571 Evans Hall
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November 10, 1992

Professor Waite
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Dear Professor Waite:

We recently discovered several errors in "Measurements of a Distributed File System" presented at the Thirteenth ACM Symposium on Operating System Principles, and published in Operating Systems Review, Volume 25, Number 5 [Baker91]. Most of the errors are in a table summarizing file system activity during the measurement periods, such as the number of file open events and the total number of bytes read. These errors have little effect on our overall conclusions. There is a more serious error, however, in our calculation of byte lifetimes (i.e. the length of time between when a byte of a file is written and when it is overwritten or deleted). The erroneous data indicated that bytes lived much longer than they actually did. The purpose of this letter is to correct these errors and to re-evaluate the conclusions drawn in the paper.

The most serious error concerns the calculation of byte lifetimes. This data was presented in Figure 4 of the paper; the original version is shown below along with a corrected version. The original figure indicated that only 5% to 30% of the bytes written died before they were 30 seconds old, and that in some traces fewer than 40% died before they were 1000 seconds old. In the paper we compared these numbers with measurements from a similar study made five years earlier [Ousterhout85], and found that byte lifetimes had increased. Since average file lifetimes had decreased between the two studies, we concluded that there must be an increasing number of large long-lived files.

Such a conclusion is not justified by the corrected data, however. As shown in the corrected figure between 36% and 63% of newly written bytes died in fewer than 30 seconds, and 60% to 95% died in fewer than 1000 seconds. A comparison with the earlier study shows that both byte lifetimes and file lifetimes have decreased. The paper correctly concludes that large files have become more common, but they do not appear to be particularly long-lived. Both the increased use of large files and their short lifetimes can be explained by improvements in processor speed.

The rest of the errors we discovered are confined to Table 1. This table was included in the paper to provide general information about the traces and we did not draw any major conclusions from it. Both the original table and the corrected version are shown below. The erroneous entries are underlined. Four rows in the original table were incorrect: the amount of data written to files, the number of open events, the number of close events, and the number of reposition events (seeks).

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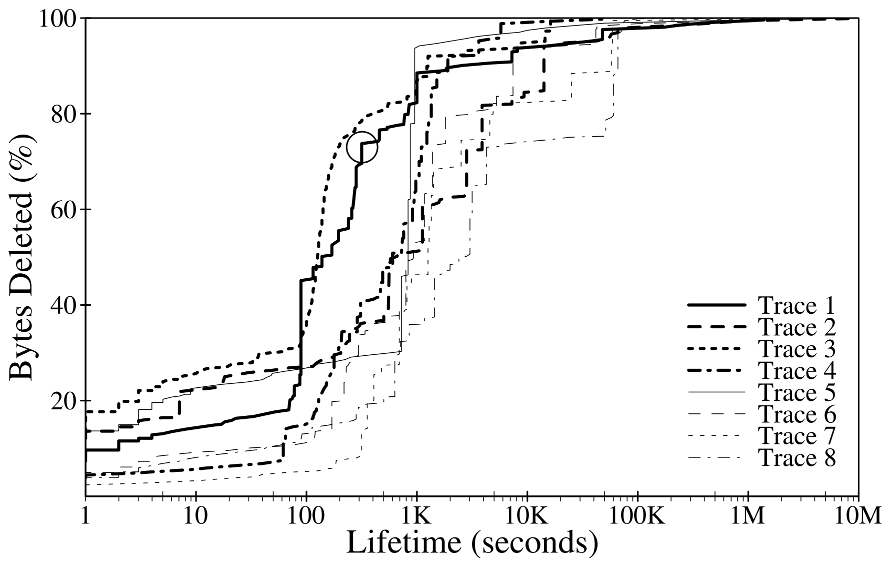
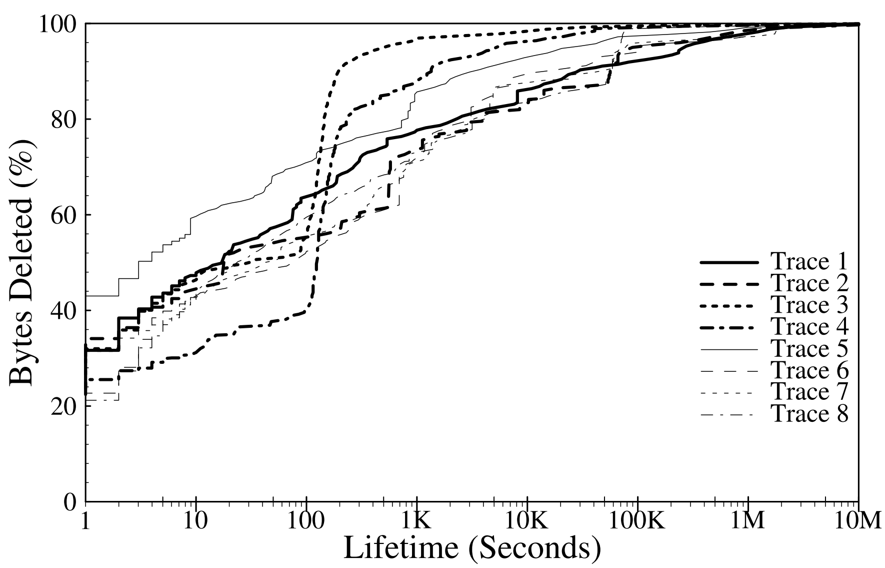


Original Figure 4: Cumulative distribution of byte lifetimes.



Corrected Figure 4: Cumulative distribution of byte lifetimes.

In addition, the amount of data read from files during traces 1 and 2 and the number of truncate events and delete events in trace 8 were computed incorrectly. One interesting observation that can be made about the corrected numbers is that the amount of data written to files is actually much lower than in the paper, causing the read/write ratio to be higher than we initially believed.

All of the errors we found occurred in the analysis of the collected trace data, not in the trace data itself. This is fortunate, since the trace data has been used in several other studies, e.g. [Baker92]. These studies should not be affected by our errors.

In conclusion we would like to apologize to the operating system research community for any problems caused by the publishing of this erroneous data. We would also like to thank Mary

Trace	1	2	3	4	5	6	7	8
Date	1/24/91	1/25/91	5/10/91	5/11/91	5/14/91	5/15/91	6/26/91	6/27/91
Trace duration (hours)	24	23.8	24	24	24	24	24	24
Different users	44	48	47	33	48	50	46	36
Users of migration	6	6	11	8	7	11	9	9
Mbytes read from files	**1282**	**1608**	13064	17754	822	1489	1292	2320
Mbytes written to files	**493**	**614**	**4892**	**1383**	**476**	**610**	506	626
Mbytes read from directories	30	67	25	18	15	17	14	15
Open events	**149254**	**224102**	**149898**	**115929**	**124508**	**184863**	**133846**	**275140**
Close events	**151306**	**225590**	**151693**	**117536**	**126222**	**186631**	136144	**278388**
Reposition events	**122089**	**221372**	**127879**	**113796**	**176733**	**104579**	**103617**	**102114**
Truncate events	5500	4883	6036	3501	6201	5860	4198	**7604**
Delete events	20278	30691	24111	16936	24495	28839	15762	**20907**
Shared Read events	21985	54351	39849	3244	832	2823	3456	9663
Shared Write events	443	1129	45043	3111	322	2499	1452	2224

Original Table 1: Various statistics about the collected trace data. Erroneous entries are underlined.

Trace	1	2	3	4	5	6	7	8
Date	1/24/91	1/25/91	5/10/91	5/11/91	5/14/91	5/15/91	6/26/91	6/27/91
Trace duration (hours)	24	23.8	24	24	24	24	24	24
Different users	44	48	47	33	48	50	46	36
Users of migration	6	6	11	8	7	11	9	9
Mbytes read from files	**1181**	**1552**	13064	17754	822	1489	1292	2320
Mbytes written to files	**287**	**376**	**4611**	**1240**	**268**	**356**	506	626
Mbytes read from directories	30	67	25	18	15	17	14	15
Open events	**150892**	**225069**	**151281**	**117175**	**125937**	**186354**	**136144**	**278321**
Close events	**150892**	**225069**	**151281**	**117175**	**125937**	**186354**	136144	**278321**
Reposition events	**100315**	**201483**	**105605**	**98883**	**134530**	**79693**	**85471**	**83058**
Truncate events	5500	4883	6036	3501	6201	5860	4198	**7603**
Delete events	20278	30691	24111	16936	24495	28839	15762	**20908**
Shared Read events	21985	54351	39849	3244	832	2823	3456	9663
Shared Write events	443	1129	45043	3111	322	2499	1452	2224

Corrected Table 1: Corrected entries are underlined.

Baker, Garth Gibson, and Mendel Rosenblum for helping us find the errors. They pointed out various inconsistencies that led us to recheck our calculations.

[Baker91] M. Baker, J. Hartman, M. Kupfer, K. Shirriff, and J. Ousterhout. Measurements of a Distributed File System. *Proceedings of the 13th ACM Symposium on Operating System Principles,* October 1991, pp 198-212.

[Baker92] M. Baker, S. Asami, E. Deprit, J. Ousterhout, and M. Seltzer. Non-Volatile Memory for Fast, Reliable File Systems. *Proceedings of the Fifth International Conference on Architectural Support for Programming Languages and Operating Systems,* October 1992, pp 10-22.

[Ousterhout85] J. Ousterhout, H. Da Costa, D. Harrison, J. Kunze, M. Kupfer, and J. Thompson. A Trace-Driven Analysis of the Unix 4.2 BSD File System. *Proceedings of the 10th ACM Symposium on Operating System Principles*, December 1985, pp 15-24.

Sincerely,

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