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# سخنرانی علمی

## ProMit: Proactive Drive Failure Mitigator for Enterprise Storage Systems

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## Abstract

The exponential growth of data in recent years has heightened the demand for reliable storage solutions to prevent the severe consequences of data loss, predominantly caused by drive failures. Traditional reactive failure tolerance mechanisms result in longer recovery times, higher operational costs, and degraded performance, while these failures continue to occur frequently. Recent research has shifted toward proactive methods that predict failures before they happen. However, most existing studies primarily rely on offline learning models, which are slow to update and lack adaptability to evolving failure patterns. While some studies explore online learning models for driving data streams, these approaches face challenges in scalability and accuracy as data volumes grow. Moreover, no prior work has developed a real-time metric for predicting drive health without the need for model training. Also, there is no proposed solution for mitigating drive failures in the previous work. Additionally, the patterns and root causes of premature failures in NVMe SSDs have remained uncharacterized until now.

To address these challenges, we analyze field data from NVMe SSDs in Alibaba data centers, identifying root causes of drive failures and presenting seven key findings. Notably, we find that the average $\frac{WAF}{PowerOnTime}$ which represents premature drive failure rates in failed drives, is 10.2× higher than in healthy ones. Given its strong predictive power, we establish this metric as a real-time indicator for drive failure prediction and health status classification—eliminating the need for model training. Based on this insight, we propose a proactive framework to mitigate premature drive failures, which dynamically recommends the best-candidate drives for incoming write requests through continuous monitoring and real-time updates of drive health status. Our framework is non-intrusive and can be implemented within the software stack or back-end storage controllers. Trace-driven analysis of 692,195 NVMe SSDs shows that the proposed framework can project a 40% reduction in premature drive failures and a 6.7× extension of drive lifespan.

Index Terms—Storage systems, reliability, operating systems, drive failure, data loss.

## Biography

Mehdi Moradi received the B.Sc. degree in computer engineering from the University of Tehran, Tehran, Iran, in 2016, and the M.Sc. degree in computer software engineering from Iran University of Science and Technology, Tehran, Iran, in 2018. He is currently working toward the Ph.D. degree in computer engineering with Sharif University of Technology (SUT), Tehran, Iran. His research interests include reliability of storage systems and application of machine learning on dependability of enterprise storage systems.

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