

# **Design and Evaluation of Fault-Tolerant Distributed Storage Systems for Big Data Applications**

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**Abstract:** *The proliferation of big data, characterized by its immense volume, high velocity, and diverse variety, has rendered traditional centralized storage solutions inadequate. Distributed storage systems have emerged as a critical enabler for handling such data, yet their inherent complexity introduces significant challenges, particularly concerning fault tolerance. This paper investigates the fundamental principles and architectural paradigms underpinning the design of fault-tolerant distributed storage systems for big data applications. It delves into key design considerations such as data partitioning, replication strategies, and consistency models, analyzing how these principles contribute to resilience against failures. Prominent systems like HDFS, Cassandra,, and Amazon S3 are examined as case studies to illustrate different architectural approaches to fault tolerance. Furthermore, the paper discusses crucial metrics and methodologies for evaluating fault tolerance, alongside the inherent challenges in designing and managing such robust systems. Finally, it explores future trends and emerging technologies poised to enhance the fault tolerance of big data storage.*

**Keywords:** Distributed Storage, Big Data, Fault Tolerance, Data Replication, Consistency Models, HDFS, Cassandra, Amazon S3, System Design, Evaluation Metrics.

