

NCSA HDF Technical Report
IOzone: An Open Source File System Benchmark Tool

Christian M. Chilan

chilan@ncsa.uiuc.edu

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The need to determine whether a platform provides adequate performance for a specific application motivates a system evaluation that includes benchmarking. In this paper, we introduce IOzone as a tool for file system benchmarking and demonstrate its use in two Linux-based systems; one of which has local disk access while the other uses Network File System (NFS). We discuss the results from an architectural standpoint, noting the performance impact caused by the different levels in the memory hierarchy and by system configurations that optimize certain types of operations.

Introduction

When a system platform is being considered for purchase, it is generally evaluated in how well it suits the requirements of a specific application, e.g. databases, graphics. System optimizations can be implemented in hardware design and configuration settings. However, the target applications may change over time modifying the way system resources are accessed and used.

It may be the case that the platform or configuration does not provide an adequate performance for the new application mixture. Therefore, it is very important to determine how well balanced the system is under different configurations. This can be accomplished by using benchmark tools that analyze the performance of the system and its components by executing several tests.

IOzone is a file system benchmark tool. It carries out a wide range of I/O operations on the file system that allows identifying the strengths and weaknesses of the platform in consideration. IOzone also permits to visualize the dependence of the throughput with respect to the size of the files and records under testing. Cache effects can be clearly observed.

Main features of IOzone include:

- High portability: it builds on most UNIX and Windows platforms and it is 64-bit compatible.
- Multi-process measurement in SMP systems.
- Large file compatible to test cache effects on the entire memory hierarchy.
- Excel binary output for graph generation.
- Options for NFS testing that minimize client cache effects between tests.

The tests performed by IOzone are generally characterized by access (read, write), type (sequential, random, backwards, strided) and frequency (new vs. recently accessed files). As output, IOzone generates Excel binary files which show the throughput (KB/s) as a function of the file size (KB) and record size (KB). Recall that a record is a portion of data requested at the system call level. Latency graphs are also available for graphical output.

Throughput graphs generated with IOzone data usually show regions that appear to have zero magnitude. By default, IOzone does not run tests using records smaller than 64 KB for files of 32 MB in size or larger. Dense testing is possible but it consumes a substantial amount of time. Also note that performing tests with records larger than files is not feasible (Excel considers blank spaces as zeroes).

Preliminary benchmark on heping and eirene

In order to show the functionality of IOzone, we performed benchmark testing on the file systems of two systems: heping and eirene. Their configuration at the time of testing is the following:

	<i>Memory</i>	<i>Kernel buffer (dynamic)</i>	<i>CPU cache</i>	<i>Block size</i>	<i>File system</i>
Heping	6,165,744 KB	178,840 KB	512 KB	4 KB	Local
eirene	2,064,876 KB	313,288 KB	512 KB	8 KB	NFS

Linux (available in both systems) provides a read-ahead feature that improves the reading performance of files that are accessed sequentially by reading extra blocks from disk. This is accomplished by the use of a read-ahead window of variable size. The minimum and maximum sizes are defined by the files `min-readahead` and `max-readahead` located in `/proc/sys/vm`. Initially, the window starts with minimum size. After the system recognizes that the reading is performed sequentially, the window size is continually increased up to the maximum size. For heping and eirene, the minimum and maximum sizes are 3 and 31 blocks, respectively.

For the sequential read test on heping shown in Fig. 1, there is only a small dependence of the throughput with respect to the file size because of the large amount of memory available. Yet, the performance seems to be affected by the record size (>128 KB). This anomaly seems to be produced by the configuration of the read-ahead window that enhances sequential read operations of 124 KB in size.

For the same read test on eirene, Fig. 2 shows a slower response as expected because the file system is not local (NFS). The decrease in throughput with respect to record sizes can be ascribed to a system optimization similar to the one present in heping. There is also a reduction in performance with respect to file size, especially when the file size has exceeded the amount of memory available (2GB). In general, the performance at each memory hierarchy level is more differentiated in a NFS client, i.e. it spans high-speed processor cache to high-latency access through the network.

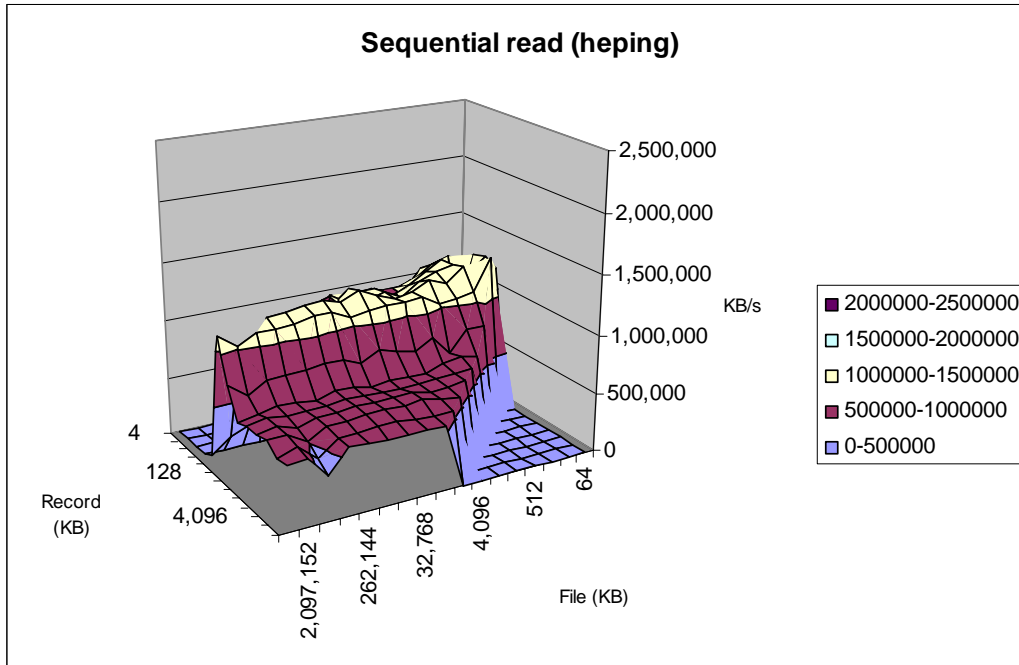


Figure 1 Sequential read test on heping

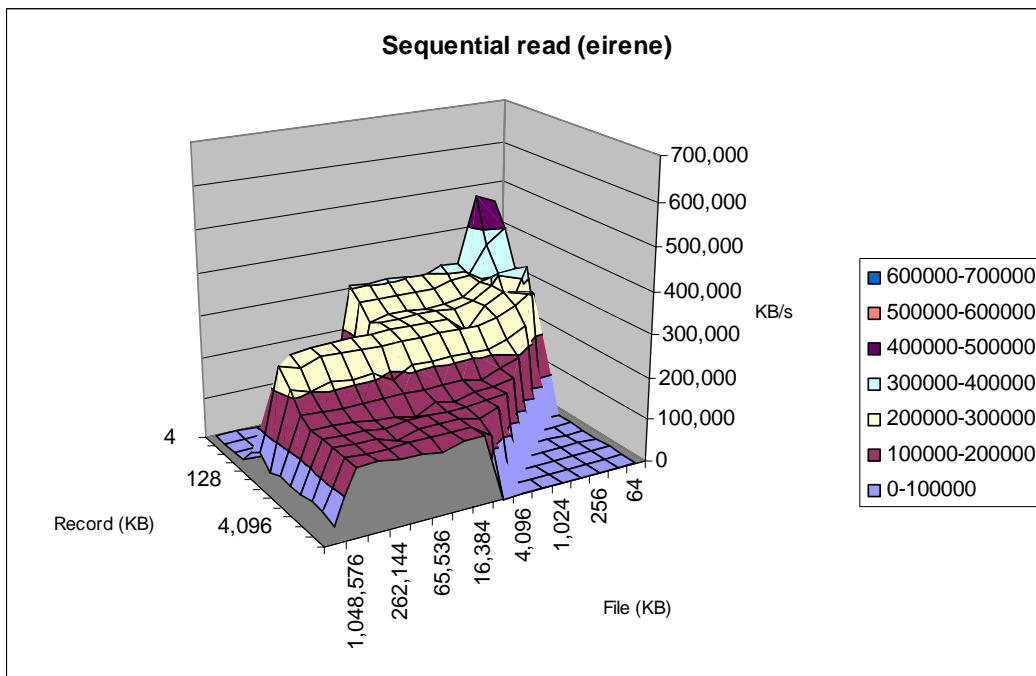


Figure 2 Sequential read test on eirene

During the reread test on heping, the performance is greatly increased as shown in Fig. 3. Note that the processor cache produces an overall increase in performance, especially for record access of less than 128 KB. As for file sizes, there is a peak in performance for files that can fit entirely in the processor cache.

For the same reread test on eirene shown in Fig. 4, the throughput is lower than heping (Fig. 3), but it is still higher than the read test on eirene shown in Fig. 2. The performance is mostly increased in the region where the records and files are smaller than the processor cache. Note that the difference in the peaks in Figs. 3 and 4 is produced by the distinction in processor speed (2.8 GHz vs. 0.55 GHz). The negligible improvement in performance for files greater than 512 KB in Figs. 2 and 4 is likely to be caused by the short life-time of the cached NFS blocks (3 seconds).

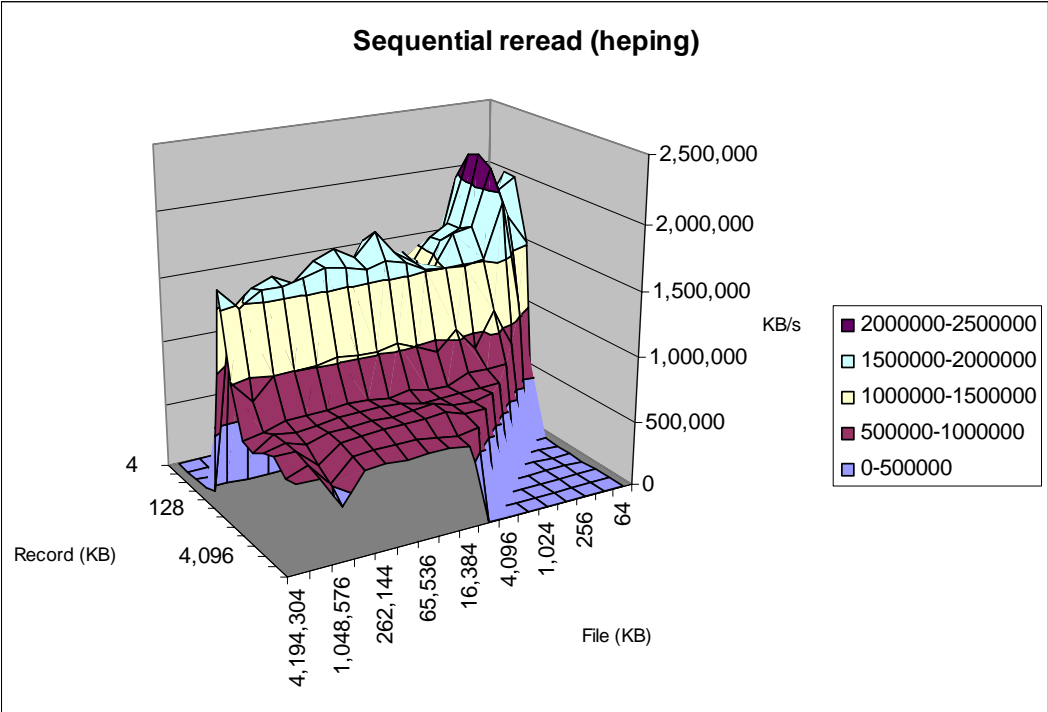


Figure 3 Sequential reread test on heping

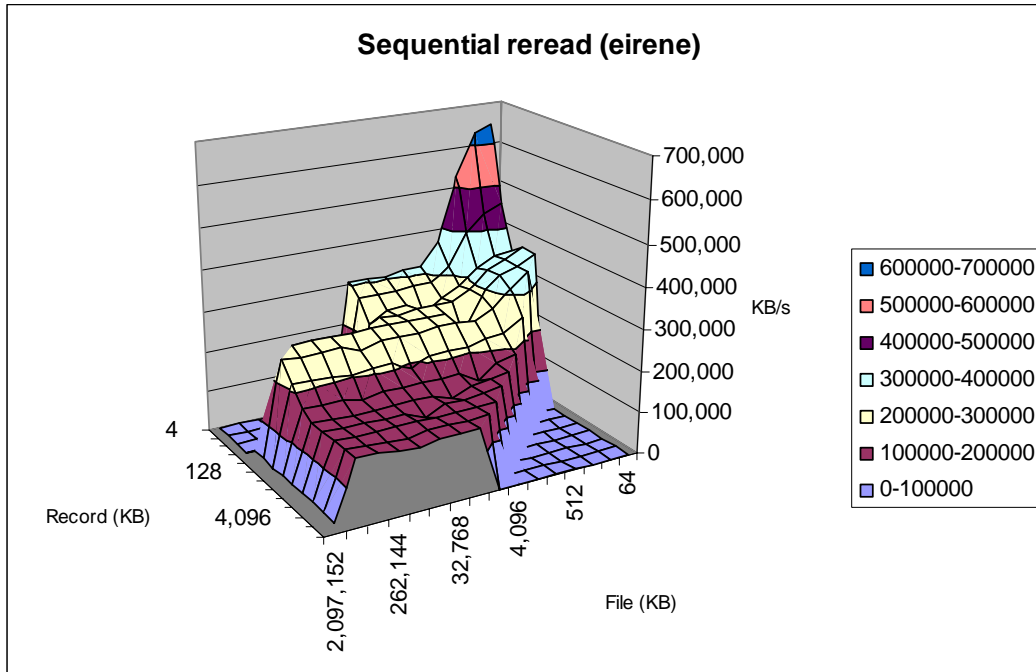


Figure 4 Sequential reread test on eirene

Encountered issues

IOzone only considers file sizes that are powers of two. In general, performing tests with large file sizes entails checking that they are supported by the system. It is also important to check for quota limits on disk space.

Thorough testing of NFS systems requires administration privileges to mount/unmount file systems between tests in order to clear the client cache.

Conclusions

We showed the functionality of IOzone by checking the output data from the tests on heping and eirene. Throughput variations due to levels in memory hierarchy were clearly shown.

As expected, heping has a better performance than eirene because of the locality of the data and system speed. The benchmark also showed that both systems have configurations that improve sequential file reading. Note that a complete performance evaluation of a platform requires analyzing the output of all the tests executed by IOzone.

References

The following documentation is available at www.iozone.org

- IOzone Filesystem Benchmark
- Analyzing NFS Client Performance with IOzone

Appendix

Output file for benchmark on heping.

```
./iozone -R -a -g 7G -b heping2.wks
```

The top row is records sizes, the left column is file sizes

Writer Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	123530	170655	131706	177797	182325								
128	123901	149894	155731	128264	139146	184726							
256	151566	177526	183775	190629	191904	189344	123905						
512	116468	139965	182793	185241	188792	168807	164369	172502					
1024	139375	156479	170553	172157	185402	171062	170838	157977	153040				
2048	135226	164168	171653	178755	180663	178289	174254	171166	164656	166099			
4096	149910	156742	167511	177847	180750	175695	172593	167210	169522	165461	169423		
8192	148518	163102	172579	174605	175519	168841	172416	160294	162898	167467	169683	169049	
16384	149018	156894	159909	162270	168139	163139	163944	161767	162447	162190	162465	159075	161394
32768	0	0	0	0	153354	174557	160623	161332	159316	167311	167764	148452	159810
65536	0	0	0	0	173534	174187	169202	166278	142950	164467	165897	166399	165292
131072	0	0	0	0	148571	162613	149425	155679	155039	144566	155130	155346	144433
262144	0	0	0	0	117355	58444	88184	58753	87618	57463	88536	89942	90438
524288	0	0	0	0	62475	60868	61101	60985	60565	61276	61070	60830	59264
1048576	0	0	0	0	51607	51732	53229	49483	53272	49353	52552	51949	51052
2097152	0	0	0	0	48432	51165	49910	50254	50098	49784	50103	49822	49484
4194304	0	0	0	0	46631	48532	48440	48416	48359	48623	48579	48185	48775

Re-writer Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	444129	240692	634289	432220	652935								
128	317600	556688	600616	582023	433811	776164							
256	446692	567731	627578	693898	716879	673816	481235						
512	321997	450750	588442	629797	605191	560199	494702	467127					
1024	369941	454716	545585	540647	595344	536138	481629	490662	466103				
2048	367954	454714	518748	426844	543372	566853	534462	473638	460633	489589			
4096	376370	460584	466358	538450	518605	558882	514440	451846	485473	475454	480129		
8192	367929	432795	485363	439487	520492	521685	471429	447845	461026	457833	458937	456378	
16384	358260	404263	450989	470006	489719	495614	472080	421064	404044	453249	430818	440502	453059
32768	0	0	0	0	521252	504891	460463	434848	438080	471129	471366	454599	456785
65536	0	0	0	0	518149	527007	493813	468150	471373	467309	470787	467340	461508
131072	0	0	0	0	435495	383829	354759	339804	330913	346743	331511	343348	312841
262144	0	0	0	0	106349	104874	102261	103143	102146	103477	102256	79908	107280
524288	0	0	0	0	63811	64314	64444	65099	62682	62549	63406	64574	60912
1048576	0	0	0	0	47064	50986	53247	49915	51738	51999	52920	50445	51334
2097152	0	0	0	0	47285	49760	49066	49012	49199	48915	49278	48896	48898
4194304	0	0	0	0	47142	50102	49150	49518	49266	49588	49437	49632	49717

Reader Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	971327	1105421	1207726	1233352	1184693								
128	983791	1175445	761789	1113661	799408	1349039							
256	1032445	1117513	1218494	1218957	1249224	1076039	833888						
512	882715	1029977	1130012	1179417	1130222	1047139	833923	643309					
1024	879042	975228	1037475	1123976	1189353	1029201	652278	681323	627810				
2048	932206	972936	974822	1012304	1107654	1127709	813033	650754	624771	630350			
4096	927309	989390	1063595	1087915	1079568	1101362	733267	596913	606993	600664	579673		
8192	917861	917152	1069047	1040526	1139348	1109258	761482	604128	603822	601949	599270	563256	
16384	914438	1013794	1043565	1184505	1219491	1099378	817073	606094	594809	635212	633150	560154	534497
32768	0	0	0	0	1149274	1068750	726434	591724	603507	617506	619280	573177	547309
65536	0	0	0	0	1192194	1147196	791219	624169	619034	615015	620694	558817	550185
131072	0	0	0	0	1177222	1150258	794645	624384	622953	621647	620635	585072	549565
262144	0	0	0	0	1146732	1112066	781882	583816	604747	607145	602322	577948	554939
524288	0	0	0	0	1140552	1098111	765964	605077	599193	600503	600482	575723	567018
1048576	0	0	0	0	250881	1097150	766524	605338	585762	560007	560701	445335	382399
2097152	0	0	0	0	191468	1023792	666890	579202	614687	602648	602139	584661	558118
4194304	0	0	0	0	65268	1135412	786188	545222	574448	583869	610959	523475	537095

Re-reader Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	1643962	1776230	1999598	1996555	1523375								
128	1600865	1231238	1472904	1913551	1752561	1122131							
256	1569857	1969238	2185942	2227140	2152791	1923238	853287						
512	1077986	1395196	1662180	1667271	1724076	1514810	1155483	780417					
1024	1217554	1446284	1582695	1597680	1695542	1484066	877549	778727	721153				
2048	1261950	1350132	1380887	1325554	1439170	1500361	1063959	776084	717614	731148			
4096	1212910	1299086	1465463	1555585	1517033	1518697	913285	710614	715216	702566	709263		
8192	1221779	1294764	1482719	1487283	1626974	1594371	991405	717464	706445	708522	712723	662884	
16384	1214526	1394256	1497479	1695005	1803986	1633977	1052955	739485	700378	758306	755861	642457	625752
32768	0	0	0	0	1638887	1599292	1020590	707810	734593	737553	735485	656527	648639
65536	0	0	0	0	1731278	1642303	1027596	738766	745429	730702	735632	686815	641754
131072	0	0	0	0	1672945	1662862	1036518	742167	737254	737134	736619	686424	641531
262144	0	0	0	0	1525467	1621415	1011650	729062	730501	721756	722114	684065	642743
524288	0	0	0	0	1611715	1578334	999675	721202	713263	714440	708058	677258	638031
1048576	0	0	0	0	1544749	1578123	993070	720247	685939	663007	572823	511009	416975
2097152	0	0	0	0	1410311	1476389	837045	666258	712832	713575	712957	687827	654134
4194304	0	0	0	0	51452	1640695	1015287	641938	618466	683258	721819	622605	657242

Random Read Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	790384	1232843	1049444	1944275	1452025								
128	1041437	412803	1911050	1879853	612271	1346516							
256	1242322	1741243	2133666	2557164	2226714	2391555	924561						
512	898100	1079979	1815837	1889195	1771696	1614859	1207777	714049					
1024	920048	1309571	1452333	1600009	1841955	1479768	842861	823202	720565				
2048	1018888	1207579	1361738	1529596	1526178	1645034	1061687	757149	732760	721396			
4096	976618	1117262	1358539	1556783	1557367	1582101	1025507	710235	713705	705111	714825		
8192	883609	982493	1307998	1267896	1636442	1543321	966391	720744	736028	707982	732084	642258	
16384	928216	1141336	1344832	1610375	1748942	1609118	1062578	756311	673297	758416	763645	648203	657567
32768	0	0	0	0	1587373	1411986	999999	726241	731739	740300	718896	683322	647538
65536	0	0	0	0	1666734	1605880	1003966	730630	729116	726032	740853	679728	639931
131072	0	0	0	0	1607555	1613470	1019713	742120	733836	730152	732957	686984	642320
262144	0	0	0	0	1577242	1573351	995738	731304	718236	718689	713872	683163	644034
524288	0	0	0	0	1567041	1542781	984364	718000	714139	717252	706512	672045	644527
1048576	0	0	0	0	1344195	1341287	977623	717631	685237	666053	655346	498589	435208
2097152	0	0	0	0	1369728	1432737	832835	667319	710928	720178	712990	686058	655024
4194304	0	0	0	0	188911	1605274	1009081	633396	536634	681402	722539	605457	651747

Random Write Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	429515	524332	645956	762654	652759								
128	426763	544741	673846	695929	830925	496348							
256	441354	583067	692107	839600	778223	876911	321619						
512	323844	415616	652186	670229	686308	552845	587811	409937					
1024	342018	470384	559552	581156	622520	543828	452686	443696	455514				
2048	337950	423393	497580	522304	538088	552634	528094	435383	459816	443759			
4096	338569	408989	480751	539937	526683	550313	479685	465353	454251	471892	428540		
8192	310657	348816	451450	454152	537819	532435	451103	427490	439273	426420	417680	393829	
16384	332583	388236	439319	476431	476530	454392	452396	426233	407218	441546	419456	408294	412873
32768	0	0	0	0	519878	477855	461417	435721	449319	443842	465514	426889	472515
65536	0	0	0	0	505016	512688	474547	446300	448602	448382	444166	464221	431816
131072	0	0	0	0	511346	500777	458340	433125	445877	439588	441891	427503	462967
262144	0	0	0	0	44098	63147	229023	253509	144724	217543	108613	111733	197630
524288	0	0	0	0	26552	38493	54298	58326	63291	64547	80226	72808	71100
1048576	0	0	0	0	19269	30293	40461	45132	48857	54947	56018	53559	54057
2097152	0	0	0	0	16866	24528	35263	40771	42968	43674	46984	50511	48783
4194304	0	0	0	0	12886	22826	30735	37085	43877	43356	44278	45337	50590

Backward Read Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	800678	1017548	1031990	1083905	1031289								
128	848228	573945	1131749	992490	1208676	1033201							
256	904296	1044999	1202194	1320341	1219470	1236401	844975						
512	639975	843464	1190616	1012070	1230544	1014077	948293	652298					
1024	862734	951704	1158369	1022981	1265788	1105690	712565	737796	661024				
2048	789529	966444	1101617	1168219	1263381	1191430	905815	650775	695655	608617			
4096	796282	925425	1099019	1188963	1138759	1193478	813011	654836	626785	652642	567632		
8192	813422	1004530	1041568	1161330	1257992	1223579	819698	640005	647542	608706	627929	550354	
16384	740483	955006	1062034	1239521	1326969	1222226	827432	669336	625866	686071	660750	632685	557962
32768	0	0	0	0	1235315	1142937	838549	656067	658137	647664	669334	590679	589884
65536	0	0	0	0	1303812	1256346	850189	658104	655287	660179	655104	630747	529541
131072	0	0	0	0	1270298	1267951	838662	651999	661007	657810	659873	613955	590257
262144	0	0	0	0	1269806	1239908	837732	648253	641495	646252	646451	619211	581112
524288	0	0	0	0	1241006	1199033	834245	641648	632648	639564	638022	604870	578689
1048576	0	0	0	0	277254	1102001	763481	645005	596572	521060	502522	476031	384404
2097152	0	0	0	0	1165775	1072714	747678	598489	639682	640750	619807	615698	592602
4194304	0	0	0	0	161881	1262027	850343	581801	438834	608842	647640	579033	573075

Record Rewrite Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	418168	492747	429547	310733	108862								
128	453743	392692	346802	331548	199981	185250							
256	514088	671999	748361	673777	493298	316440	142611						
512	423526	500472	844979	757440	594042	398170	281324	155911					
1024	535862	688137	907086	863403	827801	594640	354570	257486	160806				
2048	482118	682236	857597	946418	946351	781663	494091	348183	259208	164458			
4096	530495	774746	947714	1073385	1063898	975212	566065	417451	347471	257155	160256		
8192	531600	832012	984029	1088193	1272069	1035665	672410	463744	404022	323271	233717	158409	
16384	548236	734375	935005	1203470	1135023	914544	644225	488533	431760	408680	332899	247388	155626
32768	0	0	0	0	1338566	1121842	648179	487611	475373	447620	405143	310812	242661
65536	0	0	0	0	1202848	1259022	711482	502912	488819	475025	447622	394733	284237
131072	0	0	0	0	1361008	1308089	723179	531081	521586	510464	485174	440350	384351
262144	0	0	0	0	1204977	1242570	788571	508077	503666	498627	492888	460868	413567
524288	0	0	0	0	1358924	1284166	685881	505317	505360	501125	497906	453257	442830
1048576	0	0	0	0	1199210	1158920	570622	454917	445789	452737	370885	322736	275739
2097152	0	0	0	0	1336317	1084440	573890	501799	537816	521081	476750	490458	472507
4194304	0	0	0	0	1196504	1226980	717272	486341	338334	488343	515942	453436	461467

Stride Read Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	1066106	1559281	1824854	1597579	1144294								
128	977269	1706227	2067438	2169085	865302	1347333							
256	1070730	1354907	2636781	2752739	2722506	1938459	995954						
512	792426	982636	1454747	3064919	2496538	1896290	1204570	735637					
1024	987470	1151772	1444486	1399087	3030403	2694010	960517	720056	771707				
2048	952533	1048144	1280807	1422148	1534077	2904787	1274507	785899	759639	722889			
4096	944666	1173651	1346072	1489394	1447828	1526676	1274052	734065	732213	721133	706341		
8192	914693	1207190	1171631	1499247	1609113	1583012	899437	775308	769209	750668	700950	652485	
16384	888790	1174562	1313144	1585901	1712746	1680257	1054312	766470	722463	764324	723962	677304	654731
32768	0	0	0	0	1589128	1595474	1001986	726835	738684	727788	704159	654105	644544
65536	0	0	0	0	1679463	1621772	1014032	734132	738326	731869	702218	676284	652950
131072	0	0	0	0	1625677	1634170	1013908	744308	740319	734609	737150	675980	648085
262144	0	0	0	0	1624379	1585407	1001711	732129	717819	718996	719898	681286	648155
524288	0	0	0	0	1578772	1568667	994299	718218	722388	719335	709160	674605	665916
1048576	0	0	0	0	1563927	1277357	910663	684998	647626	642430	543869	424198	387694
2097152	0	0	0	0	1482868	1376422	905351	676439	711558	711658	712583	686968	653769
4194304	0	0	0	0	1572903	1612071	1016119	644104	517791	669617	734480	627757	583908

Fwrite Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	125997	117406	210544	279572	128507								
128	139281	148131	155335	215889	277653	187960							
256	161622	163785	187119	202840	227745	293597	147553						
512	125770	137782	177102	163782	182137	199681	255629	163010					
1024	151771	154732	176795	165351	161209	176308	180314	222270	171039				
2048	140872	150798	157030	166844	166803	176826	172901	177809	245357	169143			
4096	147918	159694	168920	175073	166051	171287	159830	151154	188416	239531	167876		
8192	147726	161050	161009	170442	172216	168244	156874	152573	161670	179566	228335	163219	
16384	122531	150925	156292	163763	164214	161247	147059	147907	151449	159860	177959	229596	164296
32768	0	0	0	0	169248	160284	150848	149135	155364	159304	167226	177519	237611
65536	0	0	0	0	168822	164599	153610	152539	130607	155353	158825	167198	184792
131072	0	0	0	0	159480	144267	140012	141391	142845	142946	145168	141693	151201
262144	0	0	0	0	81713	81957	83643	79734	89842	82735	85380	83043	91895
524288	0	0	0	0	64190	62833	62786	62569	62453	61494	55662	61550	61958
1048576	0	0	0	0	52196	47880	44854	40065	43803	47549	46840	46430	46807
2097152	0	0	0	0	49018	48518	48096	48639	47910	48836	48308	48610	48987
4194304	0	0	0	0	47352	47681	47943	47753	47541	47358	47801	47714	48250

Re-fwrite Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	418271	256919	674286	889594	444800								
128	318385	507970	587191	727065	1024647	770944							
256	427453	536565	621355	646389	725015	810238	543428						
512	284921	430995	549909	566339	570749	563275	742124	479898					
1024	344211	438157	480954	512243	504209	461468	456729	586858	458164				
2048	375784	413746	477273	541528	496234	501966	430166	437699	624000	486447			
4096	352583	408004	484165	524795	514567	477828	396357	413526	434727	610617	476224		
8192	351106	434890	420512	495013	494418	469106	385905	379242	389446	444371	570709	482078	
16384	338449	400038	446417	459091	439839	441437	345042	349644	359030	378925	426833	543038	415638
32768	0	0	0	0	493159	445865	374410	369574	375323	386972	408257	426783	572806
65536	0	0	0	0	489205	301655	384607	371260	370220	378167	388158	410050	452390
131072	0	0	0	0	373976	306696	291550	276315	281287	280864	283458	284314	308016
262144	0	0	0	0	92951	86082	86800	89370	93012	94432	92910	80784	106114
524288	0	0	0	0	66151	63857	63177	63825	63165	62901	59826	60272	60507
1048576	0	0	0	0	46001	47991	44732	38134	43932	47347	46748	46857	46767
2097152	0	0	0	0	48889	48658	48547	48648	48383	48194	48538	48820	48703
4194304	0	0	0	0	49616	48856	46593	49053	49054	48843	48760	49132	48638

Fread Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	770109	942041	1085255	1049290	1104270								
128	895501	985185	1015165	1103492	1346396	1184278							
256	996481	1031893	1127281	1142293	1224209	1053507	742246						
512	867678	1034406	1122856	1143118	1082214	975353	892135	632139					
1024	868515	992171	1081384	951668	1086971	1158461	815977	603428	592901				
2048	902645	1006344	1099267	1111869	1098688	1096936	819820	621566	615752	624214			
4096	797800	985309	1076486	1096633	1063884	1109093	752815	602786	603061	599617	606375		
8192	858246	1007496	1051750	1115018	1144310	1113344	745612	606364	602705	612028	615842	579559	
16384	891060	994711	1013540	1173391	1162636	1111692	805625	635928	630032	627692	619388	585035	547574
32768	0	0	0	0	1170702	1059461	712578	606792	618159	619245	606254	575542	557687
65536	0	0	0	0	1179192	1143198	793730	626275	617722	617262	624021	586084	547159
131072	0	0	0	0	1185850	1145574	797711	626407	622841	622654	619734	584474	547799
262144	0	0	0	0	1136613	1127864	768192	612899	611209	610434	608471	583131	553473
524288	0	0	0	0	1126035	1109679	765650	605253	600863	605406	588770	575373	553045
1048576	0	0	0	0	1128452	1009631	767207	593812	581862	497179	480853	463271	460559
2097152	0	0	0	0	1022454	988798	628622	574300	572333	564386	565565	565005	515119
4194304	0	0	0	0	1128740	1029677	738340	520486	550031	579284	487036	537949	455042

Re-fread Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	1726690	1640474	1561384	1643156	2070268								
128	908297	1562711	1754334	1936117	2975649	2673077							
256	1608975	1421926	2063965	2131767	2115281	1551165	850819						
512	1216365	1483806	1624978	1684547	1695615	1383499	1191017	801338					
1024	1044846	1432399	1501659	1416420	1640777	1646076	1102188	715133	703350				
2048	1152431	1434201	1517163	1588710	1568052	1608691	1079554	736421	718878	627833			
4096	1107652	1325556	1424250	1552683	1511386	1522677	979432	722520	704261	702578	712485		
8192	1188101	1406097	1403677	1602792	1627320	1601566	948592	714702	714271	718788	712967	679830	
16384	1164045	1413510	1425927	1759826	1707916	1677832	1050525	758134	753498	748706	732833	696332	648945
32768	0	0	0	0	1674907	1527500	968892	717512	738518	741141	715191	676732	652230
65536	0	0	0	0	1703297	1659517	1029776	743081	735301	731501	741407	691023	638073
131072	0	0	0	0	1678666	1650633	1034939	743064	736413	738433	739041	687216	639422
262144	0	0	0	0	1646881	1610112	1009426	728323	720340	720605	717135	683857	646847
524288	0	0	0	0	1623116	1589073	995637	719959	714537	728487	678901	676603	643204
1048576	0	0	0	0	1608102	1459836	996448	700155	686343	577368	547486	529425	526765
2097152	0	0	0	0	1375315	1382306	849363	710583	704452	701750	707248	679325	654110
4194304	0	0	0	0	1542440	1475216	1003667	640080	695439	718914	582551	656625	555624

Output file for benchmark on eirene.

./iozone -R -a -g 2304M -b eirene2.wks

The top row is records sizes, the left column is file sizes

Writer Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	57347	55119	55029	55996	51446								
128	67226	63525	61157	57319	58687	49174							
256	67172	69984	71092	72912	72975	66752	62031						
512	80326	87223	11984	89462	85789	80807	75526	69993					
1024	92020	94125	96705	97467	94413	89463	82902	82044	76469				
2048	20026	15604	20157	20156	14669	20026	19813	19769	19765	19662			
4096	14436	14410	14416	14433	14445	10867	14346	14333	14358	14354	14338		
8192	12275	12648	12664	12628	11900	12651	10940	12588	12515	12586	12599	12598	
16384	10792	11335	10150	10868	11184	11259	11254	9787	11773	11228	11167	11194	10753
32768	0	0	0	0	11126	10266	10604	11136	10851	10898	10883	10812	10859
65536	0	0	0	0	10898	10771	10838	10712	10828	10603	10399	10735	10528
131072	0	0	0	0	10585	10532	10670	10622	10687	10618	10768	10769	10735
262144	0	0	0	0	10703	10753	10062	10738	10498	10624	10530	10567	10607
524288	0	0	0	0	9489	9766	10046	10579	10830	10410	10785	10780	10948
1048576	0	0	0	0	11020	10858	11003	10764	10856	10916	11054	10728	11015
2097152	0	0	0	0	10796	9386	10204	10785	10937	10731	9640	10808	10931

Re-writer Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	53874	59429	55796	57810	60270								
128	70057	65270	61449	50276	52695	60661							
256	77860	69132	78238	78003	77883	67922	67582						
512	93481	92786	91657	96315	91039	91198	81129	77966					
1024	103079	101085	104352	105448	99766	97272	87402	87342	86281				
2048	20313	20301	20411	20325	20249	20169	15555	19941	19963	19928			
4096	14465	14487	14479	9896	14487	14439	14399	14389	11658	14397	14432		

8192	11494	10608	12697	11485	11129	11697	12602	12429	12648	11310	12624	12619	
16384	11919	10709	10959	11203	11248	11167	11753	10403	11432	11249	11212	10067	11234
32768	0	0	0	0	10919	11196	11182	10956	11209	11154	10786	10408	10924
65536	0	0	0	0	10827	10730	10852	10604	10425	10615	10600	10250	10577
131072	0	0	0	0	10324	10634	10627	10274	10639	10016	10747	10738	10766
262144	0	0	0	0	10760	10723	10666	10765	10805	10597	10466	10571	10608
524288	0	0	0	0	9474	10177	10846	10881	10779	10932	10807	10812	11038
1048576	0	0	0	0	10927	11034	11056	10417	11042	10961	11092	10863	10978
2097152	0	0	0	0	10907	9571	10074	10949	10986	11034	10437	10845	10736

Reader Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	453665	399738	310552	328017	184994								
128	476008	365817	304729	231071	281285	304757							
256	308452	295602	291268	299800	299041	281933	246156						
512	313148	289912	263918	270462	273349	260812	223572	194009					
1024	296293	275858	254087	260101	218475	248911	205949	179961	171752				
2048	301708	278715	250093	261861	257383	251408	211025	160161	165136	166259			
4096	306426	280238	258209	263594	260691	250979	211373	173171	161890	161475	162192		
8192	303779	277665	256520	262521	259907	249088	209675	171833	149803	156964	145351	125742	
16384	304824	279447	246354	262614	260543	250469	211011	170759	158391	156264	156793	157502	158082
32768	0	0	0	0	261289	248127	186400	170646	134956	157294	157525	157047	157267
65536	0	0	0	0	260574	250700	210328	170506	147098	156110	156707	156950	144602
131072	0	0	0	0	260707	250680	208307	170370	150382	147862	142161	156849	150873
262144	0	0	0	0	256363	253419	212811	169641	157338	157833	156674	156679	151558
524288	0	0	0	0	252265	237946	200606	171370	158451	156146	156765	157287	159800
1048576	0	0	0	0	47281	252169	213831	173687	160871	160060	160030	160080	160191
2097152	0	0	0	0	39700	58041	33912	44332	45118	45005	53315	52671	39831

Re-reader Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	646601	457289	349922	369872	365731								
128	630582	436791	342255	347888	346891	346993							
256	524572	396970	321195	329905	332016	312177	256257						
512	368845	317223	281619	289939	287803	273340	227656	189283					
1024	310109	283266	260957	267637	203420	249759	221744	178456	173528				
2048	311341	283895	226948	265836	260294	254124	212116	146410	165815	167198			
4096	301619	282425	260362	266699	261489	253623	212547	172579	162450	162288	161846		
8192	306230	278137	257181	256954	260808	249315	210293	171884	140666	157829	158354	159107	
16384	306174	280178	230930	262981	260385	250542	190087	170746	158432	156942	157913	157602	158068
32768	0	0	0	0	261643	250038	209609	170670	157753	134187	157568	157303	157208
65536	0	0	0	0	259802	235642	210459	170499	157878	156561	157121	156850	157145
131072	0	0	0	0	260766	250867	202615	163752	157293	155878	156555	150528	148262
262144	0	0	0	0	263990	249953	209541	171181	155266	156740	156862	154794	154150
524288	0	0	0	0	260699	247647	210695	169449	156989	158521	154807	158525	160191
1048576	0	0	0	0	28098	253148	214130	173715	160958	160168	160141	160087	160192
2097152	0	0	0	0	25266	27467	23204	25578	26215	26607	29726	26767	24837

Random Read Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	397651	376582	330077	349738	349710								
128	455594	376522	324807	335978	344190	330658							
256	433081	360515	315269	333369	316029	326570	245190						
512	381219	322816	295594	306417	316443	277490	237475	186792					
1024	304300	295612	273146	282089	29294	268762	216672	176735	172650				
2048	286589	272486	108040	274749	269155	258941	213046	53526	164549	166911			
4096	264959	263596	255521	266579	266717	255646	211669	171854	162675	161903	161412		
8192	263789	258921	251597	261532	262951	251188	209718	171334	159315	156569	158676	158651	
16384	256084	257626	249212	259326	259828	250646	115235	170069	158317	156593	157556	157237	158128
32768	0	0	0	0	260150	249006	208556	170359	157787	157123	157175	157138	156296
65536	0	0	0	0	183580	249479	209643	170362	155732	129622	156806	133732	156901
131072	0	0	0	0	258111	210062	208795	169958	156899	137238	156724	156586	157016
262144	0	0	0	0	236676	243109	212432	170209	160248	151974	151460	154048	154935
524288	0	0	0	0	244310	241413	203920	167841	153414	153439	157370	154202	160200
1048576	0	0	0	0	49207	252151	213111	173292	160590	159903	159801	159872	159679
2097152	0	0	0	0	38744	62805	23822	28381	47562	44923	53843	52218	51852

Random Write Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	6860	6383	10295	6585	56237								
128	6525	7477	6403	9377	6364	51677							
256	6292	6921	7813	6102	9506	6406	64826						
512	6517	7123	7008	7910	6148	9228	6321	79603					
1024	6548	6969	6993	7161	7837	5987	9311	6131	84265				
2048	7255	8556	7329	8112	5261	8737	5785	9069	4597	19935			
4096	7467	7965	10085	9638	10030	10858	8127	14366	14410	9822	14409		
8192	9753	10204	9362	11688	10629	11149	9233	9417	12662	12445	12597	12226	
16384	9784	10584	10630	10329	10332	10765	10644	10351	10057	10787	11112	11203	10808
32768	0	0	0	0	10551	10459	10713	10488	9475	11043	10883	10587	11186
65536	0	0	0	0	9238	10495	10432	10550	10698	10593	10488	10660	10439
131072	0	0	0	0	10185	10567	10514	9324	9271	10696	10744	10813	10691

262144	0	0	0	0	8338	9101	10362	10395	10727	10320	10537	10345	10523
524288	0	0	0	0	8566	7682	8843	9784	10397	10841	10745	10811	10632
1048576	0	0	0	0	7620	9703	10846	10980	10897	11069	11108	10643	11030
2097152	0	0	0	0	8468	9293	10346	10123	10504	10791	10824	10602	10492

Backward Read Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	402379	345943	313778	323209	319967								
128	406219	338542	301943	254439	209462	282603							
256	266674	278225	277077	258039	277373	263127	236832						
512	273080	262422	251480	261487	257409	249282	15118	191686					
1024	257417	248183	237531	249152	247645	240146	215983	176793	171180				
2048	262561	254439	245211	254951	254122	249024	207856	175042	164246	165816			
4096	271256	260542	247224	257317	257657	250812	210223	172826	161904	161789	161114		
8192	269215	258405	247844	258798	258299	248332	209572	171570	158830	157908	158302	158658	
16384	273837	168855	244107	259577	256004	249554	209101	169682	158136	157709	157511	157561	149279
32768	0	0	0	0	259150	247565	209445	170071	157698	157051	157545	153157	156285
65536	0	0	0	0	253934	250174	210202	170190	157834	156907	156399	156909	157150
131072	0	0	0	0	254346	249444	198589	151675	153357	156148	147382	153255	146731
262144	0	0	0	0	261009	252353	197199	162523	160720	149827	152829	153683	155251
524288	0	0	0	0	250877	223972	205784	160272	155898	152447	157542	154955	159541
1048576	0	0	0	0	26312	252100	211351	173415	160838	160025	159941	160036	160171
2097152	0	0	0	0	18055	44414	20134	19665	36823	36719	39997	43633	32521

Record Rewrite Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	432644	4137	5312	6085	53201								
128	482978	3691	4690	4379	6370	51490							
256	508028	1536	4432	4374	5022	6473	62805						
512	520317	3615	4290	4627	4565	4927	3702	74396					
1024	530327	3692	4346	4689	4747	4631	3457	6004	79720				
2048	539517	3065	3738	3613	4306	4361	4464	4918	5887	19796			
4096	527763	3497	3985	4399	3948	4466	4326	3609	4689	14422	14318		
8192	542801	2926	3312	4193	4149	4054	3875	4353	4207	11105	9471	11119	
16384	491908	3400	3666	3949	4021	3960	4037	3890	4137	10597	11201	11086	11739
32768	0	0	0	0	3981	4011	4063	4035	4025	9317	10743	10608	11184
65536	0	0	0	0	3609	4033	4075	4008	3959	10769	10515	10777	10600
131072	0	0	0	0	4004	4072	4128	3704	3959	10851	10749	10817	10800
262144	0	0	0	0	3979	4139	4287	4094	3957	10885	10810	10869	10727
524288	0	0	0	0	3764	4100	4295	4271	4105	10983	10938	10957	11073
1048576	0	0	0	0	4315	4445	4498	4415	4333	11244	11260	11170	11198
2097152	0	0	0	0	3264	3187	4340	3715	3658	11132	11020	11119	10870

Stride Read Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	542874	460577	323416	323162	285753								
128	438352	472498	298389	287636	301955	253483							
256	356046	255757	329480	321982	325714	293262	227139						
512	316841	277948	239137	343140	333525	306403	216575	189131					
1024	278790	262024	251664	261893	353703	341113	222462	178459	172941				
2048	268486	258979	248637	256964	255872	295567	227783	173692	163185	144499			
4096	266717	258375	244769	256112	256544	248604	228317	172360	160715	160395	159850		
8192	262615	256367	247044	257181	256024	246384	208447	171553	160567	159756	159250	158790	
16384	261938	258704	248948	257646	257403	248182	92170	168917	159487	156576	157870	156313	157042
32768	0	0	0	0	259011	247728	128765	170322	157813	158198	157629	156929	157110
65536	0	0	0	0	186459	248634	209527	170059	157697	130085	157925	132282	144548
131072	0	0	0	0	227244	210384	200229	169520	157371	156834	156669	156247	156915
262144	0	0	0	0	235095	229710	206397	162899	152026	156730	149961	152490	150668
524288	0	0	0	0	250180	211008	204622	163828	156672	153656	154827	157738	159551
1048576	0	0	0	0	206237	252782	210014	172392	160496	159898	159919	160046	159117
2097152	0	0	0	0	37691	36670	47517	31587	31855	33671	41894	45546	33622

Fwrite Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	53287	56739	66739	92204	57143								
128	60608	52567	53199	62902	86429	54029							
256	62978	63886	63603	65274	66322	68540	63872						
512	70369	73849	76326	77483	77893	69535	74493	74181					
1024	79906	76952	82421	81762	79564	70626	67042	77015	82031				
2048	19583	19697	19685	10789	19731	19396	19557	20013	81141	19630			
4096	14312	14304	14337	11587	13069	12308	14273	14405	15007	31744	11596		
8192	11408	11467	12615	11373	11385	9757	12118	12662	14452	15515	24328	12246	
16384	10903	10217	11853	11210	11201	11048	11776	11136	12036	13375	14443	19239	11292
32768	0	0	0	0	10519	10855	11158	10884	11527	11229	12476	14203	19962
65536	0	0	0	0	10804	10739	10746	10723	10779	10971	11219	11663	13567
131072	0	0	0	0	9965	10710	10754	10697	10469	10847	11073	11268	11717
262144	0	0	0	0	10143	10700	10752	10755	10670	10584	10794	10812	10904
524288	0	0	0	0	10412	10829	10767	10443	10817	10828	10846	10876	10810
1048576	0	0	0	0	10917	10912	10984	10883	11050	11039	10872	10909	10774
2097152	0	0	0	0	9910	8602	10661	10722	10095	10065	10621	10582	10430

Re-fwrite Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	56890	59375	69635	101431	57972								
128	59899	59560	60234	65107	95744	53964							
256	62992	65421	69660	71628	73668	83007	66649						
512	83130	76899	77586	83103	81879	81294	89105	78443					
1024	84272	84030	86399	89541	85935	68130	78013	95265	82117				
2048	19961	19853	19839	13154	11958	19678	19689	20205	100382	19895			
4096	14388	11478	14400	14420	14378	14343	14332	10712	20270	34313	11660		
8192	12648	12596	12623	12567	12376	11949	12247	11300	12805	16925	25752	11314	
16384	11266	9535	11259	11525	11023	10717	11252	11226	11733	12563	14130	22733	11020
32768	0	0	0	0	10827	11157	10900	11331	11212	11851	12310	13816	20900
65536	0	0	0	0	10634	10616	10527	10543	10786	11017	11208	11636	13425
131072	0	0	0	0	8889	10596	10551	10496	10750	10905	11006	11308	11989
262144	0	0	0	0	10051	9620	10782	10746	10617	10655	10776	10749	10955
524288	0	0	0	0	10495	10165	10772	10847	10566	10760	10864	10834	11124
1048576	0	0	0	0	10890	11028	10936	10969	11063	11071	10932	10987	10977
2097152	0	0	0	0	9539	9038	10707	10774	9881	9867	10812	10262	10641

Fread Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	347725	190476	293725	244319	318397								
128	386781	315275	276481	286352	271717	193671							
256	304797	277345	269727	278839	274669	250951	241502						
512	274076	262827	250862	260706	244846	241732	222598	197148					
1024	273940	252338	246097	254150	248481	248659	215301	180406	172917				
2048	278826	257317	249025	252992	253151	247553	210289	174669	164565	165189			
4096	282133	260246	250212	260262	257723	247521	204105	173604	162179	162095	161642		
8192	281628	259527	250329	258447	257812	247935	179365	171657	158630	158379	148634	157547	
16384	282662	263535	250267	259491	259100	248879	208686	169648	158333	157495	157494	155877	157369
32768	0	0	0	0	259386	248875	208555	170275	157912	133970	156783	157266	157266
65536	0	0	0	0	258775	249880	209975	170161	157341	156939	156468	157227	144159
131072	0	0	0	0	258951	247723	201871	158825	156559	152509	148136	156896	157355
262144	0	0	0	0	255103	252836	209475	173333	157205	156630	156561	155130	156257
524288	0	0	0	0	257399	248978	206847	170240	159250	157129	157333	154681	160496
1048576	0	0	0	0	260708	251567	213016	173461	160636	159876	159970	157322	159342
2097152	0	0	0	0	52322	37587	46844	46606	34358	37481	49373	46459	43981

Re-fread Report

	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384
64	515914	374383	338448	349540	363586								
128	520558	377624	324903	339561	346961	337681							
256	443618	344510	306617	318380	317207	292257	249499						
512	326314	286818	270201	282103	266127	265825	229997	191406					
1024	284605	262358	253397	262828	256893	254597	216948	180601	174388				
2048	284799	263272	252715	262763	256672	249418	213198	173972	165374	166289			
4096	286551	263304	248665	263376	261659	251380	182474	173112	162191	158606	162416		
8192	282522	261717	250619	259026	258358	248499	182089	171287	158722	158116	129782	157887	
16384	283391	263594	250880	259940	259433	249516	209908	170522	158285	155852	157533	156925	137674
32768	0	0	0	0	259741	249087	208909	170366	157846	156978	155654	157231	157238
65536	0	0	0	0	259044	249995	196006	170240	145241	156972	147801	144458	157018
131072	0	0	0	0	257428	243071	209517	169409	148735	156600	155607	153758	155687
262144	0	0	0	0	261363	249377	212790	169106	157284	154189	155993	155937	159053
524288	0	0	0	0	257084	250096	206267	168535	157253	158894	157391	88736	160553
1048576	0	0	0	0	261296	253559	213359	173677	160803	160036	160004	159746	160044
2097152	0	0	0	0	25337	22979	25567	26093	21817	22293	25789	25889	26700