Case study: ext3 FS

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

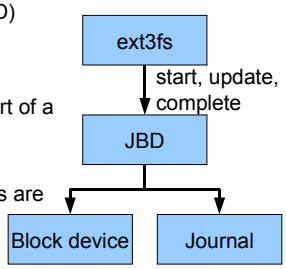
Option2: Journal disk block updates

- ✗ 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

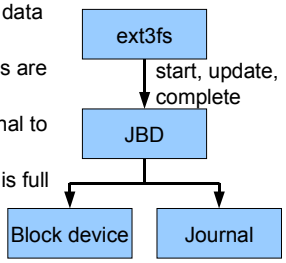
Journaling Block Device (JBD)

- 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 cached in RAM

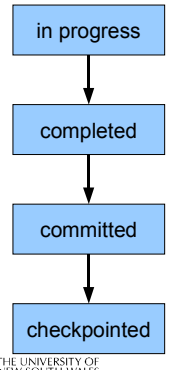


Journaling Block Device (JBD)

- JBD interface (continued)
  - Commit: write transaction data to the journal
    - 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



Updates are cached in RAM

Updates are cached in RAM; no additional updates are allowed in the same transaction

Updates are written to the journal and marked as committed. Transaction can be replayed after an unclean unmount

Updates are written to the file system; the transaction is removed from the journal

Journaling modes

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

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