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# The Mojette Erasure Code for Distributed File Systems

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## 1 Data protection is expensive

In distributed storage systems, failures are the norm

### Replication

- $n$  copies
- $n - 1$  storage overhead
- ok for hot data



Figure 1: Data triplication (200% overhead)

### Erasure Coding (EC)

- same protection
- only  $\frac{n}{k} - 1$  overhead
- limited to cold data

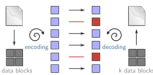


Figure 2: (6,4) Erasure coding (50% overhead)

**Problem:** implementations of Reed Solomon codes are computational bottlenecks for I/O-intensive applications  
→ Galois field multiplication  $GF(2^m)$  is expensive

**Our goal:** design fast ECs for Distributed File Systems  
→ intense random access over small blocks (e.g. 4 kB)

## 2 The fast Mojette erasure code

### The $(n, k)$ non-systematic Mojette encoding

- $k$  lines of the grid (i.e. data blocks)
- $n$  projections  $(p, q)$  (i.e. parity blocks)
- based only on additions (XORs)
- reconstruction if  $\sum |q_i| \geq k$
- $(1 + \epsilon)$  optimal

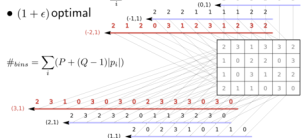


Figure 3: (6,4) Mojette encoding (mod 4) over a 6x4 discrete grid of data

### The Mojette decoding

- decoding dependency graph
- deterministic path
- complexity is  $\mathcal{O}(kPQ)$

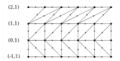


Figure 4: Mojette dependency graph

## 3 Performance comparison with Reed Solomon codes

Intel Xeon @3.10 GHz

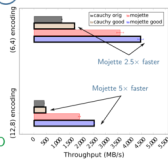
### Criteria

- blocks of 4 kB
- input: 704 MB video
- output: desired protection

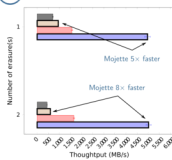
### In competition

- cauchy RS (Jerasure 1.2)
- cauchy good: sparse matrix
- mojette (RozoFS)
- mojette good: optimized I/O

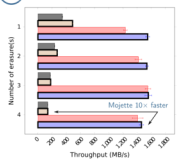
### ① Encoding performance



### ② (6,4) Decoding perf



### ③ (12,8) Decoding perf



## 4 Conclusion and future works

**Conclusion:** Mojette provides better performance, independently of the number of erasures

### Future works:

- systematic Mojette for better performance
- repair problem

## 5 Acknowledgments

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Mojette code available at <http://github.com/rozofs/rozofs>

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