Understanding the lock manager with the fb_lock_print utility

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Firebird Project
http://www.firebirdsql.org/
Synchronization in Firebird

- **Internal vs external locks**
  - Mutexes, spinlocks, RW locks, latches
  - Lock manager

- **Features of the global locks**
  - Multiple states (SR, PR, SW, PW, EX)
  - Blocking notifications
  - Deadlock detection
  - Monitoring abilities
Lock Types and their Usage

- Lock types
  - Database lock
  - Existence locks (table, procedure, index, collation)
  - Table access locks
  - Transaction locks
  - Sweep, shadow, monitoring, etc locks
  - Page locks (!)
Lock Types and their Usage

Lock types

LCK_database = 1 // Root of lock tree
LCK_relation = 2 // Individual relation lock
LCK_bdb = 3 // Individual buffer block
LCK_tra = 4 // Individual transaction lock
LCK_rel_exist = 5 // Relation existence lock
LCK_idx_exist = 6 // Index existence lock
LCK_attachment = 7 // Attachment lock
...

Locks and Firebird Architectures

- SuperServer
  - No page locks
  - Small lock table
  - Fast LM operations

- Classic and SuperClassic
  - Page locks are widely used
  - Large lock table
  - LM operations may require IPC
Lock Manager in Classic

fb_inet_server

Connection 1

IPC

fb_lock_mgr

IPC

Connection 2

fb_inet_server

Lock table (shmemb)

Connection 1

IPC

IPC

Connection 2
Inside the Lock Table

- Block types
  - Header section
  - Lock owners
  - Lock resources
  - Lock requests

- Internals
  - Single mutex around the shmем region
  - Remappings
  - Hash table of lock keys
Inside the Lock Table

Lock resource
Series: page lock
Key: 01:75
State: PR

Lock request 1
PR (granted)
Owner 1
PID = 1008

Lock request 2
PR (granted)
Owner 2
PID = 788

Lock request 3
EX (pending)
Owner 3
PID = 870

Lock request 4
EX (pending)
Owner 4
PID = 114
Inside the Lock Table

- **Owner states**
  - Waiting = 0x4
  - Signaled = 0x10

- **Request states**
  - Pending = 0x2
  - Blocking = 0x1
  - Blocking seen = 0x100
Tuning the Lock Manager

- Configuration options
  - LockMemSize (1MB)
    \[ \sim \langle \text{cache pages} \rangle \times \langle \text{max connections} \rangle \times 100 \]
  - LockSemCount (32) – deprecated in v2.5
  - LockHashSlots (1009)

- Other considerations
  - FIREBIRD_LOCK envvar
Using the Lock Print Utility

Output control switches

- `-o [wners]`
- `-l [ocks]`
- `-r [equests]`
- `-s [eries] <number>`
- `-a [ll]`
- `-w [ait list]`

Default output

- Header and owners only
Using the Lock Print Utility

- Interactive mode
  -i [aotw] <number> <number>
  - Acquires, operations, types, waits
  - Seconds and intervals

- Other options
  -c
  -d <database> or -f <lock file>
  -m
Questions?