Double Feature & Extended Cut: Oracle's kernel debug, diagnostics & tracing infrastructure

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TEAM UP FOR POUG

About me

Stefan Koehler

- Independent Oracle performance consultant and researcher
- 17+ years using Oracle RDBMS - Independent since 2011
- Oracle performance and internals geek
- Main interests: Cost based optimizer and Oracle RDBMS internals

Services: “All about performance & troubleshooting”

- Oracle performance tuning (e.g. Application, CBO, Database, Design, SQL)
- Oracle core internals researching (e.g. DTrace, GDB, Perf, etc.)
- Troubleshooting nontrivial Oracle RDBMS issues (e.g. Heap dumps, System state dumps, etc.)
- Services are mainly based on short-term contracting

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Agenda

- Introduction into Oracle events
- Oracle's kernel debug, diagnostics & tracing infrastructure APIs
  - Numeric Events (ks*/dbkd*)
  - Events++ / Generic Debug API (dbgd*)
  - Kernel Server Trace (KST) Diagnostics Framework
  - UTS (Unified Tracing Service) / Generic Trace API (dbgt*)
- How to list and disable set events
- Event propagation

Disclaimer: Almost everything is based on research and testing. Test it yourself - with your release and operating system - always! Do not trust anybody! ☺

Introduction into Oracle events

- Events are built into Oracle‘s low-level kernel debug, diagnostics & tracing infrastructure
- Oracle reengineered its low-level kernel debug, diagnostics & tracing infrastructure with 11g - major kernel components were instrumented with 3 APIs (ks*/dbkd*, dbgd*, dbgt*)
- In general events have 3 different main purposes
  - Create additional diagnostic data (on specific errors/actions or immediately)
  - Change Oracle behavior or workaround a specific problem
  - Enable hidden or undocumented features
- Oracle’s diagnostic and error numbers have the same number range (0 to 65535) and may have an associated default action (e.g. ORA-00600 triggers an errorstack trace)

Oracle's kernel debug, diagnostics & tracing APIs - Numeric Events (ks*/dbkd*)

- Event syntax is based on KSD (KSD = Kernel Service Debug)
- Oracle no longer adds new numeric trace events - going forward new trace events use the UTS (Unified Tracing Service)
- Some numeric events (e.g. 10046) are mapped (under the hood) to an Event++ (e.g. sql_trace[])
- Some numeric events also have text aliases (e.g. ORA-00060 → deadlock, ORA-10035 → parse_sql_statement)


```
alter … set events '<EVENT_NUMBER> trace name context forever, level <X>'
```

When
… should action take place

Type of action
… "trace" is used for tracing, altering behavior and dumps

Name
… always used in context with "trace"

Action
… context specific trace or "oradebug dumplist"

Options
… about duration and context specific trace info

Oracle's kernel debug, diagnostics & tracing APIs - Events++ (dbgd*)

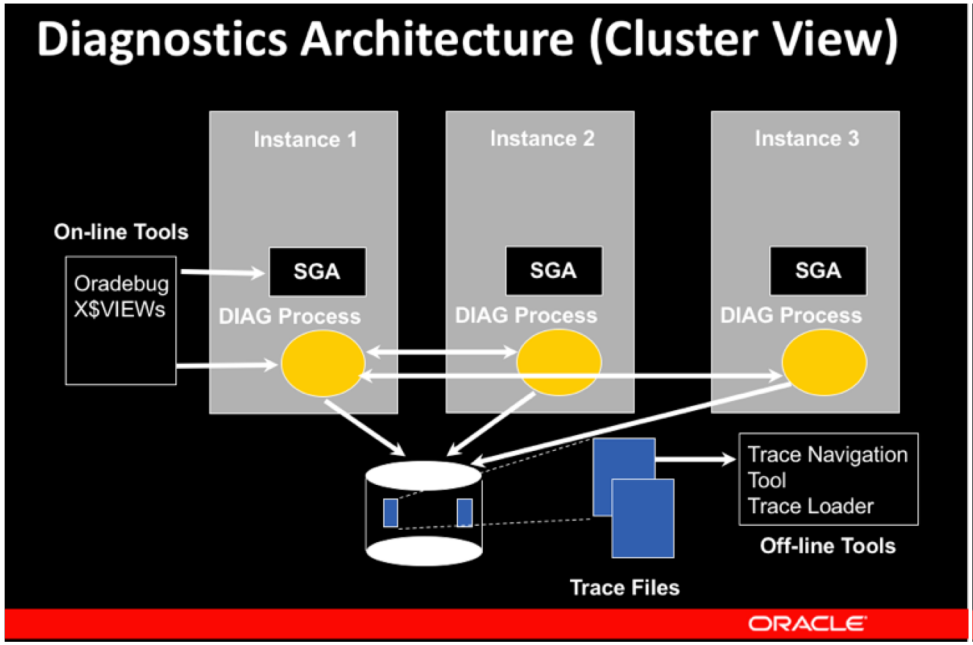
- Syntax for Events++ is more flexible and powerful
- C functions still check for numbers (for details check mapping file dbgdChkEventIntV_event_list_extended19c.txt by Hatem)

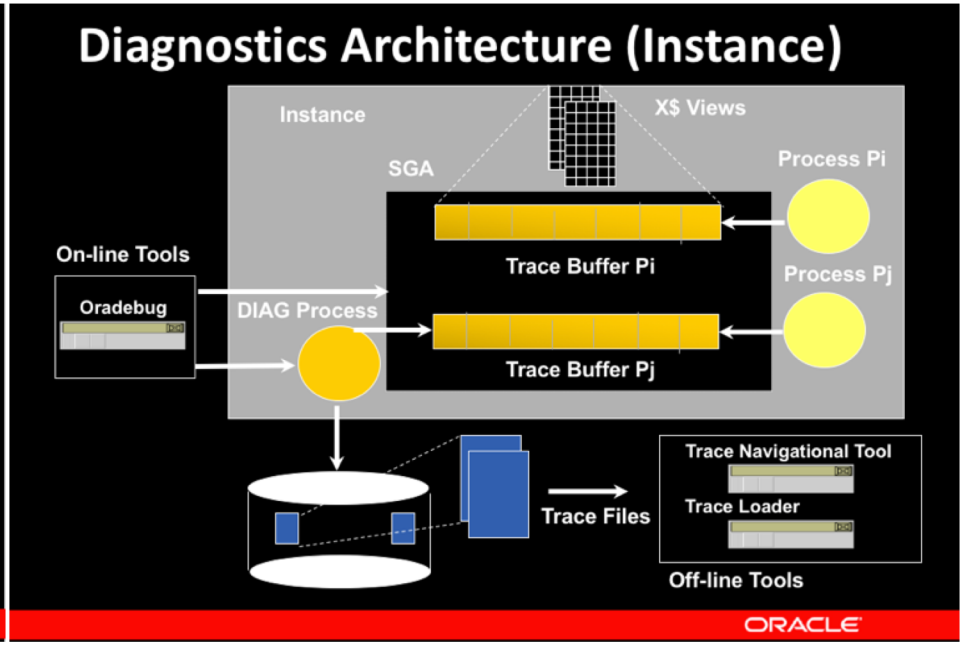
```
SQL> oradebug doc event
…
    NAME     [<event_name>]  List all events or describe <event_name>
    SCOPE    [<scope_name>]  List all scopes or describe <scope_name>
    FILTER   [<filter_name>] List all filters or describe <filter_name>
    ACTION   [<action_name>] List all actions or describe <action_name>
…
```

```
SQL> alter … set events 'sql_trace [sql: <sql_id>]';
```

Oracle's kernel debug, diagnostics & tracing APIs - Kernel Server Trace (KST)

- Generate enough diagnostic data for first pass analysis
- An always enabled in-memory ring buffer tracing
- Dumped by errorstack trace (ORA-600/ORA-7445) or DIAG process dumps KST buckets globally upon RAC instance failure
- Event based and controllable (e.g. on process level)





Oracle's kernel debug, diagnostics & tracing APIs - UTS (dbgt*)

- Tracing components can be found in ORADEBUG DOC COMPONENT
- Memory makes tracing info available in circular memory buffer (X$TRACE) and stack traces (e.g. ORA-00600), if instrumented

```
SQL> oradebug doc event name trace
trace: Main event to control UTS tracing

Usage
-------
trace [ component <string>[0] ]
 disk    < default | lowest | low | medium | high | highest | disable >,
 memory < default | lowest | low | medium | high | highest | disable >,
 get_time      < disable | default | seq | highres | seq_highres >,
 get_stack     < disable | default | force >,
 operation     <string>[32],
 function      <string>[32],
 file      <string>[32],
 line      <ub4>,
 conuid    <ub4>
```

How to list and disable set events

- Events can be listed with dbms_system.read_ev() or ORADEBUG but ORADEBUG is more convenient

```
SQL> oradebug doc event action eventdump

eventdump
    - list events that are set in the group

Usage
-------
eventdump( group     < system | process | session >)


  system   - Dump system group's event settings
  process  - Dump process group's event settings
  session  - Dump session group's event settings
```

Event propagation

- Event information is copied from PGA to SGA (shared pool) when event is set (on system level)
- Event propagation is happening on session creation or next database call by copying event information from SGA to PGA
- Can be controlled via “_evt_system_event_propagation“ (since Oracle 11g)
- Event propagation is broken in Oracle 12.2 (bug #25989066 & #25994378) and fixed in Oracle 18c

OK, this was high-level but how does it work under the hood?

Let's ask for some help from Weed Man ...

References

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