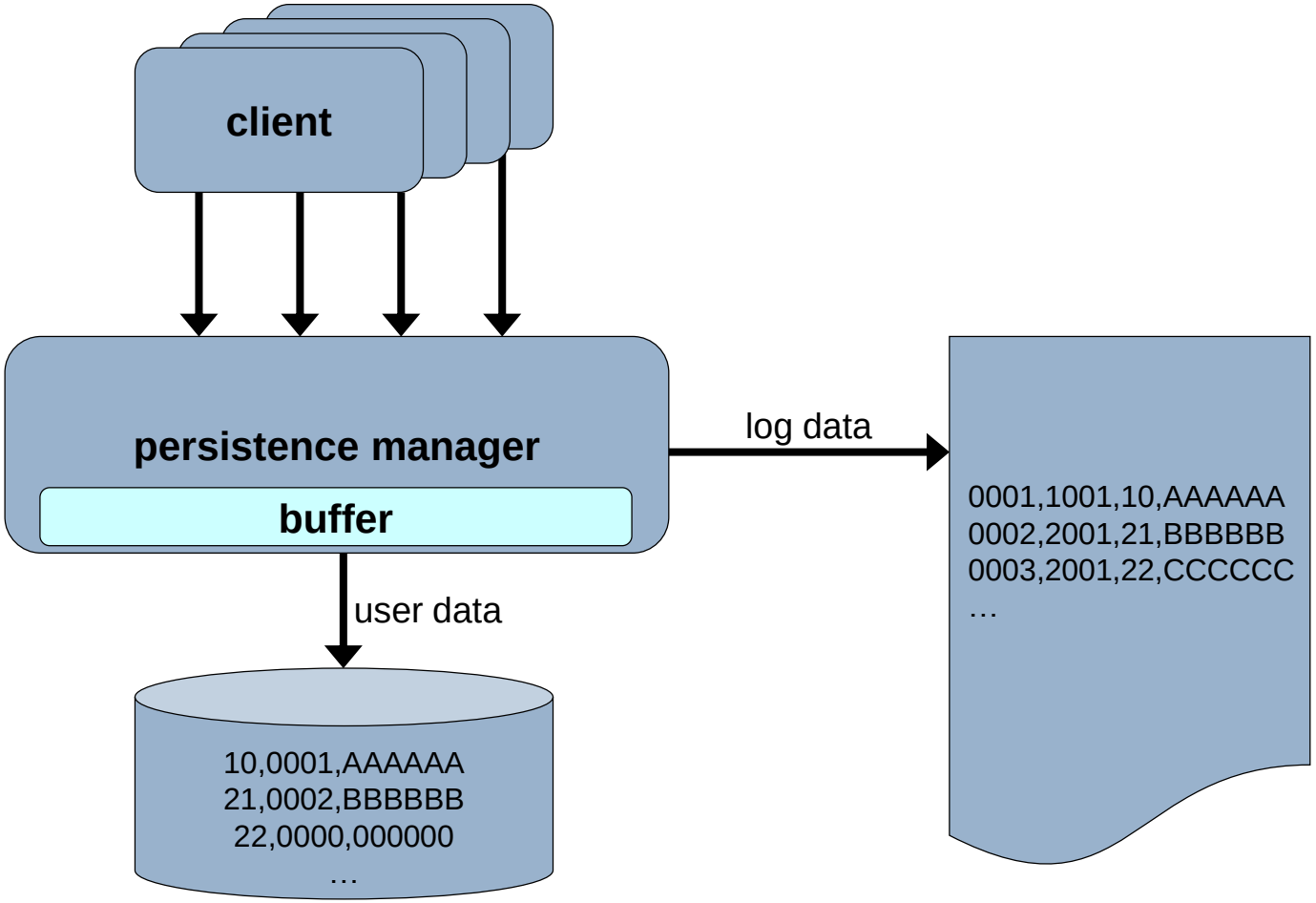
# Logging and Recovery

DIS Exercise Course


# Task

- implementing a simplified „database system“
- several clients access one single persistence
- buffer management
  - Non-Atomic
  - No-Steal
  - No-Force
- logging during normal operation
  - physical state logging
- crash recovery
  - redo recovery only
  - re-issuing lost modifications

# Architecture



# Persistence Manager

- persisting pages
  - in files, not in DB2
  - advice: one file per page
- page structure: [PageID, LSN, Data]
  - PageID: Page identifier
  - LSN: Log Sequence Number
  - Data: user data
- buffer: delayed writes
  - persisting data of **commited** transactions, when there are more than five pages in the buffer (No-Force)
  - check for a „full" buffer after every write access
  - refreshing pages in the buffer is possible
  - no dirty pages are persisted (No-Steal)
  - user data are overwritten directly (Non-Atomic)
- modifying operations are logged immediately
- requirement: support of crash recovery

# Persistence Manager: Logging

- physical state logging
- granulate: Page
- new states (after-images) of modified objects are written to the log file
- record types
  - BOT and commit record
  - modification records (after-images)
- structure of log entries: [LSN, TAID, PageID, Redo]
  - LSN: Log Sequence Number (monotonically ascending)
  - TAID: transaction ID
  - PageID: Page ID
  - Redo: information required for redo

# Clients

- 5 clients of the same kind
  - concurrent threads with ClientIDs 1..5
- access to persistence manager
  - persistence manager as Singleton: a single instance
  - clients write pages like this:
    **`beginTransaction() write() write()… commit()`**
  - no concurrent access on the same object → no locks required
    (Client 1: pages 10..19, Client 2: pages 20..29 etc.)
  - TAID is assigned by the persistence manager

# Crash Recovery

- a record in the DB is either
  - up-to-date
  - or stale (noforce) → redo
- analysis phase
  - read the entire log sequentially
  - determine winner TAs
- redo phase
  - read the entire log sequentially
  - selective redo (redo winners)
- recovery progress is logged by updating the LSNs of the completed redo steps in the corresponding pages

# Crash Recovery

- redo is only required, if
  page LSN < LSN of redo log record
- page LSN is updated on redo (grows monotonically)

```
if LSN(LS)  >  LSN(Page) then
  redo (modification from LS);
  LSN(Page) := LSN(LS);
end;
```

# Thread-Safe Singleton

```
class Singleton {

    static final private Singleton singleton;
    static {
        try {
            singleton = new Singleton();
        }
        catch (Throwable e) {
            throw new RuntimeException(e.getMessage());
        }
    }

    private Singleton() {}

    static public Singleton getInstance() {
        return singleton;
    }
}
```

# Creating Threads (1/2)

```
public class HelloThread extends Thread {
    String name;

    public HelloThread(String name){
        this.name = name;
    }

    public void run() {
        while(true){
            System.out.println("Hello from " + name);
            try{
                Thread.sleep(2000);
            }catch(InterruptedException e){
                return;
            }
        }
    }
}
```

# Creating Threads (2/2)

```
public class ThreadCreator {

        public static void main(String[] args) {
                Thread t1 = new HelloThread("Thread1");
                Thread t2 = new HelloThread("Thread2");

                t1.start();
                t2.start();

                try {
                        Thread.sleep(10000);
                } catch (InterruptedException e) {
                }

                t1.interrupt();
                t2.interrupt();
        }
}
```

# Mutual Exclusion

```
public class SynchronizedCounter {
    private int c = 0;

    public synchronized void increment() {
        c++;
    }

    public synchronized void decrement() {
        c--;
    }

    public synchronized int value() {
        return c;
    }
}
```