

## Case study: ext3 FS

1

## A brief intro to Journaling

2

## The ext3 file system

- Design goals
  - Add journaling capability to the ext2 FS
  - Backward and forward compatibility with ext2
    - Existing ext2 partitions can be mounted as ext3
  - Leverage the proven ext2 performance
  - Reuse most of the ext2 code base
  - Reuse ext2 tools, including e2fsck

3

## The ext3 journal

### Option1: Journal FS data structure updates

- Example:
  - **Start transaction**
  - Delete dir entry
  - Delete i-node
  - Release blocks 32, 17, 60
  - **End transaction**

### Option2: Journal disk block updates

- Example:
  - **Start transaction**
  - Update block #n1 (*contains the dir entry*)
  - Update block #n2 (*i-node allocation bitmap*)
  - Update block #n3 (*data block allocation bitmap*)
  - **Add transaction**

Question: which approach is better?

4

## The ext3 journal

### Option1: Journal FS data structure updates

- ✓ Efficient use of journal space; hence faster journaling
- ✗ Individual updates are applied separately
- ✗ The journaling layer must understand FS semantics

### Option2: Journal disk block updates

- ✗ Even a small update adds a whole block to the journal
- ✓ Multiple updates to the same block can be aggregated into a single update
- ✓ The journaling layer is FS-independent (easier to implement)

Ext3 implements Option 2

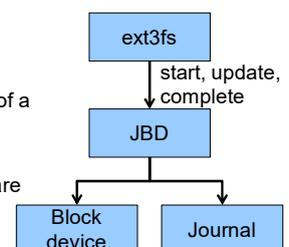
5

## Journaling Block Device (JBD)

- The ext3 journaling layer is called Journaling Block Device (JBD)

### JBD interface

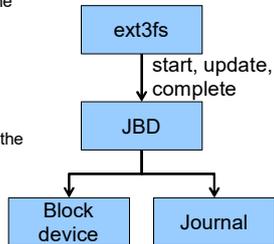
- Start a new transaction
- Update a disk block as part of a transaction
- Complete a transaction
  - Completed transactions are buffered in RAM



6

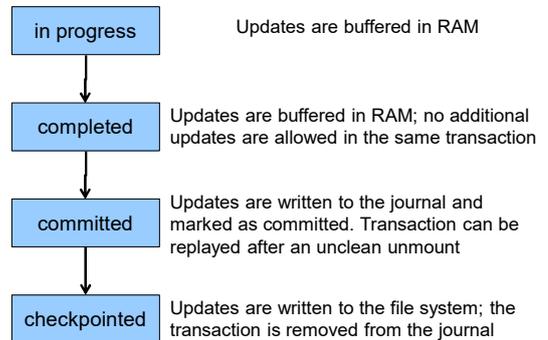
## Journaling Block Device (JBD)

- JBD interface (continued)
  - Commit: write transaction data to the journal (persistent storage)
    - Multiple FS transactions are committed in one go
  - Checkpoint: flush the journal to the disk
    - Used when the journal is full or the FS is being unmounted



7

## Transaction lifecycle



8

## Journaling modes

- Ext3 supports two journaling modes
  - Metadata+data
    - Enforces atomicity of all FS operations
  - Metadata journaling
    - Metadata is journalled
    - Data blocks are written directly to the disk
    - Improves performance
    - Enforces file system integrity
    - Does not enforce atomicity of `write's`
      - New file content can be stale blocks

9

## JBD

- JBD can keep the journal on a block device or in a file
  - Enables compatibility with ext2 (the journal is just a normal file)
- JBD is independent of ext3-specific data structures
  - Separation of concerns
    - The FS maintains on-disk data and metadata
    - JBD takes care of journaling
  - Code reuse
    - JBD can be used by any other FS that requires journaling

10