

# Metadata is Harmful to Deduplication

Xing Lin, Fred Douglass, Jim Li, Xudong Li, Robert Ricci, Stephen Smaldone, and Grant Wallace  
University of Utah, EMC Corp., Nankai University

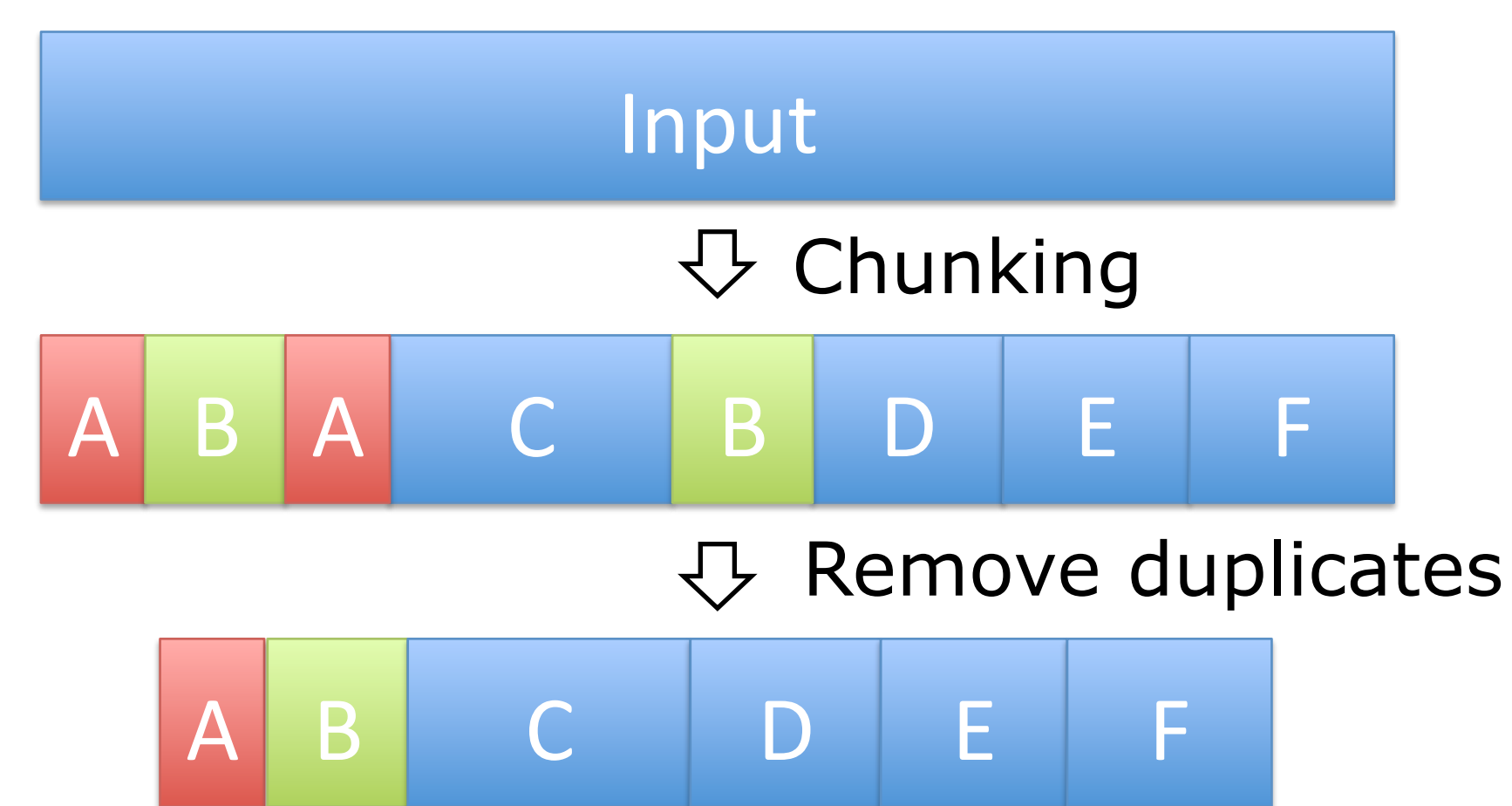


EMC<sup>2</sup>



## DEDUPLICATION

**Idea:** identify duplicate chunks and store a single copy



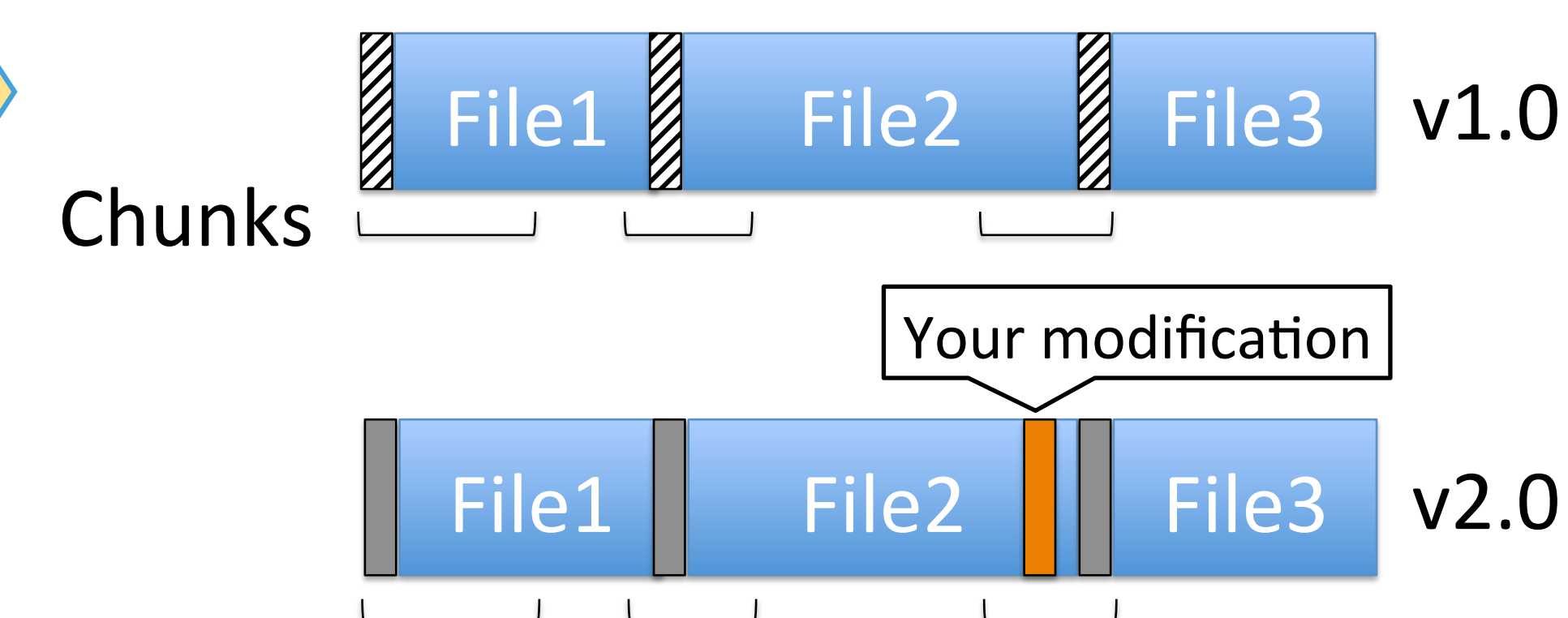
### Widely used:

- Backup & Archive: EMC Data Domain
- Primary storage: iDedup (FAST 12)
- Flash: Content-Aware Flash Translation Layer (FAST 11)

## METADATA CHANGES FREQUENTLY

### 1) Metadata Changes

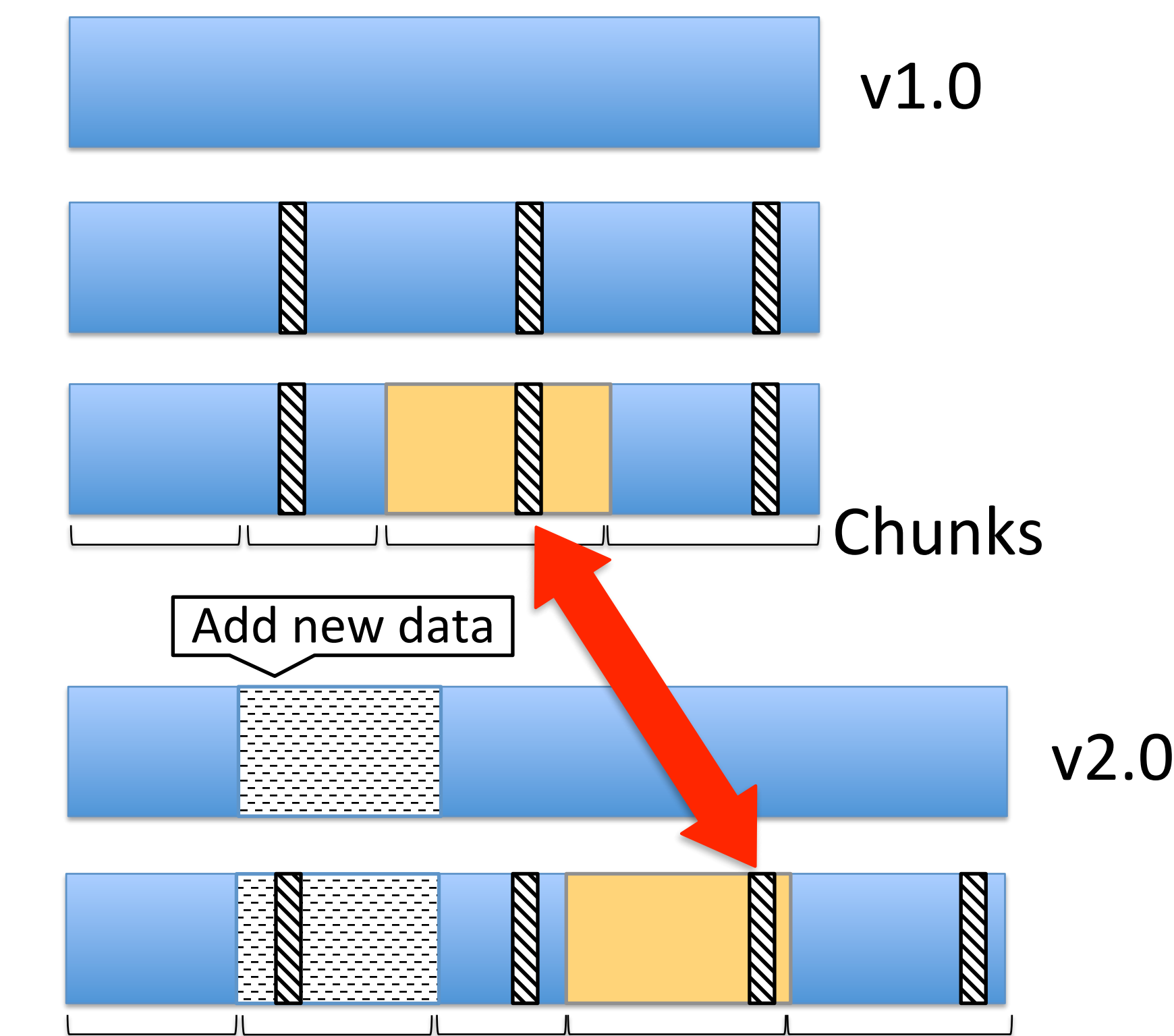
- The input is an aggregate of many small user files, interleaved with file metadata
- Metadata: file path, timestamps, etc.
- Common problem: GNU tar, EMC NetWorker



Metadata changes introduce unnecessary unique chunks!

### 2) Metadata Location Changes

An input is encoded in fixed-size blocks and metadata is attached for each block.



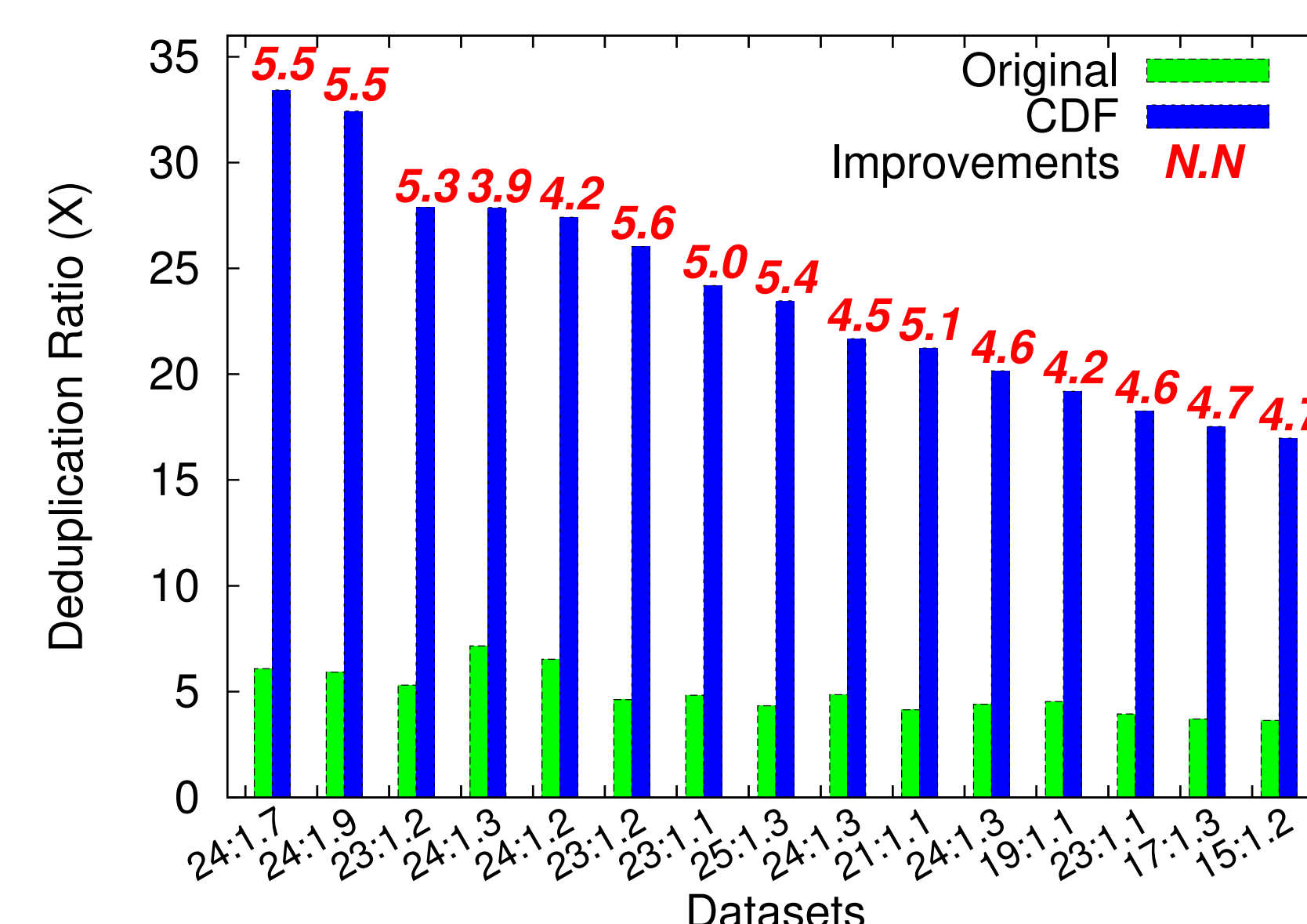
## SEPARATE METADATA FROM DATA

### Three Approaches

- a) Design deduplication-friendly formats
  - **Recommended**
  - Case study: EMC NetWorker
- b) Application-level post-processing
  - **Transparent**: no modification to applications or deduplication systems
  - Case study: GNU tar
- c) Format-aware Deduplication
  - **Last resort**: modify deduplication systems to be aware of formats
  - Case studies:
    - 1) virtual tape libraries
    - 2) Oracle RMAN backups

## a) DEDUPLICATION-FRIENDLY FORMATS

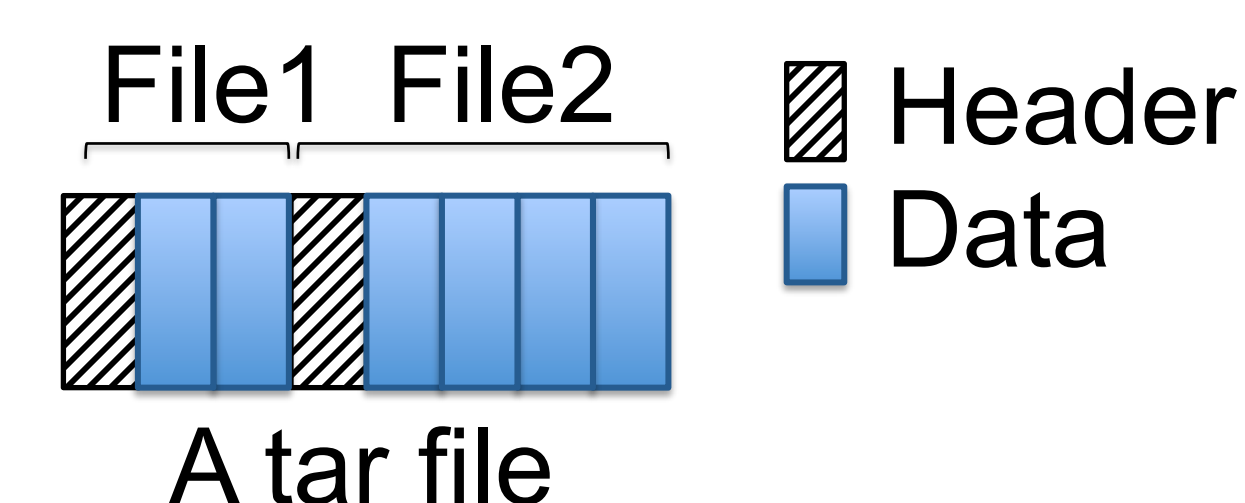
- EMC NetWorker: a backup software that collects user files and send them to a backup server
- Original format: store metadata together with data
- **Recommended**: Common Data Format (CDF) - store metadata separately



## b) APPLICATION-LEVEL POST-PROCESSING

### Background

- tar (tape archive)
  - Collects files into one archive file
  - File system archiving, source code distribution, etc.
- GNU tar format
  - A sequence of entries, one per file, each containing a file header and data blocks



- Header contains file metadata which changes frequently

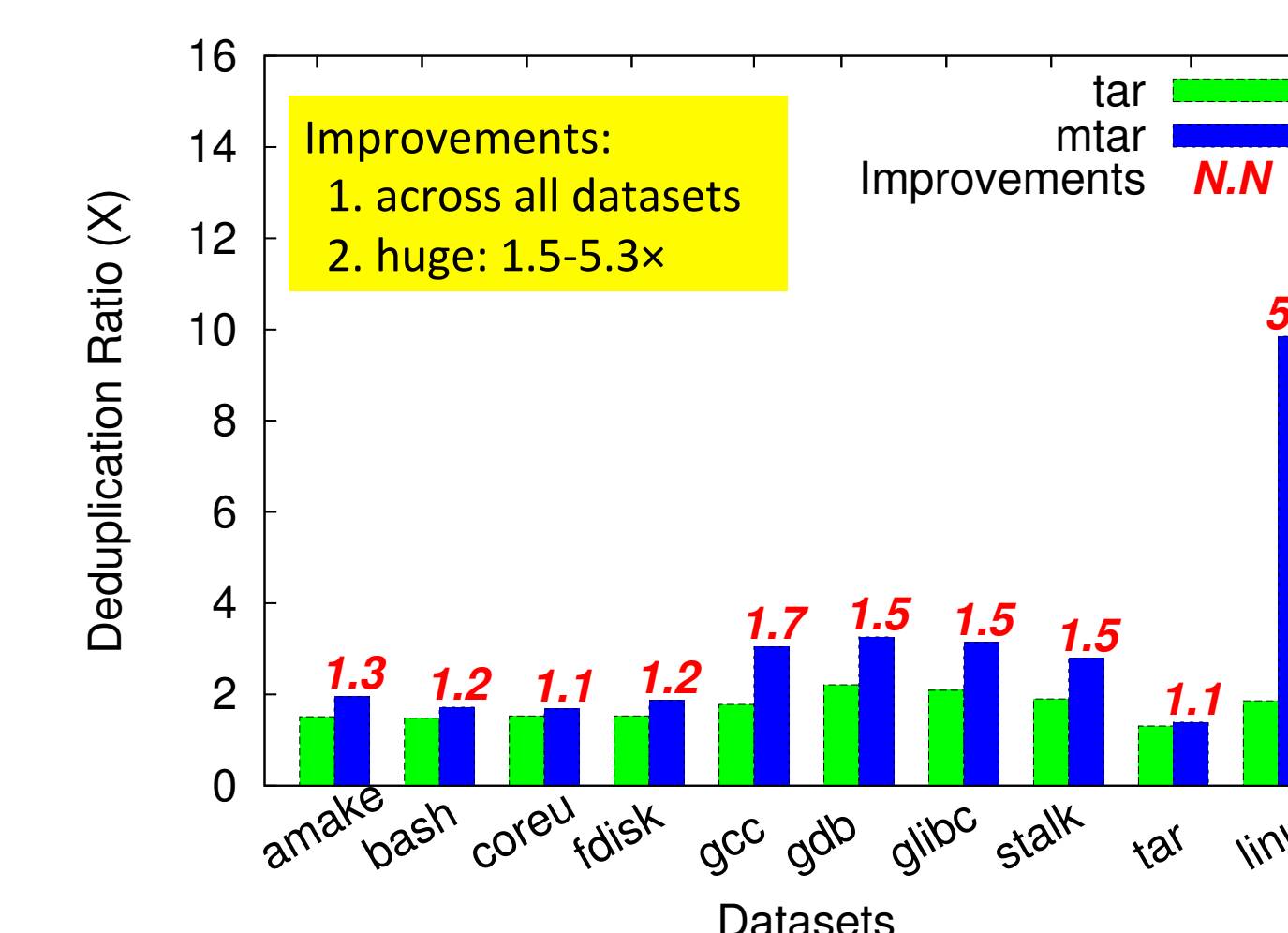
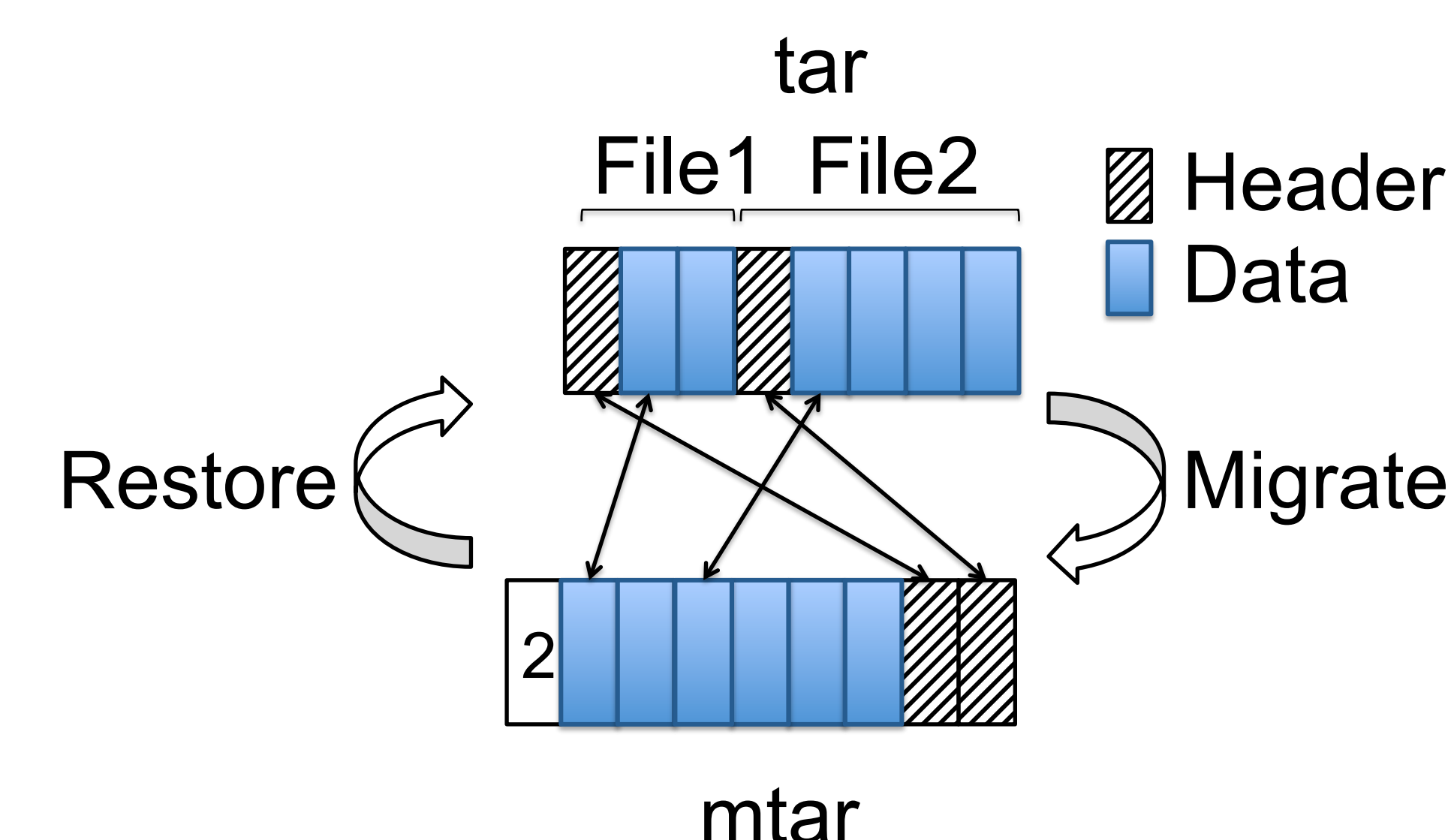
SHA1s

File	SHA1
linux-2.6.39.3/README	a735c31cef6d19d56de6824131527fdce04ead47
linux-2.6.39.4/README	a735c31cef6d19d56de6824131527fdce04ead47

linux-2.6.39.3/README -rw-rw-r-- 1 root root 17525 Jul 9 2011

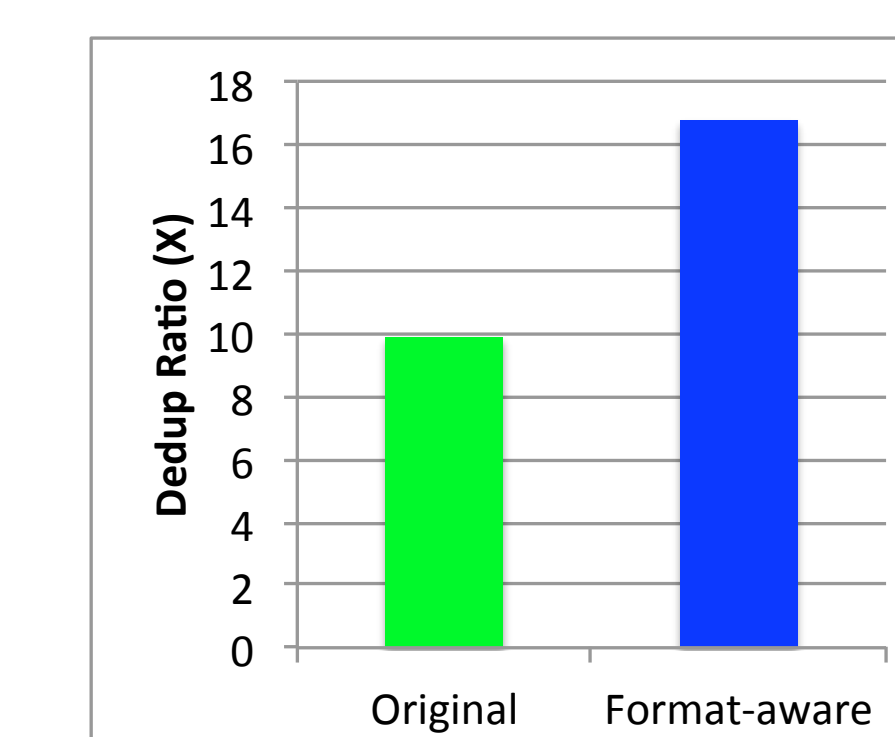
linux-2.6.39.4/README -rw-rw-r-- 1 root root 17525 Aug 3 2011

### Migratory tar (mtar)

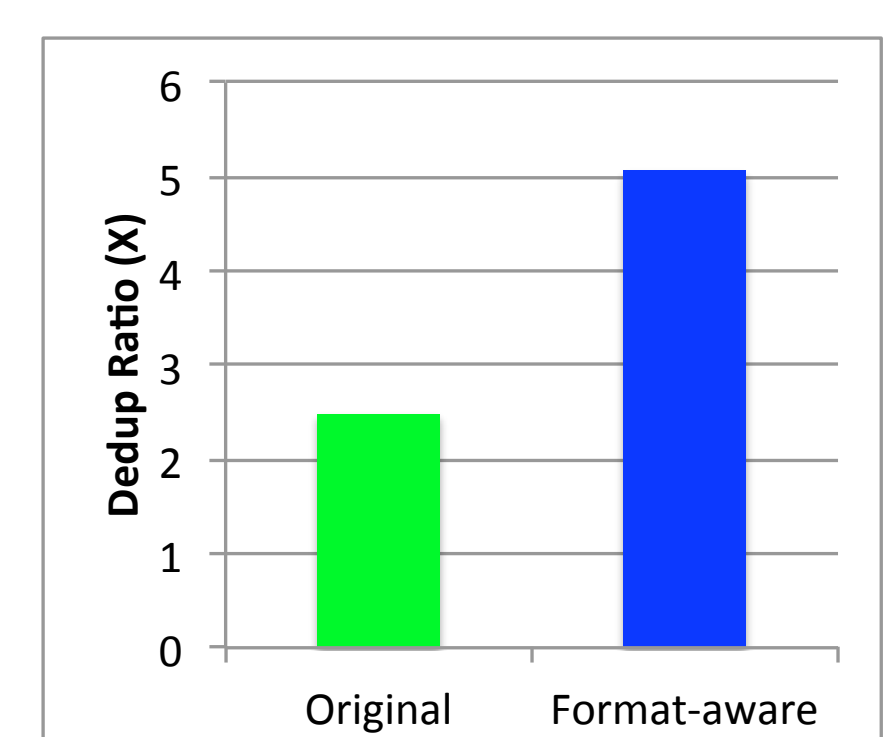


## c) FORMAT-AWARE DEDUPLICATION

- Virtual Tape Library (VTL)
  - encoded in fixed-size blocks; one block marker per block
- Oracle RMAN backups
  - RMAN writes in fixed-size blocks; each block has a variable header and footer
- **Solution**: EMC Data Domain detects these two types of backups, extracts metadata and stores it separately from data



VTL



Oracle RMAN