# Who's Afraid of Uncorrectable Bit Errors?

## Online Recovery of Flash Errors with Distributed Redundancy

**Friday, July 12th, Track 1 @ 11:50am**


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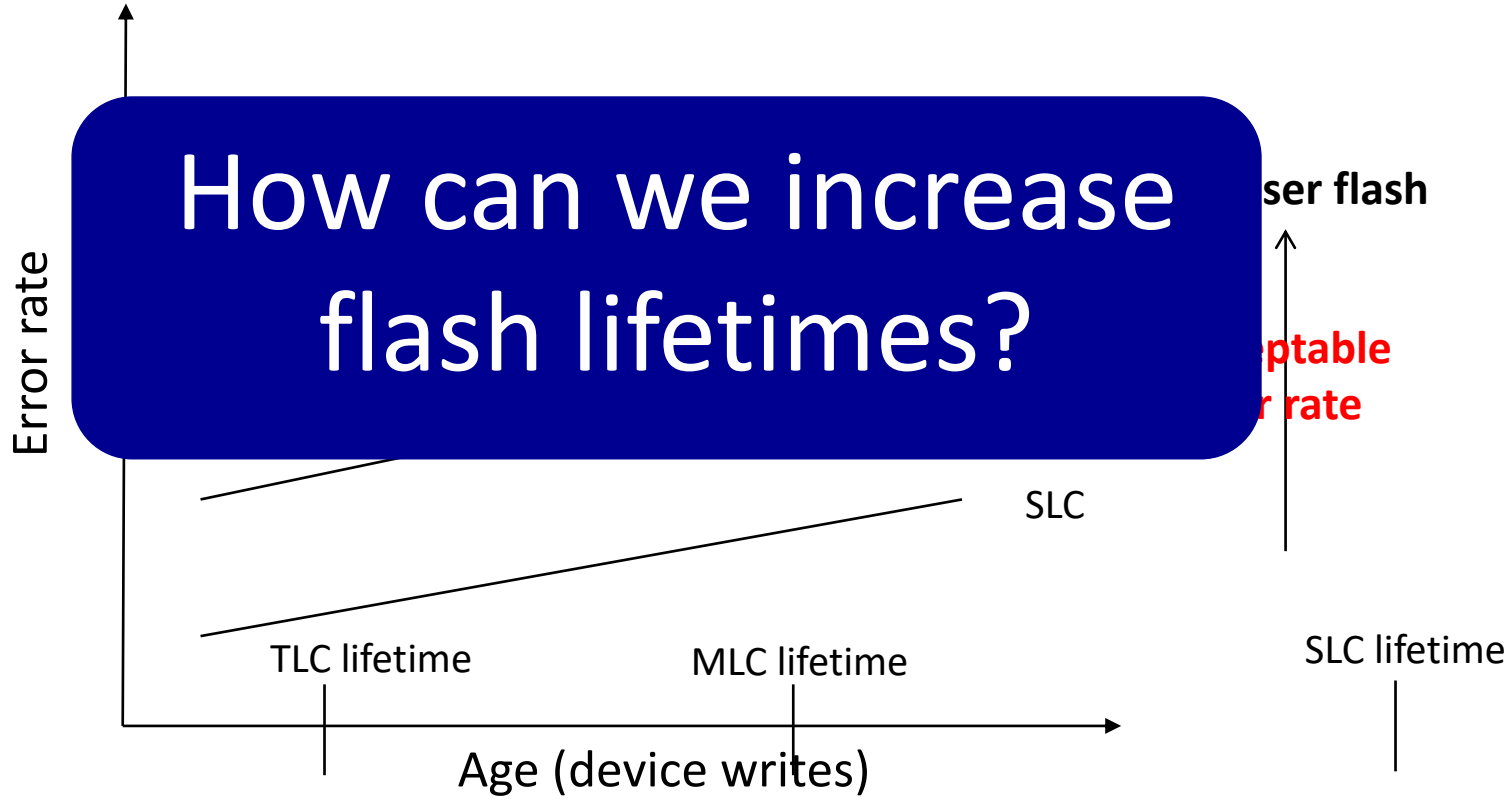
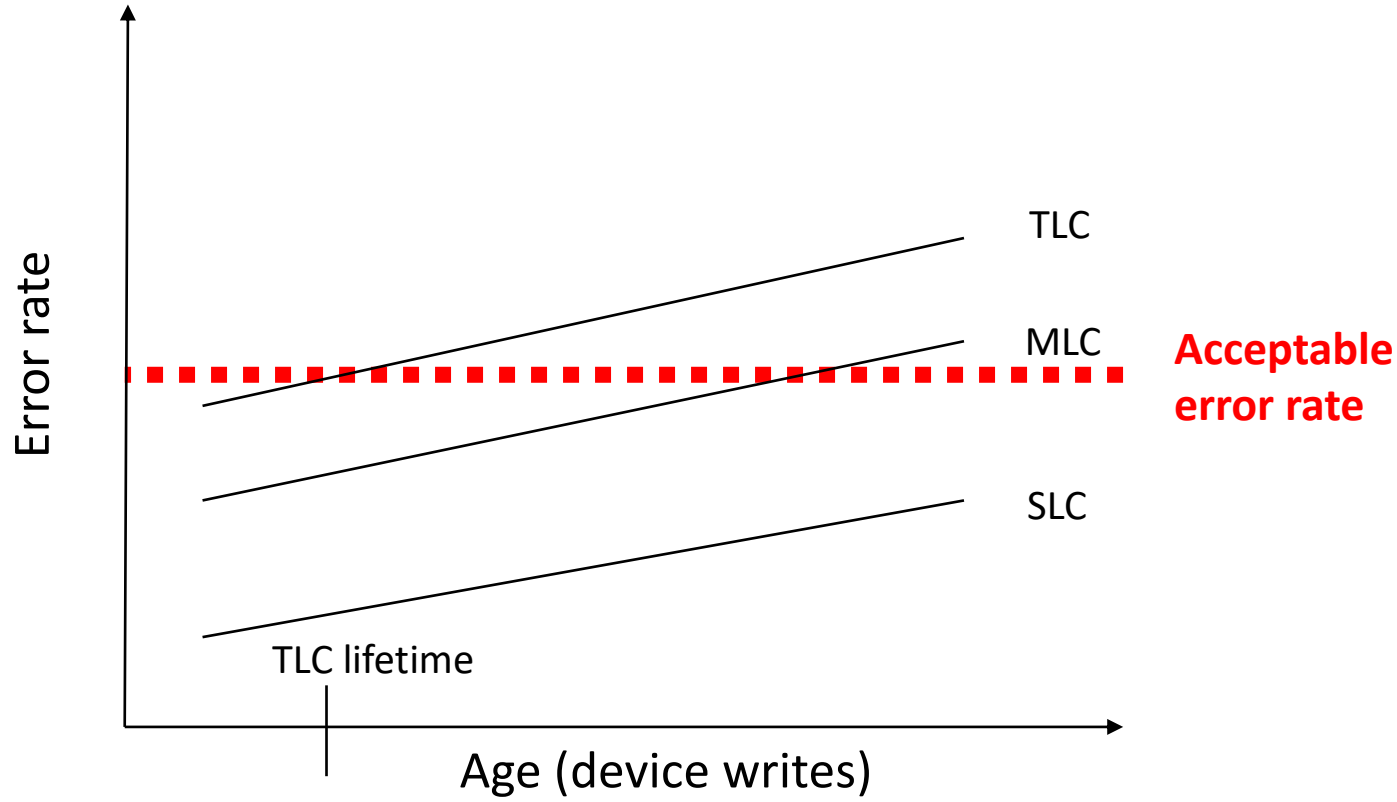
# Denser flash → shorter lifetime




Source: Novotný, R., J. Kadlec, and R. Kuchta. "NAND Flash Memory Organization and Operations." Journal of Information Technology & Software Engineering 5.1 (2015): 1.

# Increasing acceptable error rate → increase lifetimes




Source: Novotný, R., J. Kadlec, and R. Kuchta. "NAND Flash Memory Organization and Operations." Journal of Information Technology & Software Engineering 5.1 (2015): 1.

# But.. hardware is expected to have low error rates

- Software is designed so bit errors are rare
  - Corruption errors cause failed operations (correctness)
  - Error-handling path is not performant (performance)

# Solution:
# Distributed error Isolation and RECovery Techniques (DIRECT)

Observations:

1. Replication can fix bit errors in distributed storage systems *without adding additional storage redundancy*
2. Optimize error-recovery performance by reducing *error amplification*

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