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## On-line Data Compression in a Log-structured File System

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Michael Burrows, Charles Jerian, Butler Lampson,  
Timothy Mann

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April 15, 1992

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## Systems Research Center

DEC's business and technology objectives require a strong research program. The Systems Research Center (SRC) and three other research laboratories are committed to filling that need.

SRC began recruiting its first research scientists in 1984—their charter, to advance the state of knowledge in all aspects of computer systems research. Our current work includes exploring high-performance personal computing, distributed computing, programming environments, system modelling techniques, specification technology, and tightly-coupled multiprocessors.

Our approach to both hardware and software research is to create and use real systems so that we can investigate their properties fully. Complex systems cannot be evaluated solely in the abstract. Based on this belief, our strategy is to demonstrate the technical and practical feasibility of our ideas by building prototypes and using them as daily tools. The experience we gain is useful in the short term in enabling us to refine our designs, and invaluable in the long term in helping us to advance the state of knowledge about those systems. Most of the major advances in information systems have come through this strategy, including time-sharing, the ArpaNet, and distributed personal computing.

SRC also performs work of a more mathematical flavor which complements our systems research. Some of this work is in established fields of theoretical computer science, such as the analysis of algorithms, computational geometry, and logics of programming. The rest of this work explores new ground motivated by problems that arise in our systems research.

DEC has a strong commitment to communicating the results and experience gained through pursuing these activities. The Company values the improved understanding that comes with exposing and testing our ideas within the research community. SRC will therefore report results in conferences, in professional journals, and in our research report series. We will seek users for our prototype systems among those with whom we have common research interests, and we will encourage collaboration with university researchers.

Robert W. Taylor, Director

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### Abstract

We have incorporated on-line data compression into the low levels of a log-structured file system (Rosenblum's *Sprite LFS*). Each block of data or meta-data is compressed as it is written to the disk and decompressed as it is read. The log-structuring overcomes the problems of allocation and fragmentation for variable-sized blocks. We observe compression factors ranging from 1.6 to 2.2, using algorithms running from 1.7 to 0.4 MBytes per second in software on a DECstation 5000/200. System performance is degraded by a few percent for normal activities (such as compiling or editing), and as much as a factor of 1.6 for file system intensive operations (such as copying multi-megabyte files).

Hardware compression devices mesh well with this design. Chips are already available that operate at speeds exceeding disk transfer rates, which indicates that hardware compression would not only remove the performance degradation we observed, but might well increase the effective disk transfer rate beyond that obtainable from a system without compression.

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