709 MB/sec
-----

Random read from binary file DiskMark.dat
-----
Time assigned for reading file     = 10 sec
Time used for reading file         = 10.004 sec
Time difference                    = 0.004 sec
Physical time reported by time()   = 10 sec
Total number of records in file    = 961544
Number of records processed        = 3075653
Mean of the accessed record (50%) = 50.0259 %
Coefficient of variation (57.74%) = 57.6906 %
Random accesses per second         = 307442 [1/sec]
Megabytes processed                = 187.723 MB
Checksum (sum of all balances)     = 13850572
Effective random read speed        = 18.7648 MB/sec
-----

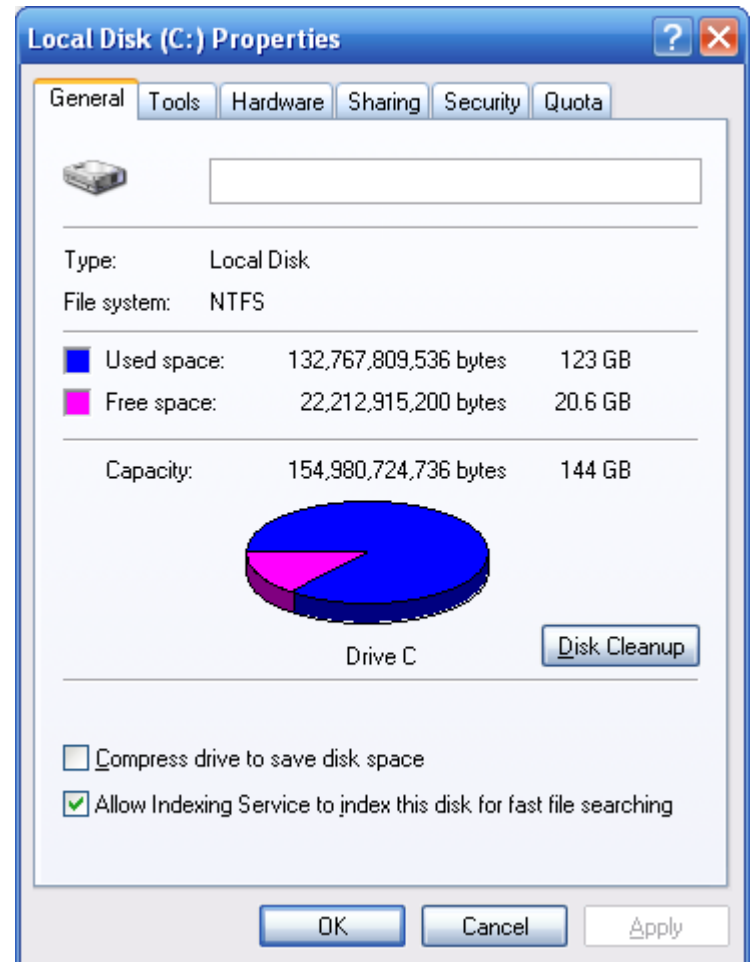
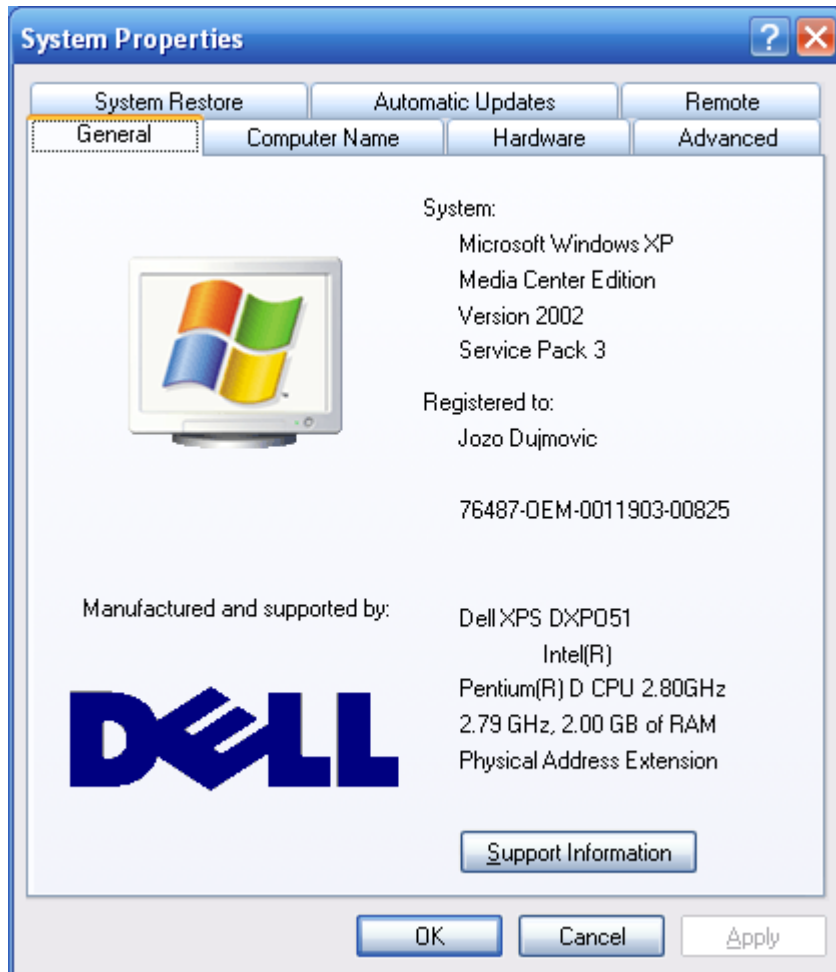
=====
DiskMark = 10.2556 MB/sec
=====
```

DiskMark Summary for IBM T41



Experiments with a desktop computer

Dell XPS 400, 2GB, 2 cores, Windows XP



Dell XPS 400 – DEV C++

```
C:\CentralFiles\Jozo\W Y DOCUMENTS\CLAS ... - □ X

Sequential binary file DiskMark.dat created

Time assigned for making file      = 80 sec
Time used for making file          = 84.687 sec
Time difference (copy to disk)     = 4.687 sec
Physical time reported by time()   = 85 sec
Number of records created          = 15196680
File size [megabytes written]      = 927.532 MB
Checksum (sum of all balances)     = 68385060
Effective sequential write speed    = 10.9525 MB/sec

Sequential read for the binary file DiskMark.dat

Time used for reading the file     = 9.656 sec
Physical time reported by time()   = 10 sec
Number of records read/processed   = 15196681
File size [megabytes processed]    = 927.532 MB
Checksum (sum of all balances)     = 68385060
Effective sequential read speed     = 96.0576 MB/sec

Random read from binary file DiskMark.dat

Time assigned for reading file     = 80 sec
Time used for reading file         = 80.016 sec
Time difference                    = 0.016 sec
Physical time reported by time()   = 80 sec
Total number of records in file    = 15196680
Number of records processed        = 5783696
Mean of the accessed record (50%) = 50.0124 %
Coefficient of variation (57.74%) = 57.7257 %
Random accesses per second         = 72281.7 [1/sec]
Megabytes processed                = 353.009 MB
Checksum (sum of all balances)     = 26026954
Effective random read speed        = 4.41173 MB/sec

=====
DiskMark = 9.13568 MB/sec
=====
```

```
C:\CentralFiles\Jozo\W Y DOCUMENTS\CLAS ... - □ X

Sequential binary file DiskMark.dat created

Time assigned for making file      = 40 sec
Time used for making file          = 44.766 sec
Time difference (copy to disk)     = 4.766 sec
Physical time reported by time()   = 44 sec
Number of records created          = 14243848
File size [megabytes written]      = 869.375 MB
Checksum (sum of all balances)     = 64097316
Effective sequential write speed    = 19.4204 MB/sec

Sequential read for the binary file DiskMark.dat

Time used for reading the file     = 9.187 sec
Physical time reported by time()   = 10 sec
Number of records read/processed   = 14243849
File size [megabytes processed]    = 869.376 MB
Checksum (sum of all balances)     = 64097324
Effective sequential read speed     = 94.6311 MB/sec

Random read from binary file DiskMark.dat

Time assigned for reading file     = 40 sec
Time used for reading file         = 40.829 sec
Time difference                    = 0.829 sec
Physical time reported by time()   = 40 sec
Total number of records in file    = 14243848
Number of records processed        = 2983846
Mean of the accessed record (50%) = 50.0222 %
Coefficient of variation (57.74%) = 57.6954 %
Random accesses per second         = 73081.5 [1/sec]
Megabytes processed                = 182.12 MB
Checksum (sum of all balances)     = 13430984
Effective random read speed        = 4.46054 MB/sec

=====
DiskMark = 10.4804 MB/sec
=====
```

Dell XPS 400 – DEV C++

```
C:\CentralFiles\Jozo\W Y DOCUMENTS\CLAS ... - □ X

Sequential binary file DiskMark.dat created

Time assigned for making file      = 20 sec
Time used for making file          = 24.406 sec
Time difference (copy to disk)     = 4.406 sec
Physical time reported by time()   = 24 sec
Number of records created          = 8467896
File size [megabytes written]      = 516.839 MB
Checksum (sum of all balances)     = 38105526
Effective sequential write speed    = 21.1767 MB/sec

Sequential read for the binary file DiskMark.dat

Time used for reading the file     = 6.094 sec
Physical time reported by time()   = 6 sec
Number of records read/processed   = 8467897
File size [megabytes processed]    = 516.839 MB
Checksum (sum of all balances)     = 38105532
Effective sequential read speed     = 84.8112 MB/sec

Random read from binary file DiskMark.dat

Time assigned for reading file     = 20 sec
Time used for reading file         = 20.531 sec
Time difference                    = 0.531 sec
Physical time reported by time()   = 21 sec
Total number of records in file    = 8467896
Number of records processed        = 1916905
Mean of the accessed record (50%) = 50.031 %
Coefficient of variation (57.74%) = 57.6859 %
Random accesses per second         = 93366.4 [1/sec]
Megabytes processed                = 116.999 MB
Checksum (sum of all balances)     = 8623625
Effective random read speed        = 5.69863 MB/sec

=====
DiskMark = 12.7935 MB/sec
=====
```

```
C:\CentralFiles\Jozo\W Y DOCUMENTS\CLAS ... - □ X

Sequential binary file DiskMark.dat created

Time assigned for making file      = 10 sec
Time used for making file          = 14.218 sec
Time difference (copy to disk)     = 4.218 sec
Physical time reported by time()   = 14 sec
Number of records created          = 4424144
File size [megabytes written]      = 270.028 MB
Checksum (sum of all balances)     = 19908640
Effective sequential write speed    = 18.992 MB/sec

Sequential read for the binary file DiskMark.dat

Time used for reading the file     = 3.063 sec
Physical time reported by time()   = 3 sec
Number of records read/processed   = 4424145
File size [megabytes processed]    = 270.028 MB
Checksum (sum of all balances)     = 19908644
Effective sequential read speed     = 88.1581 MB/sec

Random read from binary file DiskMark.dat

Time assigned for reading file     = 10 sec
Time used for reading file         = 10.156 sec
Time difference                    = 0.156 sec
Physical time reported by time()   = 11 sec
Total number of records in file    = 4424144
Number of records processed        = 1401874
Mean of the accessed record (50%) = 50.0229 %
Coefficient of variation (57.74%) = 57.6984 %
Random accesses per second         = 138034 [1/sec]
Megabytes processed                = 85.5636 MB
Checksum (sum of all balances)     = 6305662
Effective random read speed        = 8.42493 MB/sec

=====
DiskMark = 16.4211 MB/sec
=====
```

Dell XPS 400 – DEV C++

```
C:\CentralFiles\Jozo\W Y DOCUMENTS\CLAS... - □ X

Sequential binary file DiskMark.dat created

Time assigned for making file      = 5 sec
Time used for making file          = 5.641 sec
Time difference (copy to disk)     = 0.641 sec
Physical time reported by time()   = 6 sec
Number of records created          = 1959432
File size [megabytes written]      = 119.594 MB
Checksum (sum of all balances)     = 8817438
Effective sequential write speed    = 21.2009 MB/sec

Sequential read for the binary file DiskMark.dat

Time used for reading the file     = 1.281 sec
Physical time reported by time()   = 1 sec
Number of records read/processed   = 1959433
File size [megabytes processed]    = 119.594 MB
Checksum (sum of all balances)     = 8817440
Effective sequential read speed     = 93.3601 MB/sec

Random read from binary file DiskMark.dat

Time assigned for reading file     = 5 sec
Time used for reading file         = 5.032 sec
Time difference                    = 0.032 sec
Physical time reported by time()   = 5 sec
Total number of records in file    = 1959432
Number of records processed        = 840658
Mean of the accessed record (50%) = 50.0231 %
Coefficient of variation (57.74%) = 57.6771 %
Random accesses per second         = 167062 [1/sec]
Megabytes processed                = 51.3097 MB
Checksum (sum of all balances)     = 3784859
Effective random read speed        = 10.1967 MB/sec

=====
DiskMark = 19.2369 MB/sec
=====
```

```
C:\CentralFiles\Jozo\W Y DOCUMENTS\CLAS... - □ X

Sequential binary file DiskMark.dat created

Time assigned for making file      = 2.5 sec
Time used for making file          = 2.516 sec
Time difference (copy to disk)     = 0.016 sec
Physical time reported by time()   = 3 sec
Number of records created          = 1109576
File size [megabytes written]      = 67.7231 MB
Checksum (sum of all balances)     = 4993086
Effective sequential write speed    = 26.917 MB/sec

Sequential read for the binary file DiskMark.dat

Time used for reading the file     = 0.75 sec
Physical time reported by time()   = 1 sec
Number of records read/processed   = 1109577
File size [megabytes processed]    = 67.7232 MB
Checksum (sum of all balances)     = 4993092
Effective sequential read speed     = 90.2976 MB/sec

Random read from binary file DiskMark.dat

Time assigned for reading file     = 2.5 sec
Time used for reading file         = 2.5 sec
Time difference                    = 4.44089e-016 se
Physical time reported by time()   = 2 sec
Total number of records in file    = 1109576
Number of records processed        = 428908
Mean of the accessed record (50%) = 50.0335 %
Coefficient of variation (57.74%) = 57.6224 %
Random accesses per second         = 171563 [1/sec]
Megabytes processed                = 26.1785 MB
Checksum (sum of all balances)     = 1931152
Effective random read speed        = 10.4714 MB/sec

=====
DiskMark = 20.8733 MB/sec
=====
```

Dell XPS 400 – DEV C++

```
C:\CentralFiles\Jozo\W Y DOCUMENTS\CLAS... - □ X
Sequential binary file DiskMark.dat created
Time assigned for making file      = 1 sec
Time used for making file          = 1 sec
Time difference (copy to disk)     = -1.11022e-016 se
Physical time reported by time()   = 1 sec
Number of records created          = 428160
File size [megabytes written]      = 26.1328 MB
Checksum (sum of all balances)     = 1926720
Effective sequential write speed    = 26.1328 MB/sec

Sequential read for the binary file DiskMark.dat
Time used for reading the file     = 0.25 sec
Physical time reported by time()   = 0 sec
Number of records read/processed   = 428161
File size [megabytes processed]    = 26.1329 MB
Checksum (sum of all balances)     = 1926720
Effective sequential read speed     = 104.531 MB/sec

Random read from binary file DiskMark.dat
Time assigned for reading file     = 1 sec
Time used for reading file         = 1 sec
Time difference                    = 2.22045e-016 sec
Physical time reported by time()   = 1 sec
Total number of records in file    = 428160
Number of records processed        = 178555
Mean of the accessed record (50%) = 50.0471 %
Coefficient of variation (57.74%) = 57.5929 %
Random accesses per second         = 178555 [1/sec]
Megabytes processed                = 10.8981 MB
Checksum (sum of all balances)     = 805508
Effective random read speed        = 10.8981 MB/sec

=====
DiskMark = 21.4913 MB/sec
=====
```

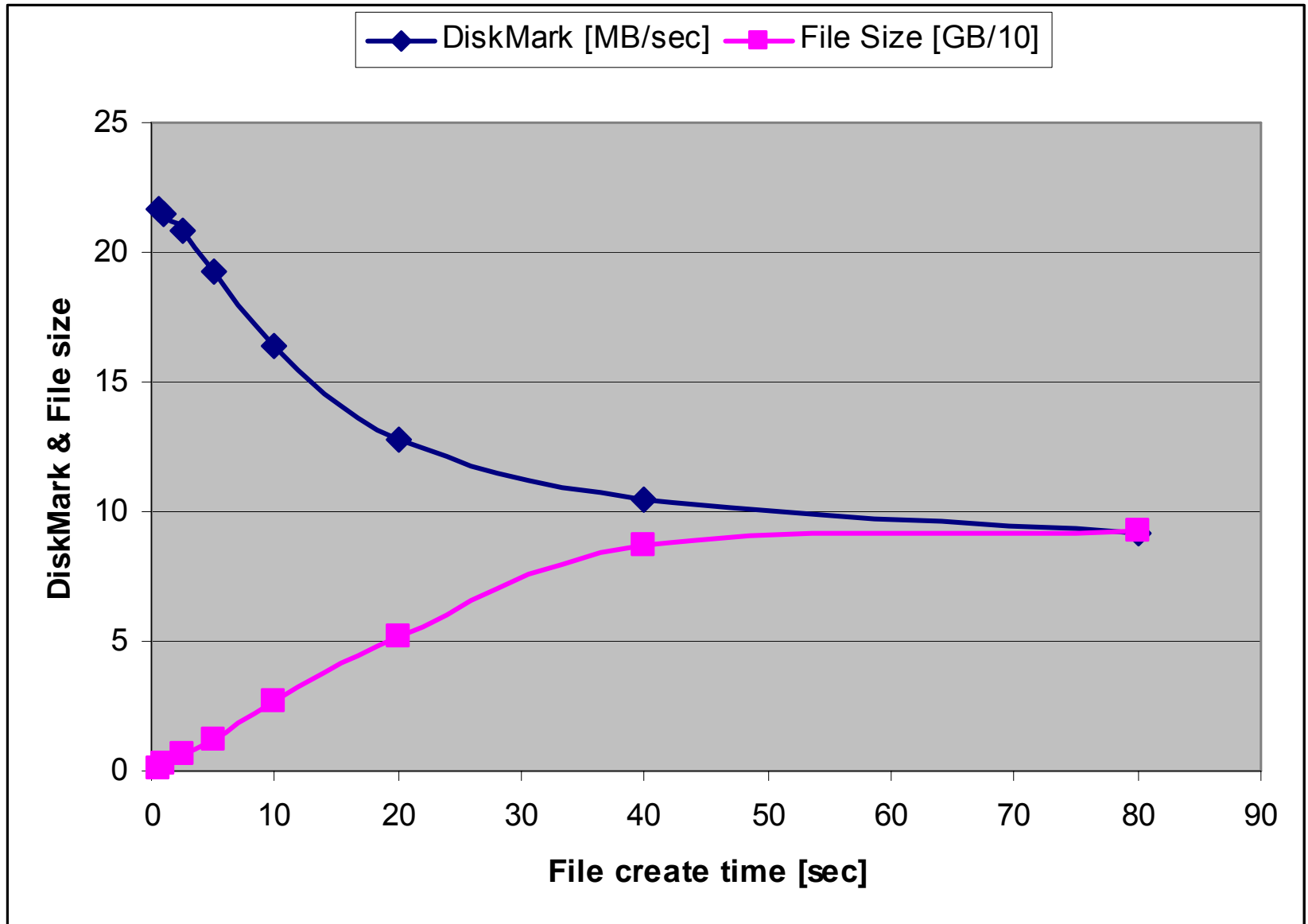
```
C:\CentralFiles\Jozo\W Y DOCUMENTS\CLAS... - □ X
Sequential binary file DiskMark.dat created
Time assigned for making file      = 0.5 sec
Time used for making file          = 0.5 sec
Time difference (copy to disk)     = 0 sec
Physical time reported by time()   = 1 sec
Number of records created          = 212810
File size [megabytes written]      = 12.9889 MB
Checksum (sum of all balances)     = 957645
Effective sequential write speed    = 25.9778 MB/sec

Sequential read for the binary file DiskMark.dat
Time used for reading the file     = 0.125 sec
Physical time reported by time()   = 0 sec
Number of records read/processed   = 212811
File size [megabytes processed]    = 12.989 MB
Checksum (sum of all balances)     = 957645
Effective sequential read speed     = 103.912 MB/sec

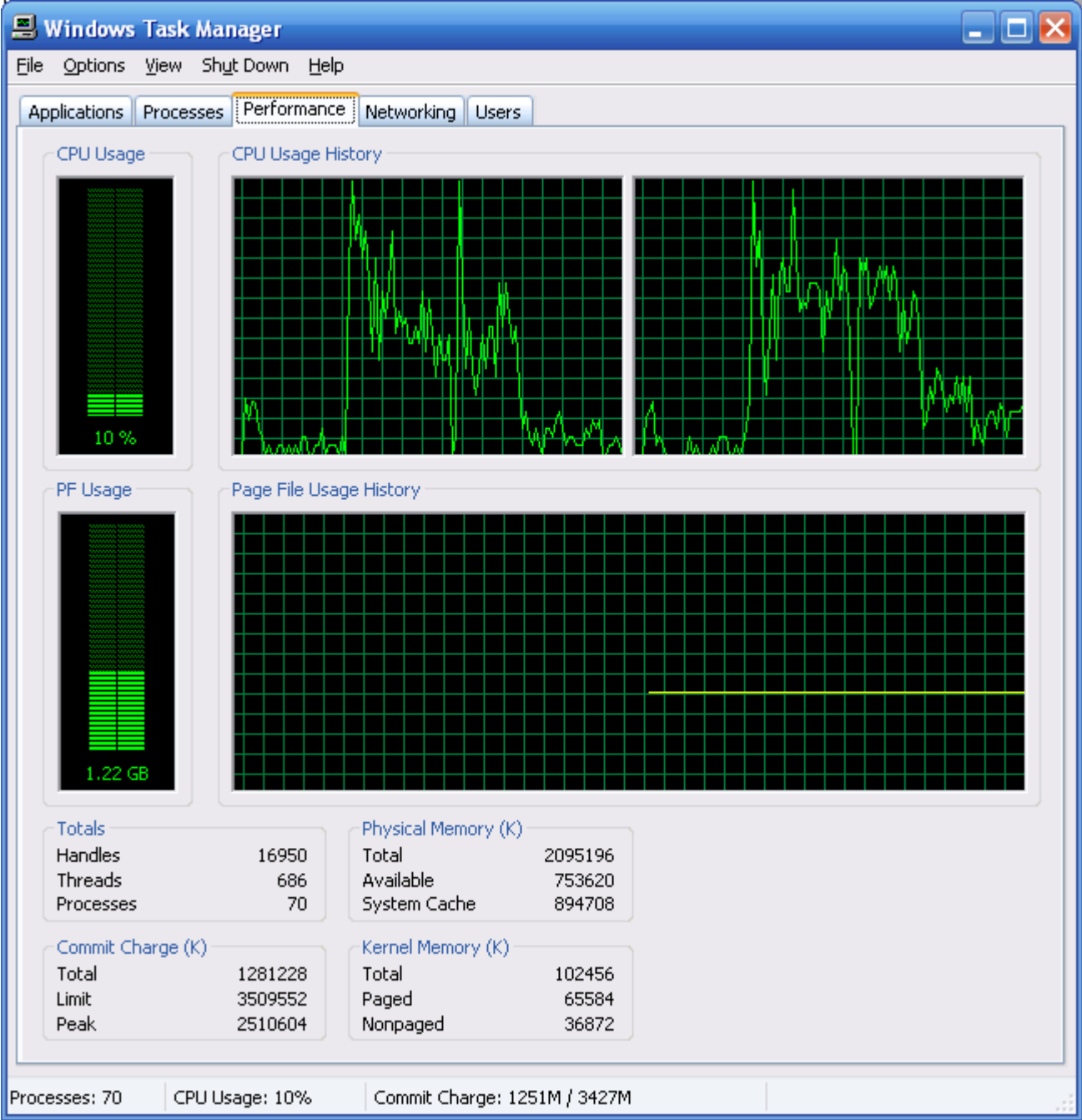
Random read from binary file DiskMark.dat
Time assigned for reading file     = 0.5 sec
Time used for reading file         = 0.5 sec
Time difference                    = 0 sec
Physical time reported by time()   = 0 sec
Total number of records in file    = 212810
Number of records processed        = 90671
Mean of the accessed record (50%) = 50.1398 %
Coefficient of variation (57.74%) = 50.5208 %
Random accesses per second         = 181342 [1/sec]
Megabytes processed                = 5.53412 MB
Checksum (sum of all balances)     = 408516
Effective random read speed        = 11.0682 MB/sec

=====
DiskMark = 21.6659 MB/sec
=====
```


Disk caching effects



DiskMark Benchmark
causes high utilization
of processor cores



Variations caused by big files

```
C:\CentralFiles\Jozo\W Y DOCUMENTS\CLAS ... - □ X

Sequential binary file DiskMark.dat created
-----
Time assigned for making file      = 100 sec
Time used for making file         = 100.281 sec
Time difference (copy to disk)    = 0.281 sec
Physical time reported by time()  = 100 sec
Number of records created         = 44788392
File size [megabytes written]     = 2733.67 MB
Checksum (sum of all balances)    = 201547758
Effective sequential write speed   = 27.2601 MB/sec
-----

Sequential read for the binary file DiskMark.dat
-----
Time used for reading the file     = 68.594 sec
Physical time reported by time()   = 69 sec
Number of records read/processed   = 44788393
File size [megabytes processed]    = 2733.67 MB
Checksum (sum of all balances)     = 201547760
Effective sequential read speed    = 39.8529 MB/sec
-----

Random read from binary file DiskMark.dat
-----
Time assigned for reading file     = 100 sec
Time used for reading file         = 100.015 sec
Time difference                    = 0.015 sec
Physical time reported by time()   = 100 sec
Total number of records in file    = 44788392
Number of records processed        = 13041
Mean of the accessed record (50%) = 50.3535 %
Coefficient of variation (57.74%) = 57.245 %
Random accesses per second         = 130.39 [1/sec]
Megabytes processed                = 0.795959 MB
Checksum (sum of all balances)     = 59171
Effective random read speed        = 0.0079584 MB/sec
-----

=====
DiskMark = 0.0238635 MB/sec
=====
```

```
C:\CentralFiles\Jozo\W Y DOCUMENTS\CLAS ... - □ X

Sequential binary file DiskMark.dat created
-----
Time assigned for making file      = 100 sec
Time used for making file         = 104.14 sec
Time difference (copy to disk)    = 4.14 sec
Physical time reported by time()  = 104 sec
Number of records created         = 19478728
File size [megabytes written]     = 1188.89 MB
Checksum (sum of all balances)    = 87654276
Effective sequential write speed   = 11.4162 MB/sec
-----

Sequential read for the binary file DiskMark.dat
-----
Time used for reading the file     = 12.219 sec
Physical time reported by time()   = 12 sec
Number of records read/processed   = 19478729
File size [megabytes processed]    = 1188.89 MB
Checksum (sum of all balances)     = 87654284
Effective sequential read speed    = 97.2982 MB/sec
-----

Random read from binary file DiskMark.dat
-----
Time assigned for reading file     = 100 sec
Time used for reading file         = 100.015 sec
Time difference                    = 0.015 sec
Physical time reported by time()   = 100 sec
Total number of records in file    = 19478728
Number of records processed        = 6336049
Mean of the accessed record (50%) = 50.0108 %
Coefficient of variation (57.74%) = 57.7259 %
Random accesses per second         = 63351 [1/sec]
Megabytes processed                = 386.722 MB
Checksum (sum of all balances)     = 28519798
Effective random read speed        = 3.86664 MB/sec
-----

=====
DiskMark = 8.41527 MB/sec
=====
```

Variations caused by big files

```
C:\CentralFiles\Jozo\W Y DOCUMENTS\CLASS ... - □ X

Sequential binary file DiskMark.dat created
-----
Time assigned for making file      = 100 sec
Time used for making file          = 105.047 sec
Time difference (copy to disk)     = 5.047 sec
Physical time reported by time()   = 105 sec
Number of records created          = 23908680
File size [megabytes written]      = 1459.27 MB
Checksum (sum of all balances)     = 107589060
Effective sequential write speed    = 13.8916 MB/sec
-----

Sequential read for the binary file DiskMark.dat
-----
Time used for reading the file     = 150.515 sec
Physical time reported by time()   = 150 sec
Number of records read/processed   = 23908681
File size [megabytes processed]    = 1459.27 MB
Checksum (sum of all balances)     = 107589060
Effective sequential read speed     = 9.69518 MB/sec
-----

Random read from binary file DiskMark.dat
-----
Time assigned for reading file     = 100 sec
Time used for reading file         = 100 sec
Time difference                    = 2.84217e-014 sec
Physical time reported by time()   = 100 sec
Total number of records in file    = 23908680
Number of records processed        = 122047
Mean of the accessed record (50%) = 50.0647 %
Coefficient of variation (57.74%) = 57.619 %
Random accesses per second         = 1220.47 [1/sec]
Megabytes processed                = 7.44916 MB
Checksum (sum of all balances)     = 550002
Effective random read speed        = 0.0744916 MB/sec
-----

=====
DiskMark = 0.220597 MB/sec
=====
```

```
C:\CentralFiles\Jozo\W Y DOCUMENTS\CLASS ... - □ X

Sequential binary file DiskMark.dat created
-----
Time assigned for making file      = 100 sec
Time used for making file          = 104.609 sec
Time difference (copy to disk)     = 4.609 sec
Physical time reported by time()   = 105 sec
Number of records created          = 23011336
File size [megabytes written]      = 1404.5 MB
Checksum (sum of all balances)     = 103551006
Effective sequential write speed    = 13.4262 MB/sec
-----

Sequential read for the binary file DiskMark.dat
-----
Time used for reading the file     = 204.5 sec
Physical time reported by time()   = 204 sec
Number of records read/processed   = 23011337
File size [megabytes processed]    = 1404.5 MB
Checksum (sum of all balances)     = 103551012
Effective sequential read speed     = 6.86797 MB/sec
-----

Random read from binary file DiskMark.dat
-----
Time assigned for reading file     = 100 sec
Time used for reading file         = 100 sec
Time difference                    = 0 sec
Physical time reported by time()   = 100 sec
Total number of records in file    = 23011336
Number of records processed        = 1586188
Mean of the accessed record (50%) = 50.0281 %
Coefficient of variation (57.74%) = 57.7063 %
Random accesses per second         = 15861.9 [1/sec]
Megabytes processed                = 96.8132 MB
Checksum (sum of all balances)     = 7133083
Effective random read speed        = 0.968132 MB/sec
-----

=====
DiskMark = 2.39425 MB/sec
=====
```

Conclusions

- Disk read/write benchmarks in the case of large main memory primarily depend on the file caching organization
- For small and medium files the measured performance is not significantly affected by performance of disk unit
- Disk unit performance is significant in cases of very large files or files that are not present in disk cache (e.g. virus scan)