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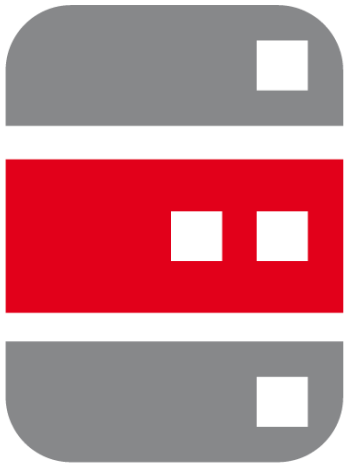

Your reliability. Our concern.

Resolving Child Cursor Issues Resulting In Mutex Waits

Martin Klier
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Performing Databases GmbH

Würzburg, 27.03.2014

Agenda

- Introduction
- Oracle Parsing, Child Cursors
- Mutexes, Waits and Reasons
- Issues, Quick Fixes and Solutions
- Summary, Acknowledgements, Q&A session

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Speaker

IOUG independent oracle users group

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- Co-Founder of Performing Databases GmbH
- Focus on Performance, Tuning and High Availability
- Linux since 1997, Oracle since 2003
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Public Appearances Mid-2014

DOAG Deutsche ORACLE-Anwendergruppe e.V.

COLLABORATE 14
TECHNOLOGY AND APPLICATIONS FORUM FOR THE ORACLE COMMUNITY

- 27.03. DOAG Regio Würzburg
- 10.04. IOUG Collaborate 2014 Las Vegas
- 02.06. FH Köln / Gummersbach
- 03.06. DOAG Database Konferenz 2014 Düsseldorf
- 13.06. DOAG Webinar

- Performing Databases GmbH, Mitterteich
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    Hochverfügbarkeit, Architekturplanung

- Web: http://www.performing-databases.com

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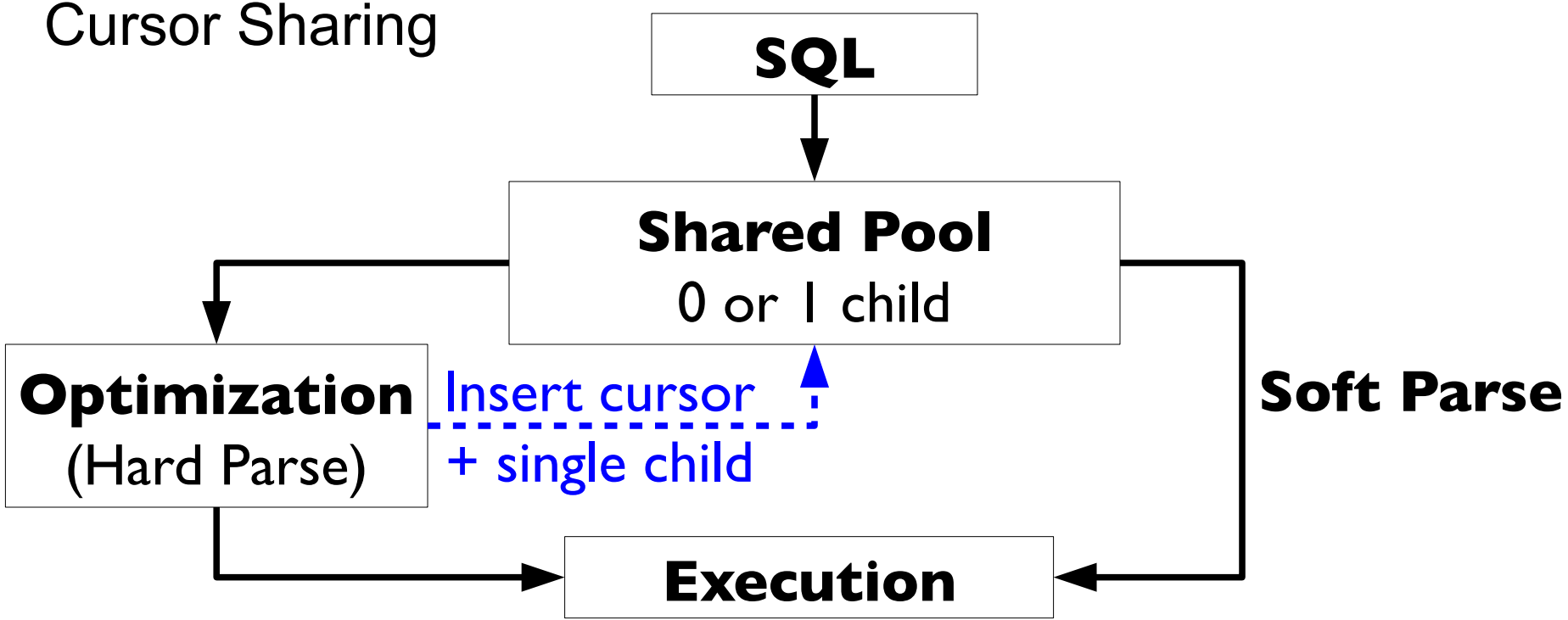
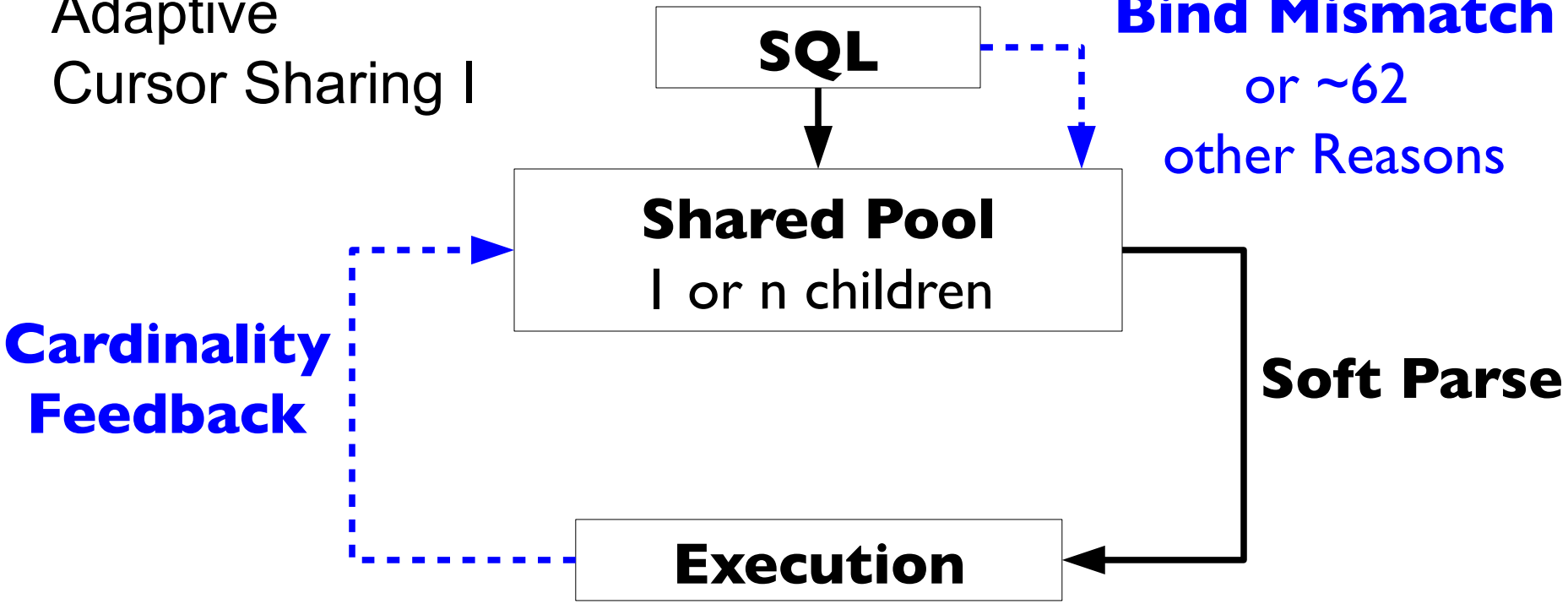
Parsing

Cursor Sharing



Parsing

Adaptive
Cursor Sharing I



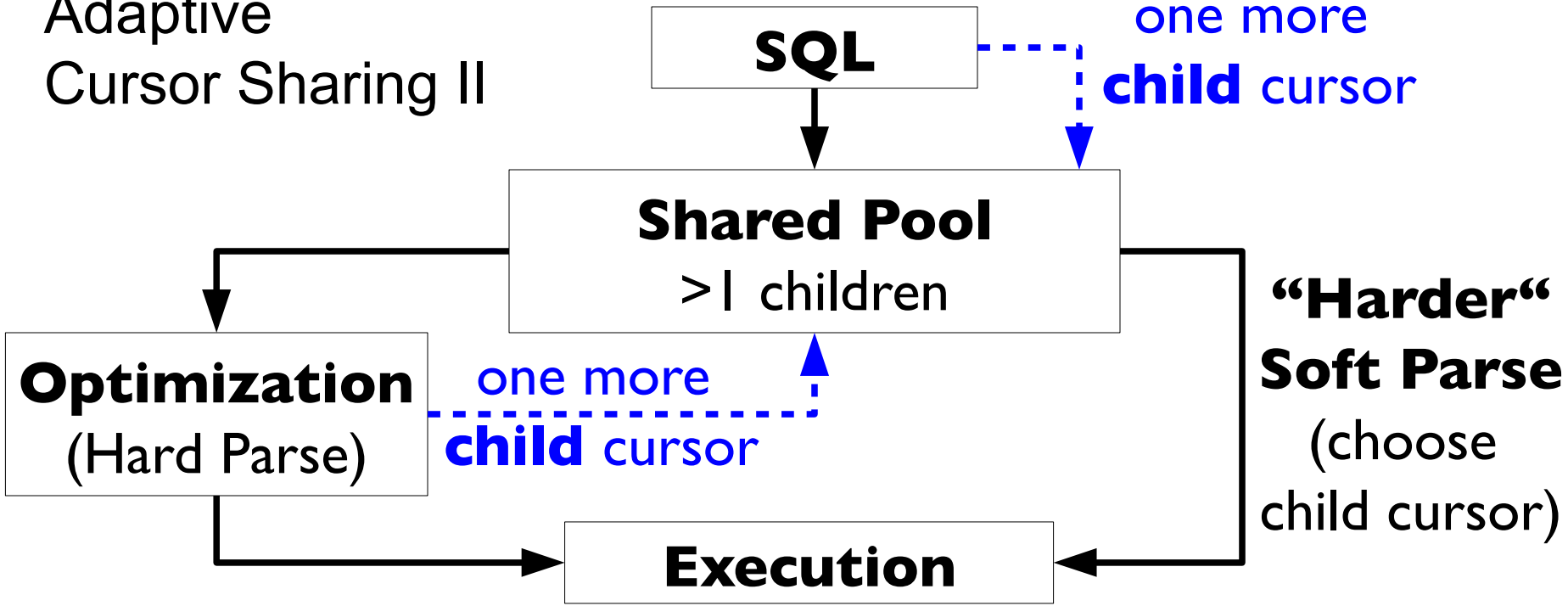
Parsing

64 Reasons for not re-using an existing child cursor

- Optimizer mode change (ALL_ROWS, FIRST_ROWS)
- NLS- and user identity trouble,
- Outline mismatch, Cardinality feedback (**wanted**)
- Bind mismatch (many sub-reasons, **most unwanted**)
- ...

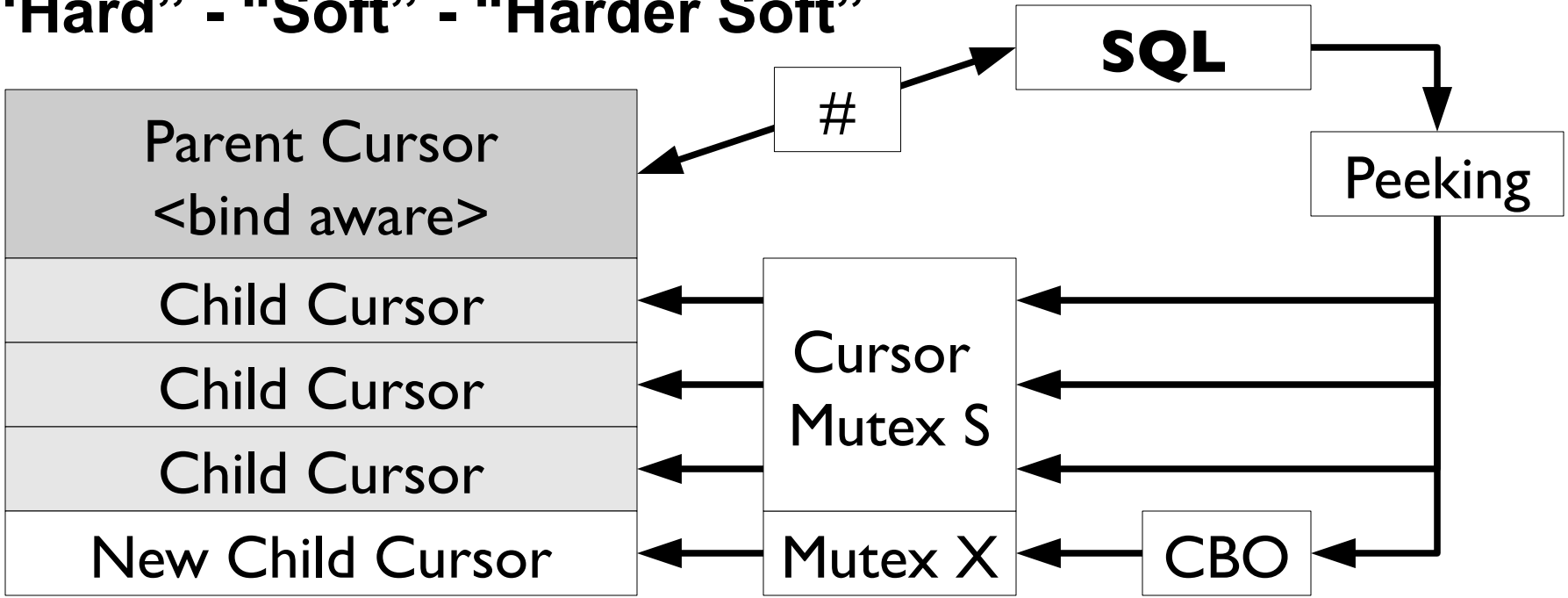
Parsing

Adaptive
Cursor Sharing II



Parsing

“Hard” - “Soft” - “Harder Soft”



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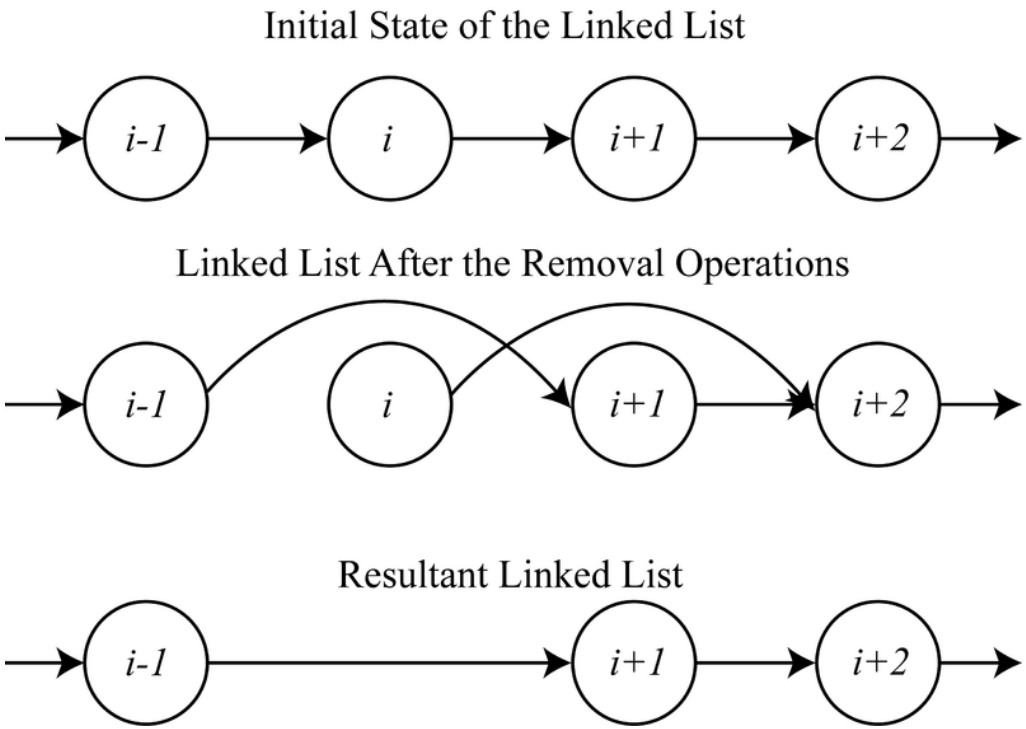
Mutex

Example:

Simultaneously removing two nodes from a singly linked list



(picture from Wikipedia)

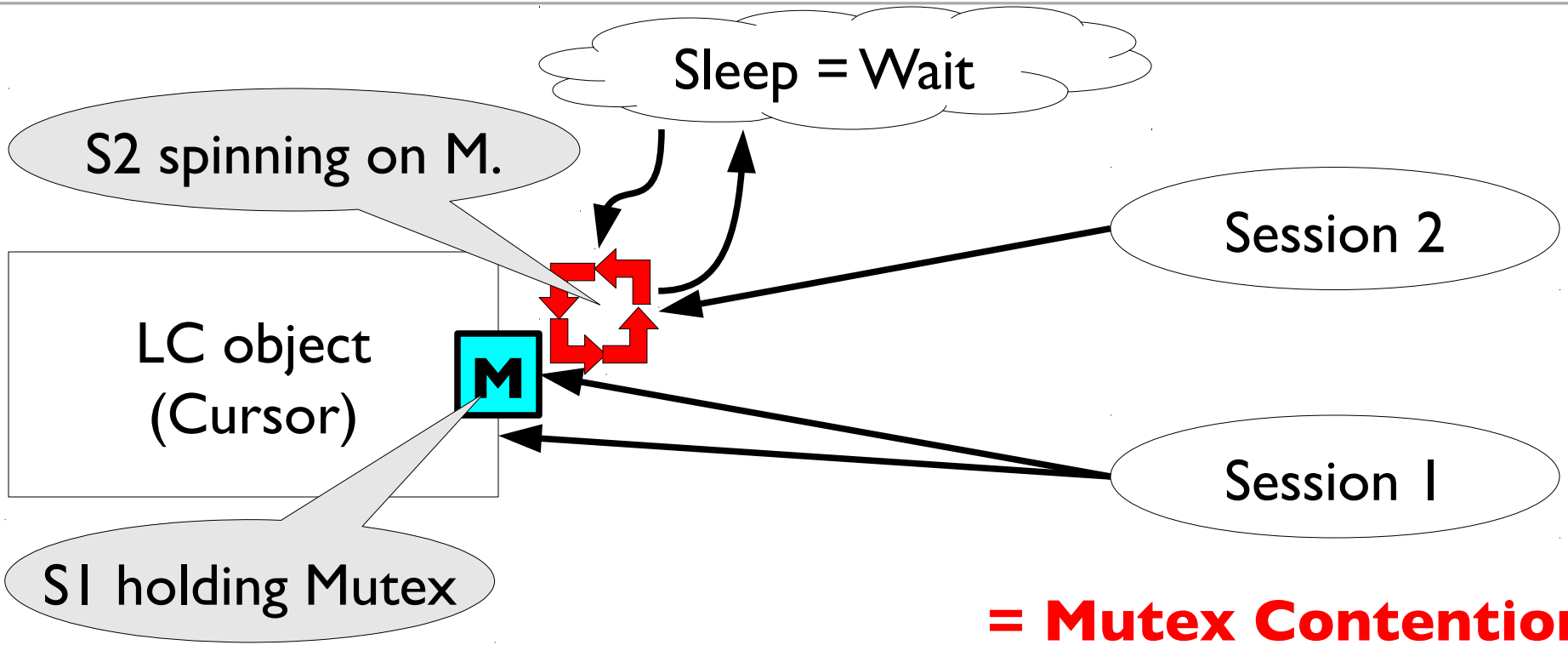
Mutex

- "Mutual Exclusion"
  = Fine-grained serialization structure

- It's just like a **latch**, but smaller, lighter, **faster**

- Introduced in 10g R2
- managed by KGX (Kernel Generic Mutex Module)

Waits



= Mutex Contention

What are Wait Events (on Mutexes)?

- Somebody **requests** a Mutex
- Can **not get it** by spinning
- And thus, **sleeps**

- Sleeping is recorded as wait time
- Spinning is **not** recorded as wait-, but as CPU time

Waits

cursor: mutex X

Wants: **Exclusive** mode on Mutex of Parent / Child

To:

- Build a new Child Cursor
- Capture SQL bind data (peek)
- Modify cursor-related statistics

Waits

cursor: mutex S

Wants: **Shared** mode on Mutex of Parent / Child

To:

- Change the reference count (“in flux”)
  = “new guy is interested / spinning”

Waits

cursor: pin X

Wants: **Exclusively** pin a P/C cursor in cache

To:

- Create the cursor
- Alter the cursor

Waits

cursor: pin S

Wants: Pin a P/C cursor in **shared** mode

To:

- Use (execute) the cursor

Waits

cursor: pin S wait on X

Wants: Pin a P/C cursor in **shared** mode
but **sb. already has it** in **exclusive** mode

To:

- Use (execute) the cursor
- When sb. is altering the cursor (e.g. due to DDL)

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Issues

Simple - <u>cursor: pin S</u>

- Caused by massively parsing one SQL_ID
  => Hot Spot Object in Library Cache

- Diagnosis: Oracle Wait Interface

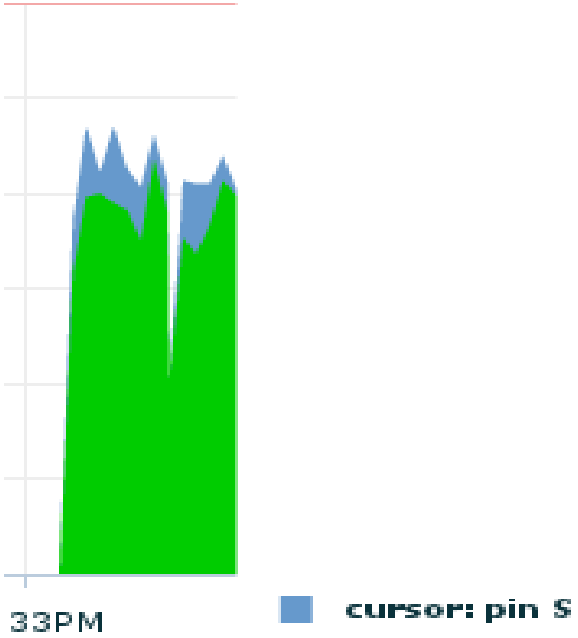
- (Half) solution: Diversify SQL_ID (not **randomize!**)
  select /* WebServer4 */ something from table;

Issues

Provocation of a
cursor: pin S wait situation

- Tightly looping one SQL 1,000,000 times
- in 20 threads

→ Overcrowding the cursor's pin mutex



Issues

Complex - cursor: mutex S/X

- Root-caused by invalidated child cursor(s)
  => Too many cursor objects in Library Cache

- Diagnosis:
  - Oracle Wait Interface
  - 10046 Level 12 session trace (=sql_trace event)
  - v$sql_shared_cursor **plus** cursortrace [296377.1]

Issues

One example reason for <u>cursor: mutex S/X</u>

Application uses jdbc setter methods improperly on INTEGER column (=2)

- setNUMBER(2) => Bind Var. is **NUMBER**
- setNULL(2) => Bind Var. is **VARCHAR2**

= BIND MISMATCH

Issues

10046 Level 12 trace for cursor: mutex S/X

```
Trace 1:
Bind#2
>> oacdty=01 mxl=32(04) mxlc=00 mal=00 scl=00 pre=00
oacflg=03 fl2=1000010 frm=01 csi=873 siz=0 off=168
kxsbbbfp=1118e1cd8 bln=32 avl=00 flg=01

Trace 2:
Bind#2
>> oacdty=02 mxl=22(22) mxlc=00 mal=00 scl=00 pre=00
oacflg=03 fl2=1000000 frm=01 csi=873 siz=0 off=168
kxsbbbfp=110977db8 bln=22 avl=02 flg=01
value=99
```

in 30 columns
= 2^30 times
BIND MISMATCH

Issues

One Quick Fix for cursor: mutex S/X

System is loaded with heavy mutex waits
due to high number of cursors (=version count)

=> **frequently** flush this cursor with
dbms_shared_pool.purge
(look out for new parsing issues = CPU)

Issues

One solution for <u>cursor: mutex S/X</u>

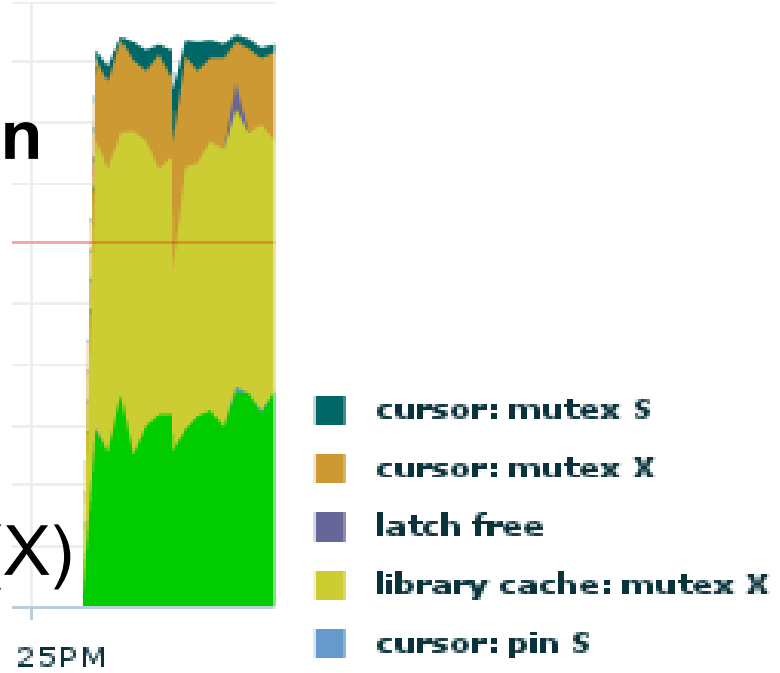
Application uses jdbc setter methods
now properly on INTEGER column (=2)

- setNUMBER(2) => Bind Var. is **NUMBER**
- setNULL(2, java.sql.Types.INTEGER)
  => Bind Var. is **NUMBER**

Issues

Provocation of a
cursor: mutex S/X wait situation

- Generating 64 child cursors for one SQL_ID
- Accessing them 20x parallel
- → Delay to create new children (X)
- → Delay to select good child (S)



Issues

Similar Problem with CHAR binds

- Bind buffers are size 32, 128, 2000 or 4000 bytes
- Changing CHAR bind length invalidates
- Reason BIND_LENGTH_UPGRADEABLE
  = 4^n cursor versions

Issues

Heavy - Oracle internal pitfalls I

- 11g “features” like
  MOS: “Its important to note that cursor obsoletion code was removed in version 11.
  *That means **we no longer obsolete a parent cursor when it reaches 1024 child cursors** [as we did in 10g.]”*
- Workaround
  Enhancement Patch 10187168 introduces parameter “_cursor_obsolete_threshold” (<= included in 11.2.0.3+)

Issues

Heavy - Oracle internal pitfalls II

- DB Bugs like 10157392 + 12939876
  (fixed in 12.1, backported to 11.2.0.3)
  Memory leak: increasing number of child cursors over time, especially if the shared pool is under load.
- DB Bug 9591812 (fixed in 12.1)
  Wrong wait events in 11.2 ("cursor: mutex S" instead of "cursor: mutex X")
  Official MOS workaround:

  Be cautious when interpreting S mode mutex / pin waits.…

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I suggest...

My suggestions for "cursor: mutex S/X" casualties

- Check how the application does handle **bind** variables
  Avoid BIND MISMATCH at (nearly) any cost
- Reduce the number of **cursor versions** below 100
  More will lead to overhead
- Look for matching Oracle **bugs** in your RDBMS release
- **Upgrade** to 11.2.0.3 or higher
  11.2.0.2 is worst version for cursor issues IMHO

Read on...

More resources on this topic

- MOS Documents
  1356828.1; 1377998.1; 296377.1
- Põder, Tanel
  Presentation: "Oracle Latch and Mutex Contention Troubleshooting"
- Shallahamer, Craig
  Book: "Oracle Performance Firefighting"
  (ISBN 978-0-9841023-0-3)
- Nikolaev, Andrey
  Blog entries: "Mutex waits. Part 1 + 2"

Thank you very much for your attention!

Martin Klier
Senior Database Analyst
Performing Databases GmbH

Würzburg, 27.03.2014

Thank you

Many people have helped with suggestions, supplying test cases or taking daily work off me during preparation and travel phase. Guys, you are top!

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