Firebird in 2011/2012: Development Review

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Firebird Project
http://www.firebirdsql.org/
Packages Released in 2011

**Firebird 2.1.4**
- March 2011
- 96 bugs fixed
- 4 improvements, new port (Renesas SH)

**Firebird 2.5.1**
- October 2011
- 140 bugs fixed
- 16 improvements, 1 new feature
- New ports: Linux/M68K, Linux/HPPA, Linux/Alpha
What's New in v2.5.1

- **Key enhancements**
  - SQLSTATE as a PSQL context variable (like GDSCODE/SQLCODE)
  - Record compression ratio estimations
  - Write operations for GTTs in RO transactions
  - Performance improvements for GTTs
  - GBAK restore performance
  - Canceling waits inside the lock manager
  - Persistent statement IDs in the MON$ tables
Maintenance Releases in 2012

- **Firebird 2.0.7**
  - 24 bugfixes up to date
  - 4 months overdue, expected in Q1 2012

- **Firebird 2.1.5**
  - 32 bugfixes and 2 improvements up to date
  - No delay, expected in Q2-Q3 2012

- **Firebird 2.5.2**
  - 13 bugfixes up to date
  - No delay, expected in Q2-Q3 2012
Development summary

- Started in October 2009
- 433 total tickets assigned
- 379 of them are already resolved
- More than 2000 changes committed
- Code cleanup, only ODS 12 is supported
- New layout of binaries
Firebird 3.0 : New Features

- Implemented SQL features
  - External procedures / functions / triggers
  - PSQL functions
  - PSQL packages
  - Sub-procedures and sub-functions
  - DDL triggers
  - Window (analytic) functions
  - Identity columns
  - Scrollable PSQL cursors
Firebird 3.0 : New Features

Implemented SQL features (continued)

- Standard compliant BOOLEAN data type
- ALTER statements for changing NULL / NOT NULL
- ALTER DATABASE for changing the default charset
- MERGE enhancements (multiple MATCHED clauses, RETURNING clause, DELETE command)
- CONTINUE statement
- Parametrized exceptions
Firebird 3.0 : New Features

- Security
  - Pluggable authentication
  - Per database user management
  - Over-the-wire encryption
  - Database encryption
  - DDL permissions
  - Aggregated privileges for roles
  - User groups (implicit roles)
Firebird 3.0: Shared Cache

- Basic architecture

Diagram showing:
- User connection 1
- User connection 2
- User connection N
- Cache writer
- Cache reader
- Page cache
- Database
- Lock manager
Firebird 3.0 : Shared Cache

- **Configuring the architecture**
  - **SharedCache** – whether multiple connections of a single process can share the database page cache
  - **SharedDatabase** – whether database pages can be shared among multiple page caches

- **Matrix of working modes**

<table>
<thead>
<tr>
<th></th>
<th>SharedDatabase = 0</th>
<th>SharedDatabase = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>SharedCache = 0</td>
<td>Singleton</td>
<td>Classic / SuperClassic</td>
</tr>
<tr>
<td>SharedCache = 1</td>
<td>SuperServer</td>
<td>Special (⋆)</td>
</tr>
</tbody>
</table>
Firebird 3.0 : Shared Cache

- Synchronization
  - Latches and locks
  - Database file open mode (SharedDatabase)
  - Cache start up (no locks)
  - New connection (SharedCache)
  - Acquire ”lazy” locks
  - Two level synchronization
Firebird 3.0: Shared Cache

Concurrency test: 1GB database, 10 terminals
Firebird 3.0

MySQL: single thread performance
Firebird 3.0 : ODS 12

“Primary” and “secondary” data pages

- New flag for both pointer pages and data pages
- Primary page contains some “head” version of the record version chain
- Secondary page contains only back versions, fragments or small blobs inside
- Full table scans (plan NATURAL) skips secondary data pages
“Swept” data pages

- New flag for both pointer pages and data pages
- Swept data page means that all records stored there have no back versions and they are known to be created by already committed transactions
- Set by the sweeper / garbage collector, cleared when new version is created on the page
- Sweep process skips swept data pages
Firebird 3.0 : ODS 12

- SCN inventory page
  - New page type
  - Global array of SCNs for the every database page
  - SCN inventory pages are distributed evenly across the database file
  - Slots are updated when some page gets a new SCN assigned
  - Nothing is changed for a level 0 backup
  - Incremental (level N) backups read only pages modified since the last (level N – 1) backup
Firebird 3.0 : Optimizer

- Detailed plan output
  - An alternative (optional) way to analyze the plan
  - All operations are reported in the hierarchical view
  - Some additional details are available
  - Cardinality and cost estimations will be reported
  - Run-time information
Firebird 3.0 : Optimizer

- Materialized sub-queries
  - Underlying stream is sequentially read and cached inside a record buffer
  - Pipeline nature of the record buffer, both sequential and random access are supported
  - Storage is provided by the temporary space manager and is dynamically balanced between memory and disk (see TempSpaceLimit in firebird.conf)
  - Useful for invariant sub-queries, hash joins, etc
Hash joins

- Larger input stream becomes an outer one, smaller input stream becomes an inner one.
- Inner stream is read in advance row by row, hash value is calculated for the join keys, row is stored in the buffer corresponding to the given hash group.
- Outer stream is read sequentially, hash value is calculated for the join keys and probed against the hash table.
- For a positive match, collisions are compared by the binary comparison of the join keys.
Firebird 3.0 : Optimizer

Miscellaneous

- Semi-materialized nested loop joins
- Reworked FULL OUTER JOIN implementation that is able to utilize indices
- Support for hash and merge algorithms for LEFT OUTER joins
- Conditional retrievals, e.g. WHERE (COL = :VAL OR :VAL IS NULL)
- Constant predicates can be evaluated beforehand
- Hashing is considered for aggregates
Firebird 3.0: Optimizer

- **Table statistics**
  - Number of data pages, average fill ratio
  - Number of rows, average row size

- **Index statistics**
  - Tree depth
  - Number of leaf pages, average fill ratio
  - Number of nodes, average node size
  - Clustering factor
Firebird 3.0 : Optimizer

- **Column statistics**
  - Number of distinct values
  - Number of NULLs

- **Histogram**
  - Endpoint boundary
  - Endpoint value
Firebird 3.0: Monitoring

- **General**
  - More details about page I/O
  - Temporary space I/O statistics
  - Statement statistics: parses / compiles / executes
  - Misc extensions

- **Timing statistics**
  - Total elapsed time
  - CPU time: user mode and kernel (system) mode
  - Waiting time: I/O, lock waits, latch waits, etc
Firebird 3.0 : API

- Extending the length limits
  - API: SQL statements and their BLR counterparts
  - API: input/output messages
  - Internal: intermediate (non-persistent) records
  - Internal: sorting records
  - Not about the ODS records!
Questions?