MEMORY USAGE IN FIREBIRD

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HQBird

Advanced Firebird for Big Databases

- Replication, Recovery and Optimization for Firebird and InterBase since 2002
- Platinum Sponsor of Firebird Foundation
- Based in Moscow, Russia

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Agenda

Part 1: Understanding memory usage in Firebird

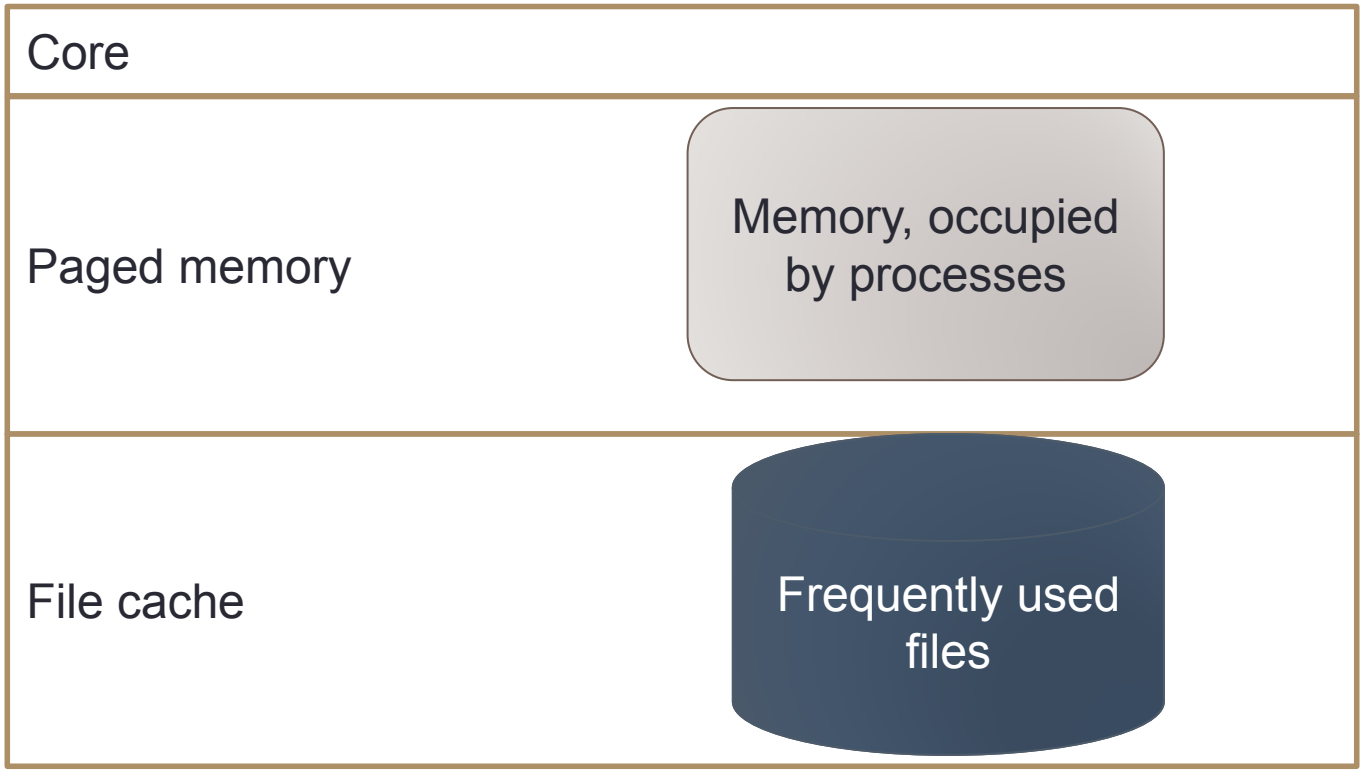
- Memory types in Windows and Linux
- How Firebird uses memory
- File cache and Firebird

Part 2: Tuning memory usage in Firebird database

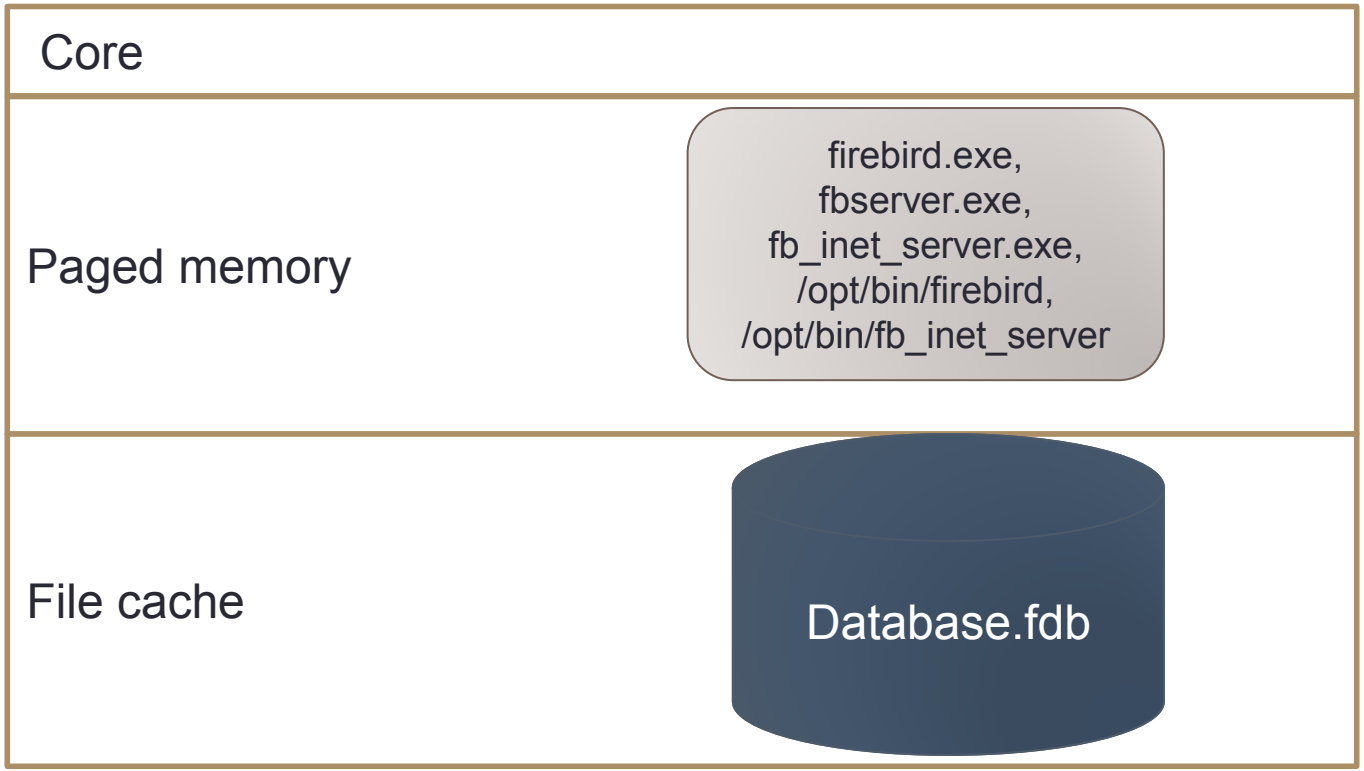
- Firebird.conf parameters for memory tuning
- Optimal firebird parameters

PART 1: UNDERSTANDING MEMORY USAGE IN FIREBIRD

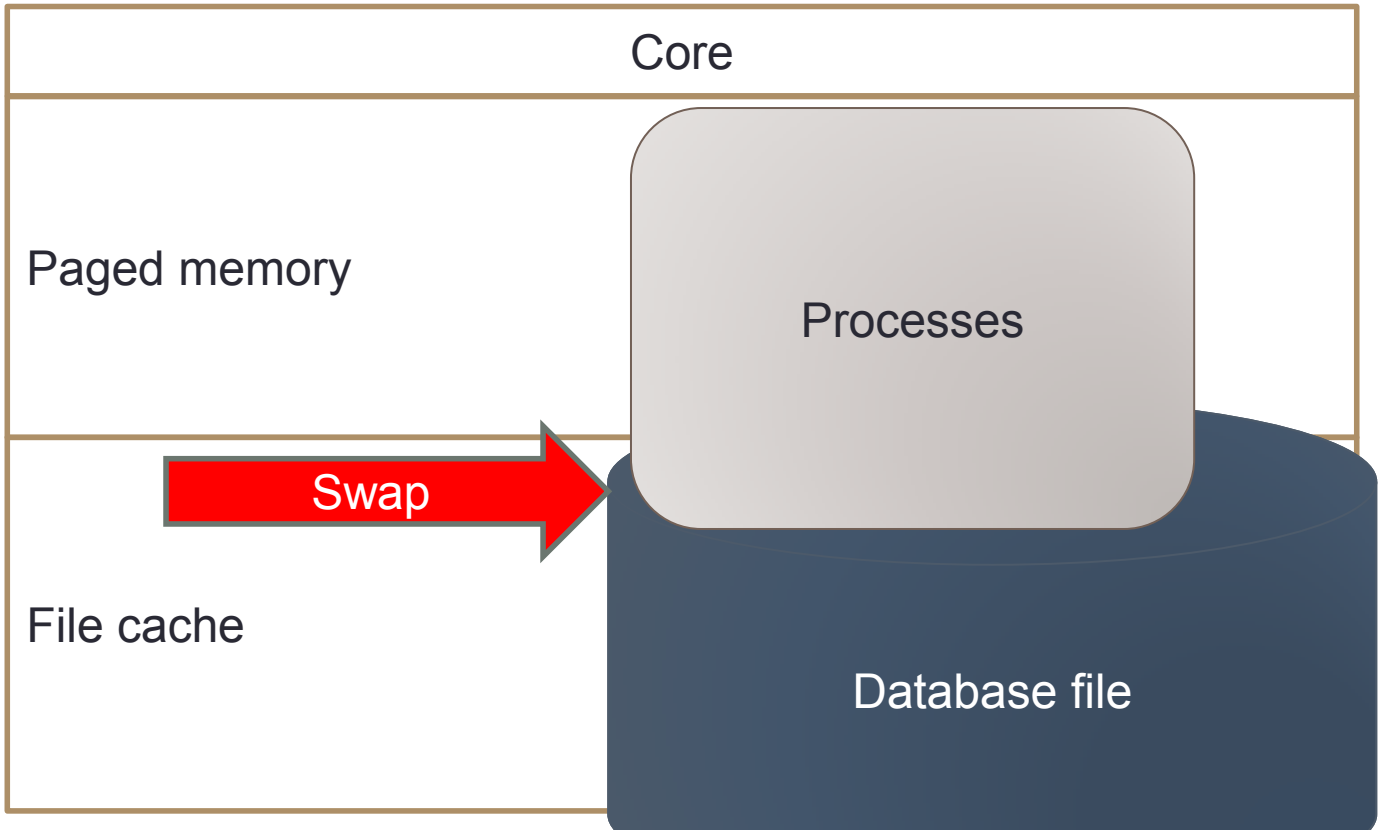
3 main types of memory in OS



For Firebird



Competing for memory (Windows)



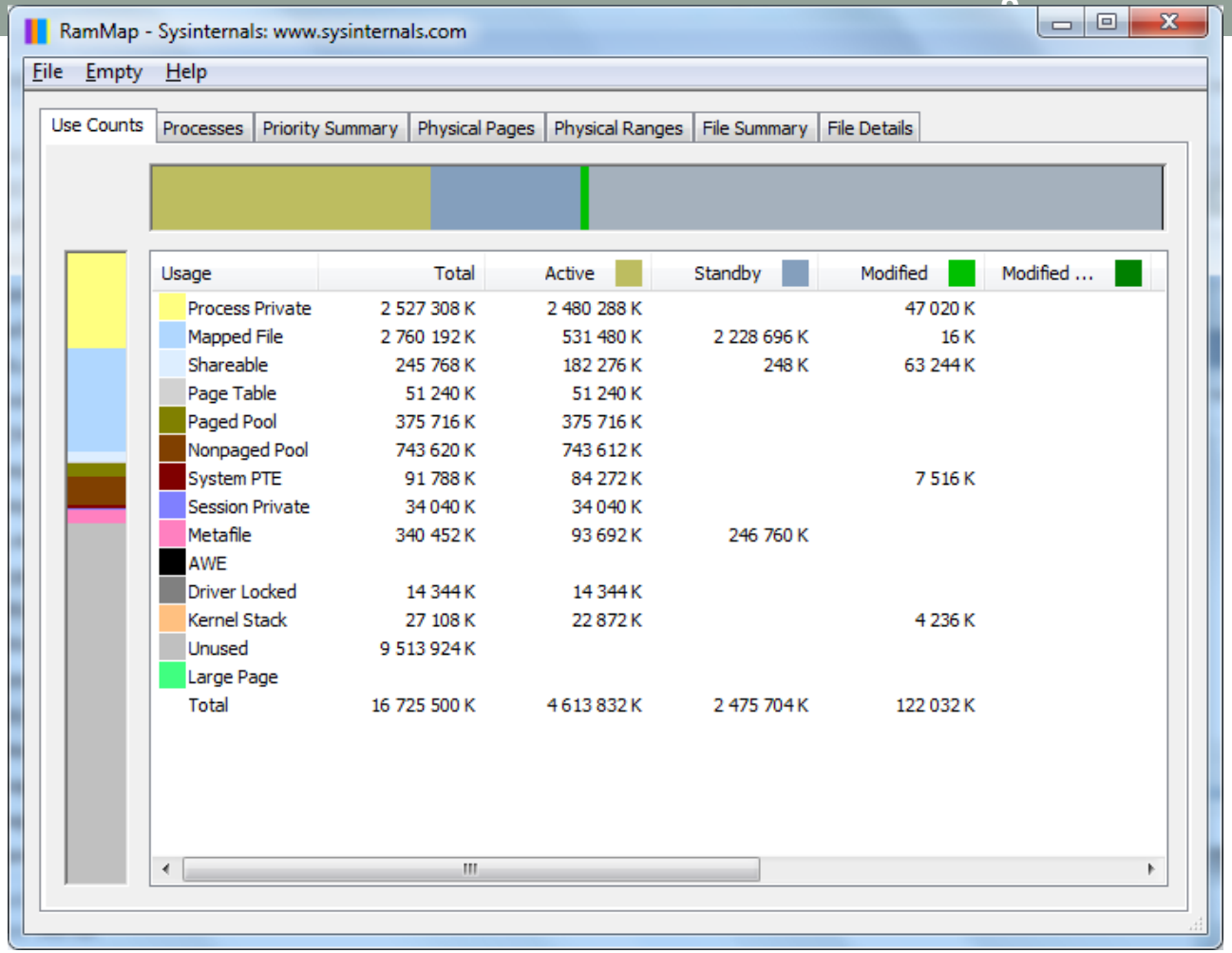
RAM on Windows

- By default, Windows memory manager has the following %% for memory types
  - 50% paged memory
  - 41% file cache
  - 9% kernel

Use RAMMap to see the real memory consumption

- It can be tuned in Windows settings/registry

RAMMap

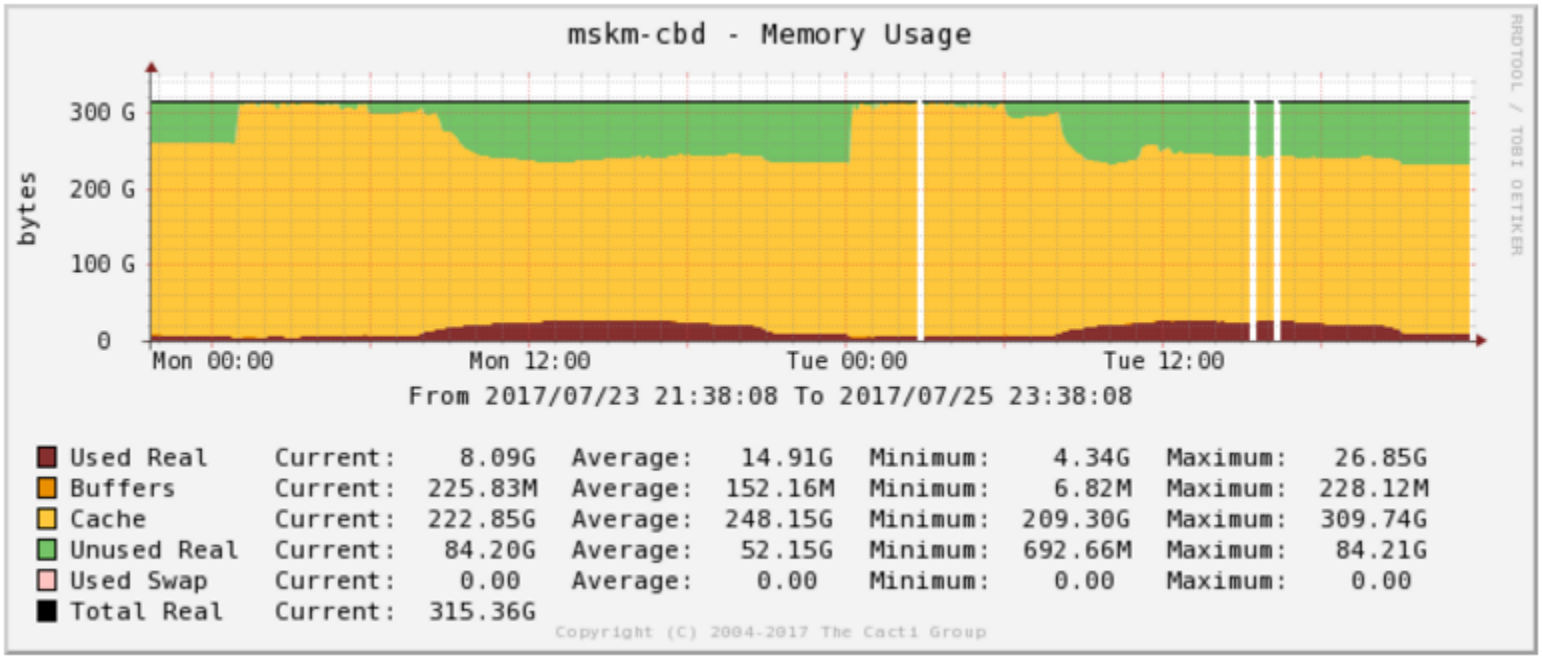

RamMap - Sysinternals: www.sysinternals.com
File Empty Help
Use Counts Processes Priority Summary Physical Pages Physical Ranges File Summary File Details
Usage Total Active Standby Modified Modified ...
Process Private 2 527 308 K 2 480 288 K 47 020 K
Mapped File 2 760 192 K 531 480 K 2 228 696 K 16 K
Shareable 245 768 K 182 276 K 248 K 63 244 K
Page Table 51 240 K 51 240 K
Paged Pool 375 716 K 375 716 K
Nonpaged Pool 743 620 K 743 612 K
System PTE 91 788 K 84 272 K 7 516 K
Session Private 34 040 K 34 040 K
Metafile 340 452 K 93 692 K 246 760 K
AWE
Driver Locked 14 344 K 14 344 K
Kernel Stack 27 108 K 22 872 K 4 236 K
Unused 9 513 924 K
Large Page
Total 16 725 500 K 4 613 832 K 2 475 704 K 122 032 K

RAM on Linux

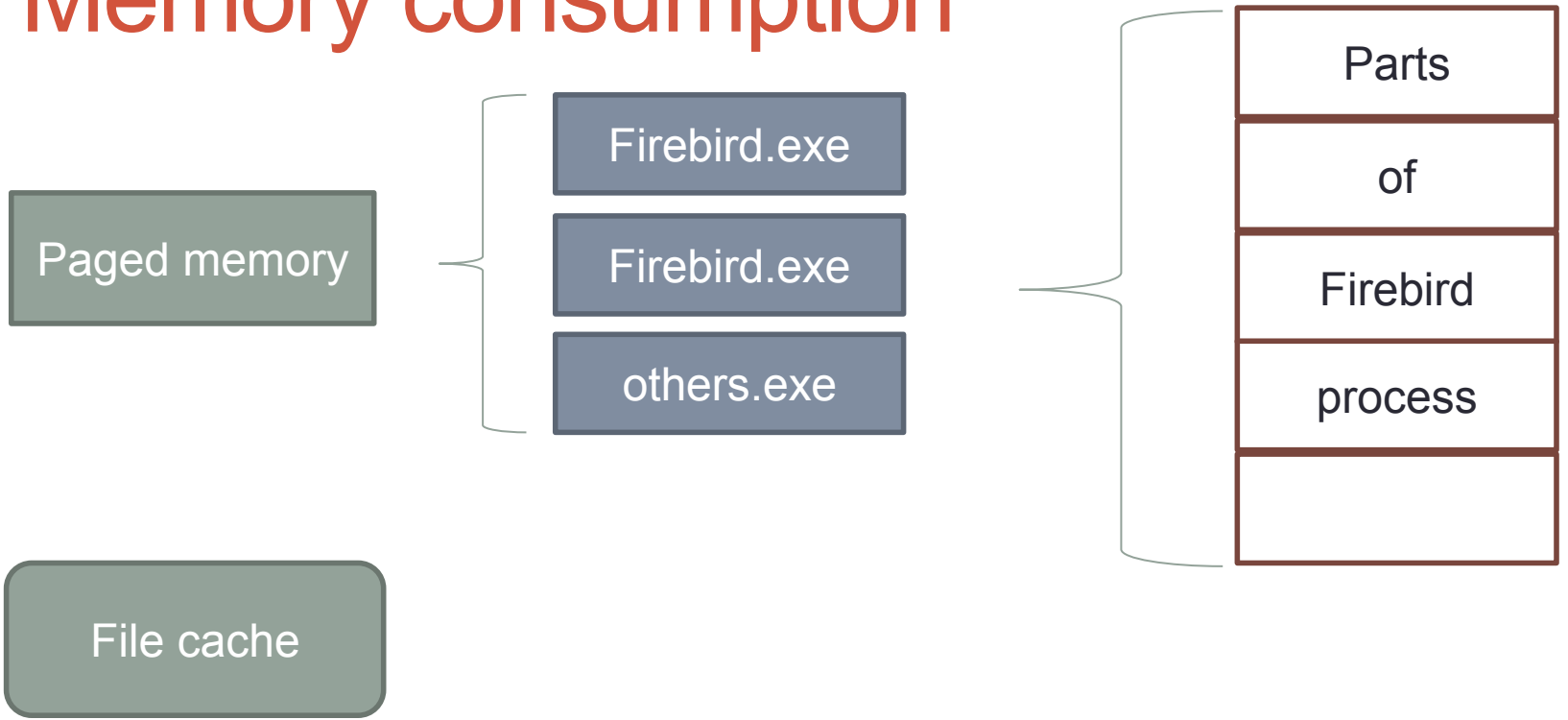
- Core – 10%
- Processes - on demand
- File cache – takes all available space

RAM on Linux: monitoring

- smem
- nmon
- Cacti



Memory consumption

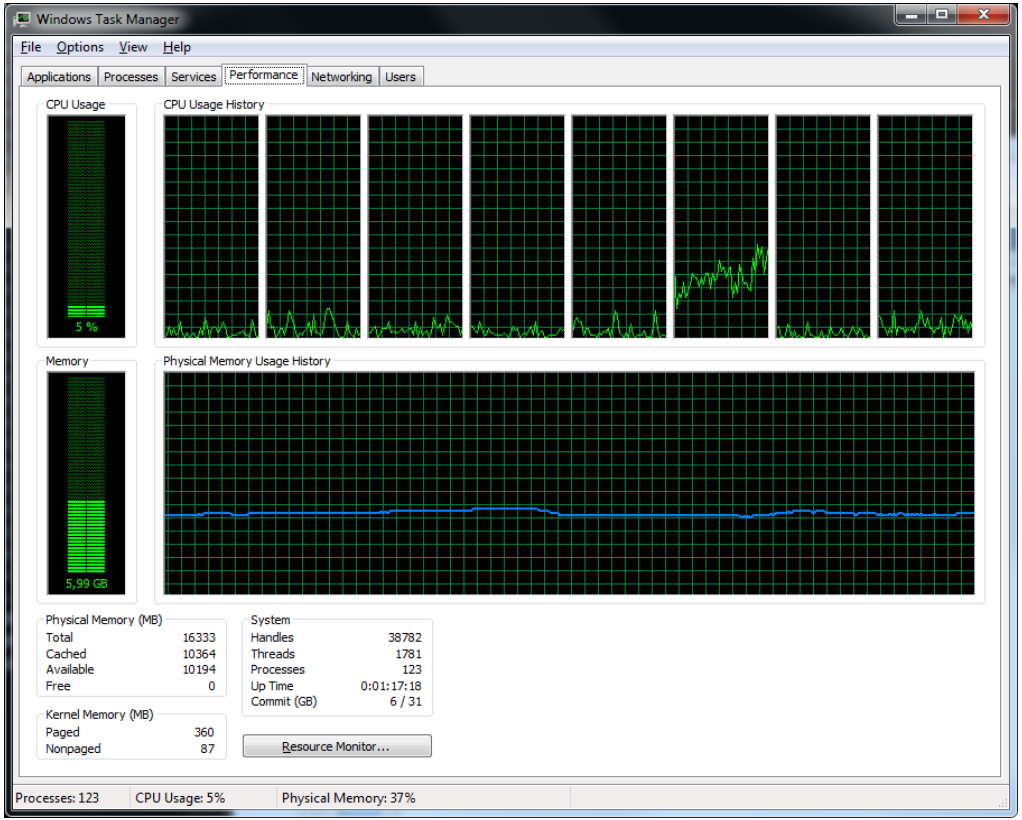


Memory usage inside Firebird process

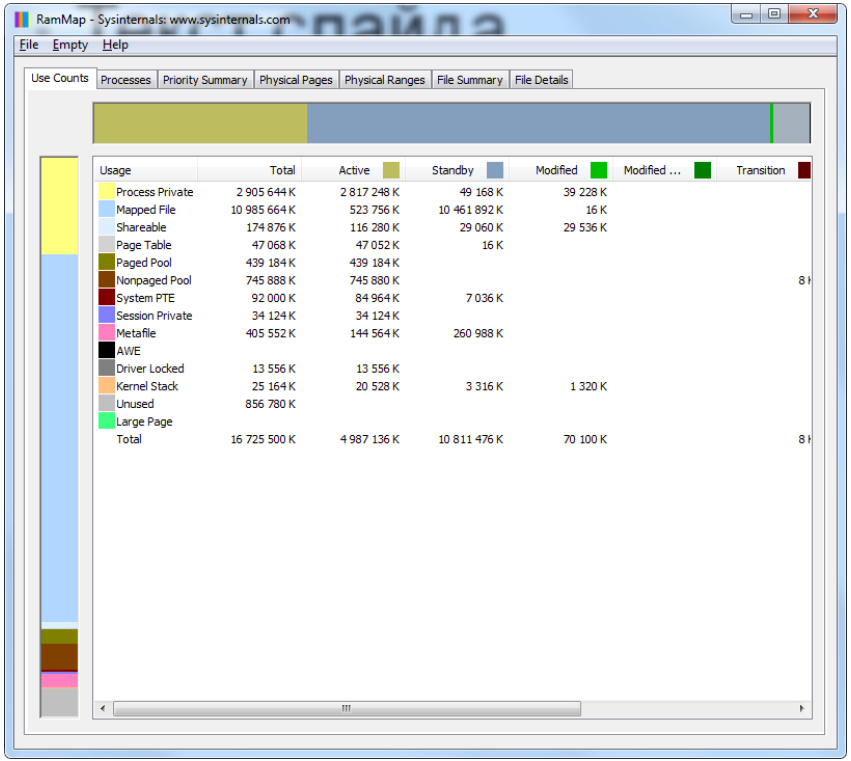
1. Page cache (buffers)
2. Memory for sorting
3. Lock table
4. Metadata cache
   - Depends on number of tables, stored procedures, triggers, etc
5. Undo лог
   - Depends on the number of changes in the frames of transactions

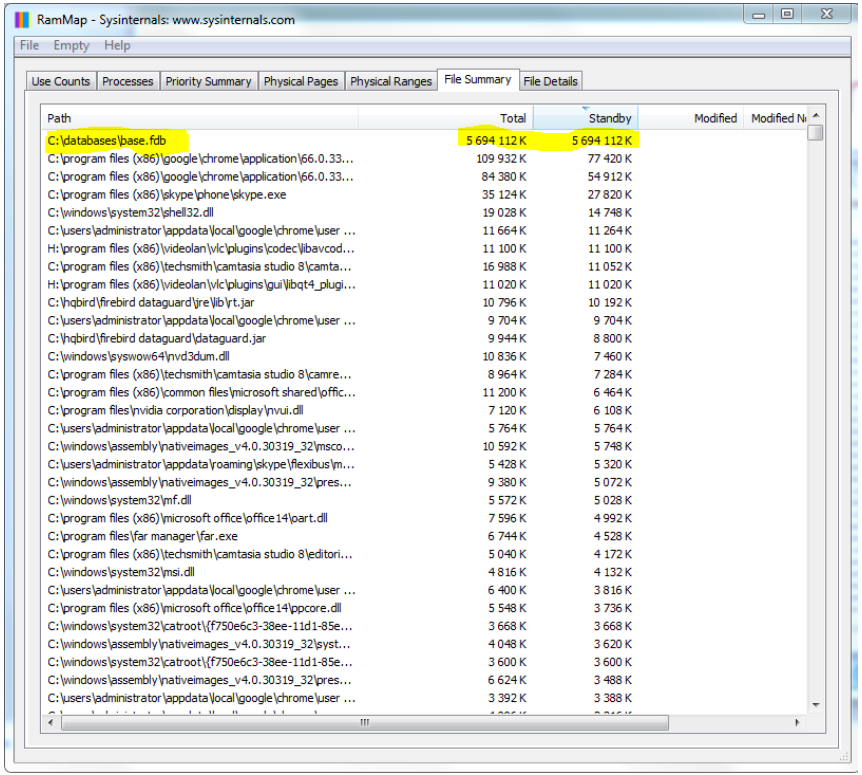
We can tune sizes of these parts

Where is the file cache?



RAMMap shows actual memory usage





Conclusions

- OS has specific default distribution between memory types
- The goal of memory management is to fit into frames of OS limits and memory use patterns
- In the second part we will consider how to tune Firebird memory usage

PART 2: TUNING MEMORY USAGE IN FIREBIRD DATABASE

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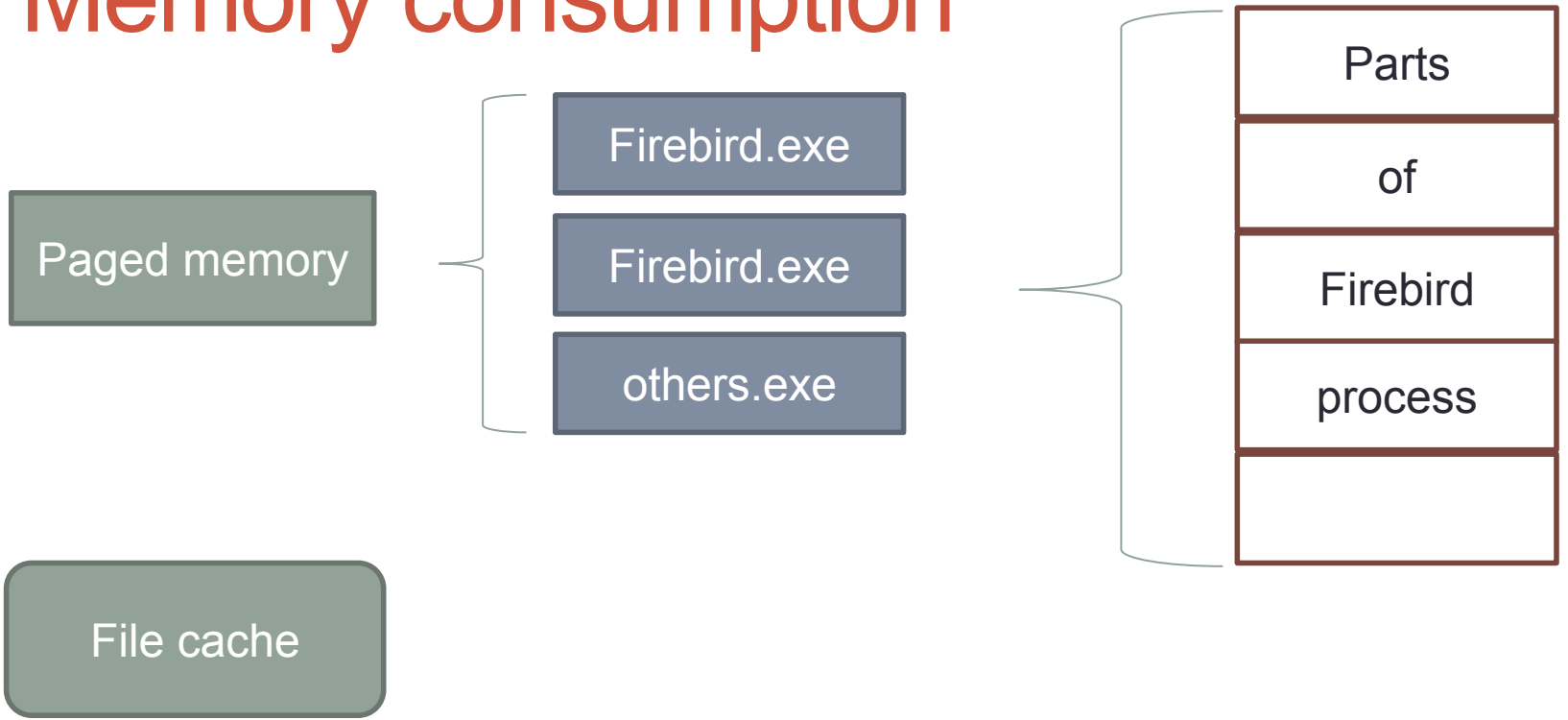
Memory consumption



Memory usage inside Firebird process

1. Page cache (buffers)
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   - Depends on number of tables, stored procedures, triggers, etc
5. Undo log
   - Depends on the number of changes in the frames of transactions

We can tune sizes of these parts

Page cache (buffers)

- Contains frequently changed database pages
- Page cache depends on Firebird architecture
  - Classic and SuperClassic – for each connection
  - SuperServer – for all connections

How to calculate page cache size

- Page cache size
  - Page Buffers X Database page size
- Default values
  - SuperServer 2.5: 2048 pages x 4096 byte = 8 Mb
  - Classic/SuperClassic 2.5: 75 x 4096 = 0,29 Mb

- Default values are low, they must be increased.

How to change page cache

- Parameter DefaultDBCachePages in firebird.conf
- gfix –buffers NNN
- Connection parameter

Recommended size of page cache for Firebird 2.5

- Classic/SuperClassic – from 512 to 2048 pages, rarely 4096
- Example for Classic: **100 users*2048*16k~=3,2Gb**
- SuperServer – the empirical limit is 10000 pages

Recommended size of page cache for Firebird 3.0

- Classic/SuperClassic – from 512 to 2048 pages, rarely 4096
- SuperServer – theoreticaly all memory can be used for the page cache – but not recommended!
- For Firebird SuperServer 3.0 empirical value is ~40% of RAM
  - For dedicated Firebird server

Memory for sorting

- Memory for sorting
  - firebird.conf parameter TempCacheLimit
- For Classic – for each connection
- For SuperClassic/SuperServer – for all connections

Memory for sorting: values

- TempCacheLimit - specified in bytes
- By default
  - Classic - 8Mb
  - SuperServer/SuperClassic – 64Mb
- Default values are low and must be increased
- Memory is allocated on demand, by default with 1Mb step.
  - It is managed by TempBlockSize parameter

Temp files for sorting

- fb_sort_xxx files are created
  - in %Temp% folder
  - In /tmp/firebird
  - or folders specified in TempDirectories parameter

- You can monitor number and size of temporary files manually, or automatically with HQbird, and increase values accordingly

Recommendations for TempCacheLimit

- Increase default value
- Monitor temp sort files to see actual sizes of sorted arrays
- Remember about OS memory manager – total size of paged memory should be less than 50% of Windows

Lock table

- Lock table size
  - Initial parameter is set in LockMemSize
- Default – 1Мб
- Automatically increased
- We recommend to set lock table size to the value you can see after the day of work

Example: lock table for database with 1036 users is 68Mb

```
LOCK_HEADER BLOCK
Version: 145, Active owner: 0, Length: 82048576, Used: 68650352
Flags: 0x0001
Enqs: 92366796464, Converts: 65879210, Rejects: 35657793, Blocks:
1021497258
Deadlock scans: 11, Deadlocks: 0, Scan interval: 10
Acquires: 96127236234, Acquire blocks: 29354592388, Spin count: 0
Mutex wait: 30.5%
Hash slots: 49009, Hash lengths (min/avg/max): 0/ 3/ 14
Remove node: 0, Insert queue: 0, Insert prior: 0
Owners (1036): forward: 6621216, backward: 49994472
Free owners (66): forward: 27637856, backward: 58344720
Free locks (18591): forward: 63254664, backward: 57867608
Free requests (188245): forward: 22698880, backward: 23113112
Lock Ordering: Enabled
```

Memory parameters in firebird.conf

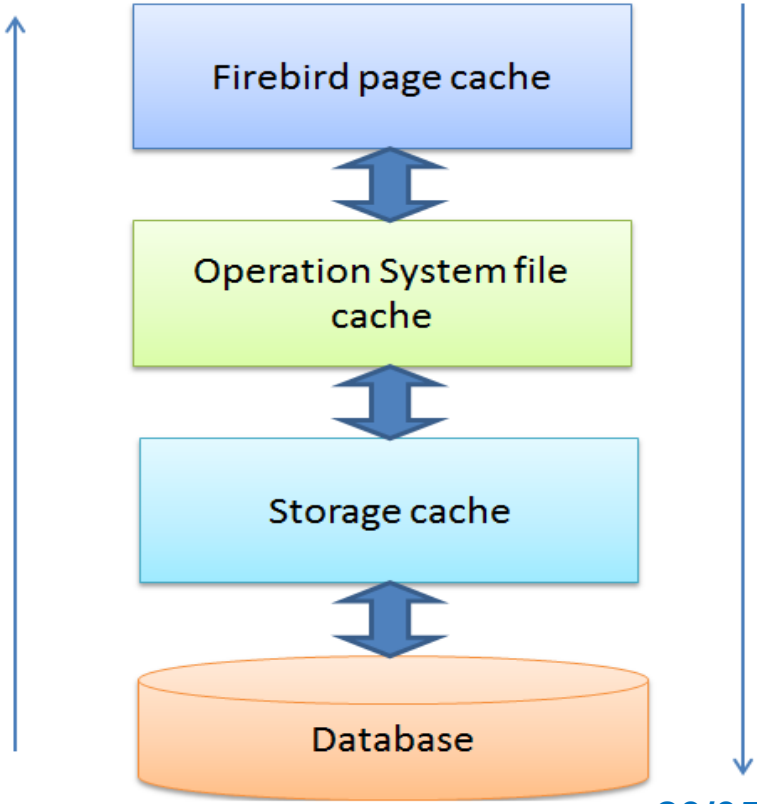
- **DefaultDBCachePages** – number of page buffers
- **TempCacheLimit** – memory size for sorting
  - **TempBlockSize** – size of memory block for TempCacheLimit
- **LockMemSize** – initial size of lock table
- **FileSystemCacheThreshold** – file cache threshold
- **FileSystemCacheSize** – for Windows, limit of of the file cache

Condition to enable file cache for Firebird

- **Page cache < FileSystemCacheThreshold**
- With default parameters file cache is always on, can be disabled if you increase page buffers without increasing FileSystemCacheThreshold

- File Cache is critically important for Classic and SuperClassic!

When can disable File Cache?



- You can try to switch the file cache off for SuperServer only in the following cases:
  - Read Only database
  - Database which fits into page buffers with low % of writes
  - For databases on SSD with very low % of writes
- Test it!

General recommendations for RAM on Windows

- Total size of all processes (for Firebird page buffers+TempCacheLimit, etc) < Paged Memory (50% of RAM by default)
- File Cache must be enabled
  - For Classic and SuperClassic without exceptions
  - For SuperServer for large databases (more than RAM size)

General recommendations for Linux

- Linux usually does not have strict allocation about paged memory, and allows file cache to grow high
- Recommended % for paged memory limit is up to 50%, but usually is less
- File Cache must be enabled in all cases

Optimized Firebird configuration files

- https://ib-aid.com/en/optimized-firebird-configuration/

Thank you!

Contact us:

- https://www.ib-aid.com
- support@ib-aid.com

Swap file tuning

- In case of balanced settings for paged memory and file cache, and RAM > 32Gb, swap file can be limited to 16Gb.
- Put swap file on the separate SSD – not on SSD with database!
  - Keep an eye on the SSD health!