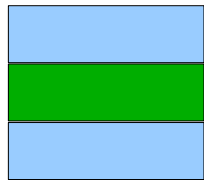


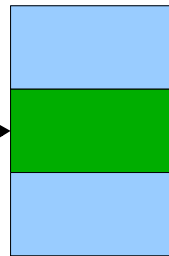
Case study: ext3 FS

Brief Journaling Intro

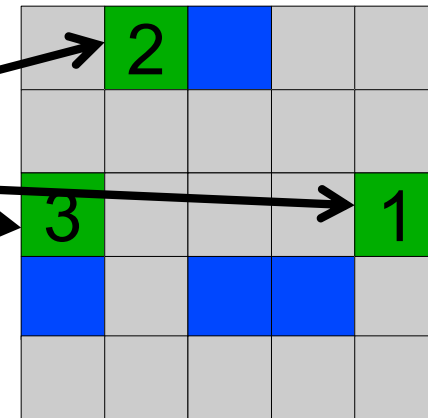
dir entries



i-nodes



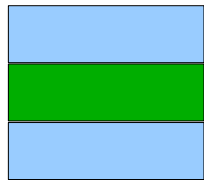
data blocks



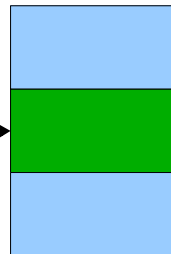
- Example: deleting a file
 1. Remove the directory entry
 2. Mark the i-node as free
 3. Mark disk blocks as free

Brief Journaling Intro

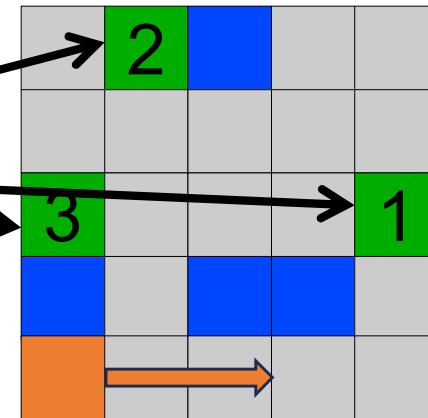
dir entries



i-nodes



data blocks



1. Write to journal
2. Perform updates
3. Remove journal entry

1.Remove the directory entry
2.Mark the i-node as free
3.Mark disk blocks as free

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

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?

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

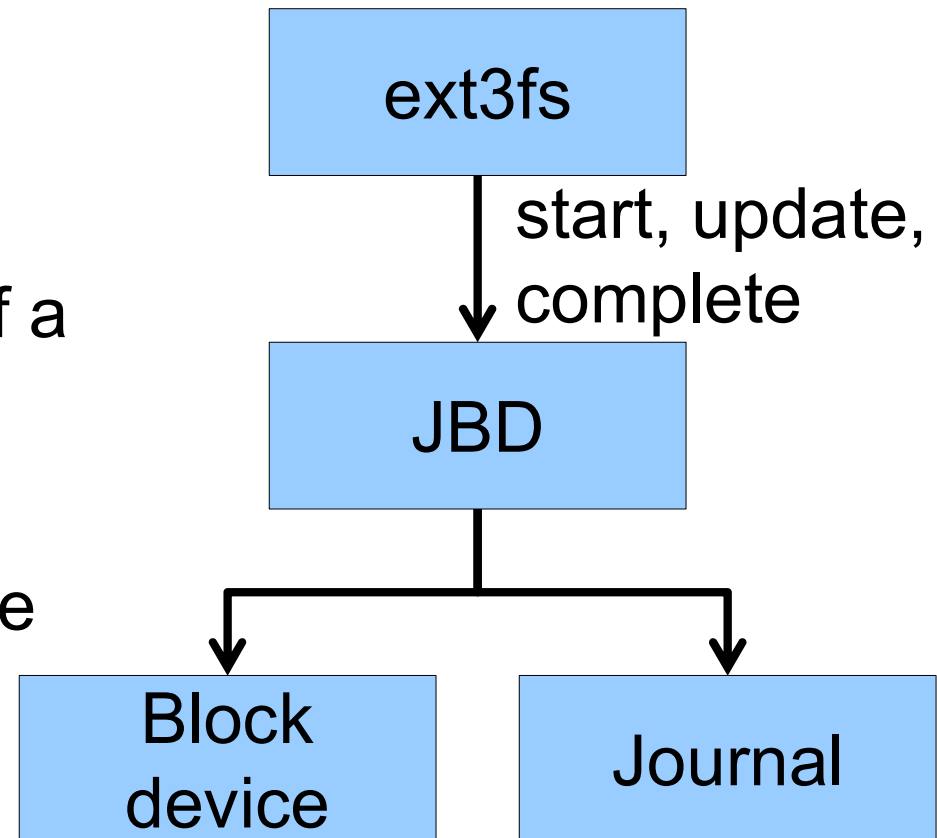
Option2: Journal disk block updates

- ✗ 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

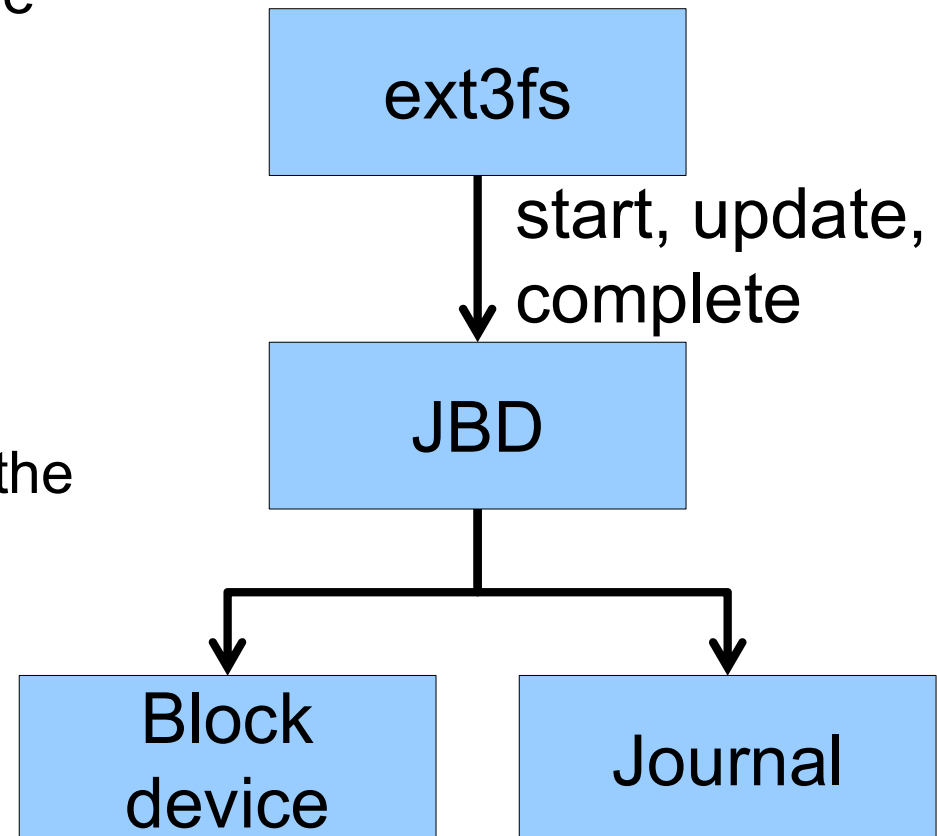
Journaling Block Device (JBD)

- 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

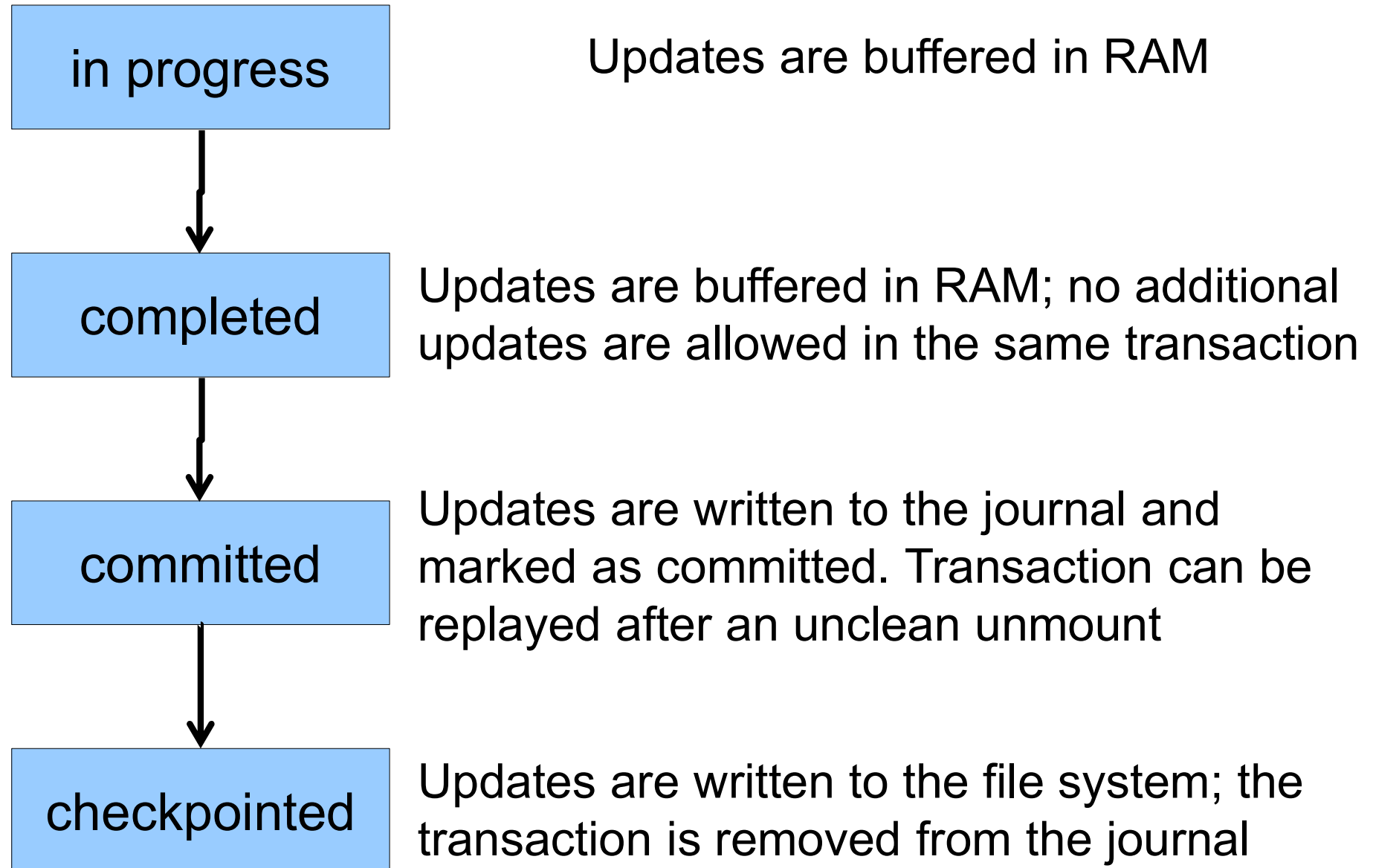


Journaling Block Device (JBD)

- 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



Transaction lifecycle



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

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