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# Five Things about SQL and PL/SQL you might not have known about

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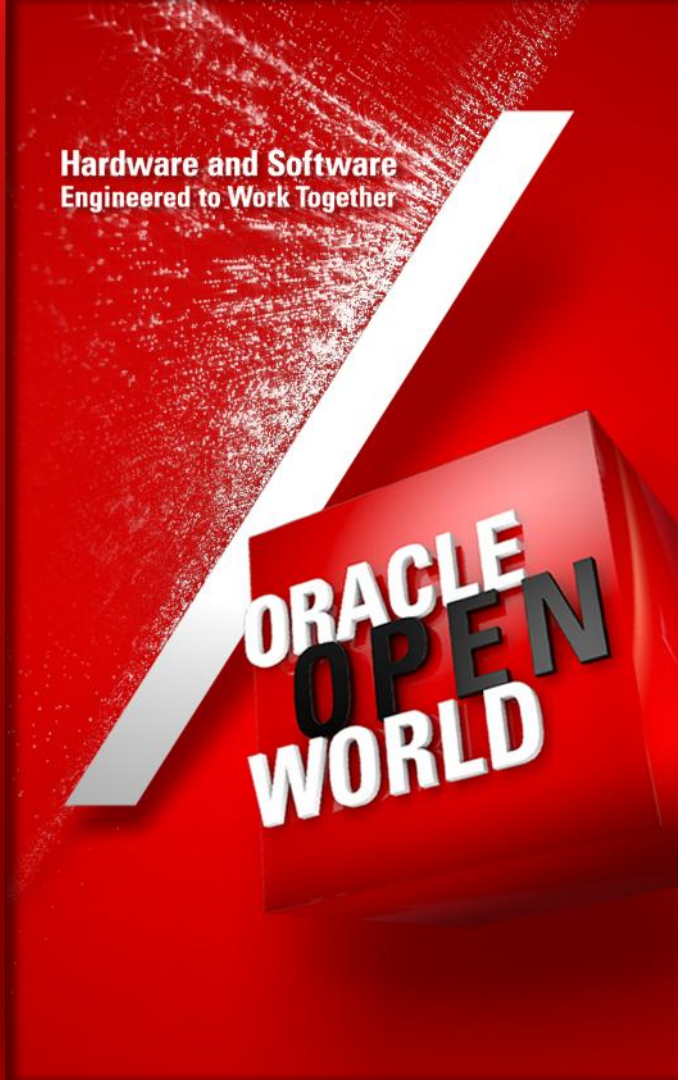

# Program Agenda

- Warnings
- Better Statistics
- Optimizer Optimizations
- SQL*Net Compression
- Implicit Conversions Are *Evil*

# Warnings

# Warnings

- PL/SQL Compiler has been warning us since 10.1 (2004!)
- Not widely used
- Can be warnings or compile errors

# Warnings

- Severe: code might cause unexpected action or wrong results
- Performance: condition might cause performance issues
- Informational: code as written won't be wrong or slow – just bad code

# Severe

```
c##tkyte%CDB1> alter session set plsql_warnings='enable:severe';
Session altered.

c##tkyte%CDB1> create or replace procedure p
  2  as
  3          procedure substr
  4          is
  5          begin
  6                  null;
  7          end;
  8  begin
  9          null;
 10  end;
 11  /
SP2-0804: Procedure created with compilation warnings

c##tkyte%CDB1> show errors
Errors for PROCEDURE P:

LINE/COL ERROR
-------- -----------------------------------------------------------------
1/1      PLW-05018: unit P omitted optional AUTHID clause; default value
         DEFINER used

3/12     PLW-05004: identifier SUBSTR is also declared in STANDARD or is a
         SQL builtin
```

# Performance

```
c##tkyte%CDB1> alter session set plsql_warnings='enable:performance';
Session altered.

c##tkyte%CDB1> create or replace procedure p
  2  as
  3          l_string varchar2(5);
  4  begin
  5          for x in (select * from emp where empno = l_string)
  6          loop
  7                  null;
  8          end loop;
  9  end;
 10  /
SP2-0804: Procedure created with compilation warnings

c##tkyte%CDB1> show errors
Errors for PROCEDURE P:

LINE/COL ERROR
-------- -----------------------------------------------------------------
5/44     PLW-07204: conversion away from column type may result in
         sub-optimal query plan
```

# Informational

```
c##tkyte%CDB1> alter session set plsql_warnings='enable:informational';
Session altered.

c##tkyte%CDB1> create or replace procedure p
  2  as
  3  begin
  4          if (null is not null)
  5          then
  6                  dbms_output.put_line( 'hello world' );
  7          end if;
  8  end;
  9  /
SP2-0804: Procedure created with compilation warnings

c##tkyte%CDB1> show errors
Errors for PROCEDURE P:

LINE/COL ERROR
-------- -----------------------------------------------------------------
6/3      PLW-06002: Unreachable code
```

# My Current Favorite…

```
c##tkyte%CDB1> alter session set
                     plsql_warnings='enable:all,disable:5018,error:6009,error:7204';
Session altered.
c##tkyte%CDB1> create or replace procedure p
  2  as
  3  begin
  4          dbms_output.put_line( 'hello world' );
  5  exception
  6  when others
  7          then null;
  8  end;
  9  /
Warning: Procedure created with compilation errors.
c##tkyte%CDB1> show errors
Errors for PROCEDURE P:

LINE/COL ERROR
-------- -----------------------------------------------------------------
6/6      PLS-06009: procedure "P" OTHERS handler does not end in RAISE or
         RAISE_APPLICATION_ERROR
```

# Warnings

- Can be set at
  - The system level ALTER SYSTEM
  - The session level ALTER SESSION
  - Unit by unit
    ALTER PROCEDURE *P* COMPILE PLSQL_WARNINGS='…' REUSE SETTINGS;

# Better Statistics

# Better Statistics

- Wrong Plan => Wrong Cardinality
- Pipelined Functions => Wrong Cardinality by default
- We can do better – five ways to better statistics for pipelined functions
- http://www.oracle-developer.net/display.php?id=427
  Nice write up of some of them by **Adrian Billington**

# #1 Cardinality Hint (9i and above, undocumented)

```
c##tkyte%CDB1> create or replace type str2tblType as table of varchar2(30)
  2  /
Type created.
c##tkyte%CDB1> create or replace
  2  function str2tbl( p_str in varchar2, p_delim in varchar2 default ',' )
  3  return str2tblType
  4  PIPELINED
  5  as
  6      l_str      long default p_str || p_delim;
  7      l_n        number;
  8  begin
  9      loop
 10          l_n := instr( l_str, p_delim );
 11          exit when (nvl(l_n,0) = 0);
 12          pipe row( ltrim(rtrim(substr(l_str,1,l_n-1))) );
 13          l_str := substr( l_str, l_n+1 );
 14      end loop;
 15  end;
 16  /
Function created.
```

# #1 Cardinality Hint (9i and above, undocumented)

```
c##tkyte%CDB1> variable x varchar2(15)
c##tkyte%CDB1> exec :x := '1,2,3,a,b,c'

PL/SQL procedure successfully completed.

c##tkyte%CDB1> select * from table(str2tbl(:x));

COLUMN_VALUE
------------------------------
1
2
3
a
b
c


6 rows selected.
```

# #1 Cardinality Hint (9i and above, undocumented)

```
c##tkyte%CDB1> select * from table(dbms_xplan.display_cursor);

PLAN_TABLE_OUTPUT
------------------------------------------------------------------------------------------------
SQL_ID  ddk1tv9s5pzq5, child number 0
-------------------------------------
select * from table(str2tbl(:x))

Plan hash value: 2407808827

-----------------------------------------------------------------------------------------------
| Id  | Operation                           | Name    | Rows  | Bytes | Cost (%CPU)| Time     |
-----------------------------------------------------------------------------------------------
|   0 | SELECT STATEMENT                    |         |       |       |    29 (100)|          |
|   1 |  COLLECTION ITERATOR PICKLER FETCH| STR2TBL |  8168 | 16336 |    29   (0)| 00:00:01 |
-----------------------------------------------------------------------------------------------
```

# #1 Cardinality Hint (9i and above, undocumented)

```
c##tkyte%CDB1> select * from table(dbms_xplan.display_cursor);

PLAN_TABLE_OUTPUT
------------------------------------------------------------------------------------------------
-------
SQL_ID  bd2f8rh30z3ww, child number 0
-------------------------------------
select /*+ cardinality(sq 10) */ * from table(str2tbl(:x)) sq

Plan hash value: 2407808827

-----------------------------------------------------------------------------------------------
| Id  | Operation                           | Name    | Rows  | Bytes | Cost (%CPU)| Time     |
-----------------------------------------------------------------------------------------------
|   0 | SELECT STATEMENT                    |         |       |       |    29 (100)|          |
|   1 |  COLLECTION ITERATOR PICKLER FETCH| STR2TBL |    10 |    20 |    29   (0)| 00:00:01 |
-----------------------------------------------------------------------------------------------


13 rows selected.
```

# #1 Cardinality Hint (9i and above, undocumented)

```
select * from t where object_name in (select * from table(str2tbl(:x)))

Plan hash value: 1957688699

-------------------------------------------------------------------------------------------------
| Id  | Operation                           | Name    | Rows  | Bytes | Cost (%CPU)| Time     |
-------------------------------------------------------------------------------------------------
|   0 | SELECT STATEMENT                    |         |       |       |   431 (100)|          |
|*  1 |  HASH JOIN RIGHT SEMI               |         |     2 |   232 |   431   (1)| 00:00:01 |
|   2 |   COLLECTION ITERATOR PICKLER FETCH| STR2TBL |  8168 | 16336 |    29   (0)| 00:00:01 |
|   3 |   TABLE ACCESS FULL                 | T       | 87322 |  9721K|   401   (1)| 00:00:01 |
-------------------------------------------------------------------------------------------------

Predicate Information (identified by operation id):
---------------------------------------------------

   1 - access("OBJECT_NAME"=VALUE(KOKBF$))
```

# #1 Cardinality Hint (9i and above, undocumented)

```
select * from t where object_name in (select /*+ cardinality(sq 10) */
* from table(str2tbl(:x)) sq)

Plan hash value: 3519658119

-----------------------------------------------------------------------------------------------
| Id  | Operation                           | Name     | Rows  | Bytes | Cost (%CPU)| Time     |
-----------------------------------------------------------------------------------------------
|   0 | SELECT STATEMENT                    |          |       |       |    44 (100)|          |
|   1 |  NESTED LOOPS                       |          |       |       |            |          |
|   2 |   NESTED LOOPS                      |          |    17 |  1972 |    44   (0)| 00:00:01 |
|   3 |    SORT UNIQUE                      |          |    10 |    20 |    29   (0)| 00:00:01 |
|   4 |     COLLECTION ITERATOR PICKLER FETCH| STR2TBL |    10 |    20 |    29   (0)| 00:00:01 |
|*  5 |    INDEX RANGE SCAN                 | T_IDX    |     2 |       |     2   (0)| 00:00:01 |
|   6 |   TABLE ACCESS BY INDEX ROWID       | T        |     2 |   228 |     3   (0)| 00:00:01 |
-----------------------------------------------------------------------------------------------

Predicate Information (identified by operation id):
---------------------------------------------------

   5 - access("OBJECT_NAME"=VALUE(KOKBF$))
```

# #2 OPT_ESTIMATE Hint (10g and above, undocumented, used by SQL Profiles)

```
c##tkyte%CDB1> select 10/8168 from dual;

   10/8168
----------
 .00122429

select /*+ opt_estimate(table, sq, scale_rows=0.00122429) */ *
  from table(str2tbl(:x)) sq

Plan hash value: 2407808827

-------------------------------------------------------------------------------------------
| Id  | Operation                           | Name    | Rows  | Bytes | Cost (%CPU)| Time     |
-------------------------------------------------------------------------------------------
|   0 | SELECT STATEMENT                    |         |       |       |    29 (100)|          |
|   1 |  COLLECTION ITERATOR PICKLER FETCH| STR2TBL |    10 |    20 |    29   (0)| 00:00:01 |
-------------------------------------------------------------------------------------------
```

# #3 Extensible Optimizer (10g and above)

```
c##tkyte%CDB1> CREATE OR REPLACE TYPE str2tbl_stats
  2  AS OBJECT
  3  (
  4     x NUMBER,
  5
  6     STATIC FUNCTION ODCIGetInterfaces
  7     ( p_interfaces OUT SYS.ODCIObjectList
  8     ) RETURN NUMBER,
  9
 10     STATIC FUNCTION ODCIStatsTableFunction
 11     ( p_function IN  SYS.ODCIFuncInfo,
 12       p_stats    OUT SYS.ODCITabFuncStats,
 13       p_args     IN  SYS.ODCIArgDescList,
 14       p_str      IN  varchar2 default NULL,
 15       p_delim    IN  varchar2  default ','
 16     ) RETURN NUMBER
 17  );
 18  /

Type created.
```

# #3 Extensible Optimizer (10g and above)

```
c##tkyte%CDB1> CREATE or replace TYPE BODY str2tbl_stats
  2  AS
  3
  4     STATIC FUNCTION ODCIGetInterfaces (
  5                     p_interfaces OUT SYS.ODCIObjectList
  6                     ) RETURN NUMBER IS
  7     BEGIN
  8        p_interfaces :=
  9                  SYS.ODCIObjectList( SYS.ODCIObject ('SYS', 'ODCISTATS2'));
 10        RETURN ODCIConst.success;
 11     END ODCIGetInterfaces;
 12
 13     STATIC FUNCTION ODCIStatsTableFunction (
 14                     p_function IN  SYS.ODCIFuncInfo,
 15                     p_stats    OUT SYS.ODCITabFuncStats,
 16                     p_args     IN  SYS.ODCIArgDescList,
 17                     p_str      IN  varchar2 default NULL,
 18                     p_delim    IN  varchar2  default ','
 19                     ) RETURN NUMBER IS
 20     BEGIN
 21        p_stats := SYS.ODCITabFuncStats
 22            ( nvl( length(p_str)-length(replace(p_str,p_delim,''))+1, 10) );
 23        RETURN ODCIConst.success;
 24     END ODCIStatsTableFunction;
 25  END;
 26  /
```

# #3 Extensible Optimizer (10g and above)

```
c##tkyte%CDB1> associate statistics with functions str2tbl using str2tbl_stats;

Statistics associated.
```

# #3 Extensible Optimizer (10g and above)

```
Select * from table ( str2tbl( :x||'',',') )

Plan hash value: 2407808827

-------------------------------------------------------------------------------------------
| Id  | Operation                           | Name    | Rows  | Bytes | Cost (%CPU)| Time     |
-------------------------------------------------------------------------------------------
|   0 | SELECT STATEMENT                    |         |       |       |    29 (100)|          |
|   1 |  COLLECTION ITERATOR PICKLER FETCH| STR2TBL |    10 |    20 |    29   (0)| 00:00:01 |
-------------------------------------------------------------------------------------------
```

# #3 Extensible Optimizer (10g and above)

```
Select * from table ( str2tbl( 'a,b,c',',') )

Plan hash value: 2407808827

-----------------------------------------------------------------------------------------
| Id  | Operation                           | Name    | Rows  | Bytes | Cost (%CPU)| Time     |
-----------------------------------------------------------------------------------------
|   0 | SELECT STATEMENT                    |         |       |       |    29 (100)|          |
|   1 |  COLLECTION ITERATOR PICKLER FETCH| STR2TBL |     3 |     6 |    29   (0)| 00:00:01 |
-----------------------------------------------------------------------------------------
```

# #4 Dynamic Sampling (11gR1 and above)

```
select /*+ dynamic_sampling( sq, 2 ) */ * from table( str2tbl(:x,',') ) sq

Plan hash value: 2407808827

-------------------------------------------------------------------------------------------
| Id  | Operation                           | Name    | Rows  | Bytes | Cost (%CPU)| Time     |
-------------------------------------------------------------------------------------------
|   0 | SELECT STATEMENT                    |         |       |       |    11 (100)|          |
|   1 |  COLLECTION ITERATOR PICKLER FETCH| STR2TBL |     6 |    12 |    11   (0)| 00:00:01 |
-------------------------------------------------------------------------------------------

Note
-----
   - dynamic sampling used for this statement (level=2)


(must be hinted)
```

# #5 Cardinality Feedback (11gR2 and above)

```
with sq as (select /*+ materialize */ *    from table( str2tbl( :x ) )
) select * from sq

Plan hash value: 630596523

-------------------------------------------------------------------------------------------------------------------
| Id  | Operation                          | Name                       | Rows  | Bytes | Cost (%CPU)| Time     |
-------------------------------------------------------------------------------------------------------------------
|   0 | SELECT STATEMENT                   |                            |       |       |    32 (100)|          |
|   1 |  TEMP TABLE TRANSFORMATION         |                            |       |       |            |          |
|   2 |   LOAD AS SELECT                   |                            |       |       |            |          |
|   3 |    COLLECTION ITERATOR PICKLER FETCH| STR2TBL                    |  8168 | 16336 |    29   (0)| 00:00:01 |
|   4 |   VIEW                             |                            |  8168 |   135K|     3   (0)| 00:00:01 |
|   5 |    TABLE ACCESS FULL               | SYS_TEMP_0FD9D6652_20F4CB  |  8168 | 16336 |     3   (0)| 00:00:01 |
-------------------------------------------------------------------------------------------------------------------


18 rows selected.
```

# #5 Cardinality Feedback (11gR2 and above)

```
with sq as (select /*+ materialize */ *    from table( str2tbl( :x ) )
) select * from sq

Plan hash value: 630596523

-----------------------------------------------------------------------------------------------------------------------
| Id  | Operation                           | Name                       | Rows  | Bytes | Cost (%CPU)| Time     |
-----------------------------------------------------------------------------------------------------------------------
|   0 | SELECT STATEMENT                    |                            |       |       |    32 (100)|          |
|   1 |  TEMP TABLE TRANSFORMATION          |                            |       |       |            |          |
|   2 |   LOAD AS SELECT                    |                            |       |       |            |          |
|   3 |    COLLECTION ITERATOR PICKLER FETCH| STR2TBL                    |  8168 | 16336 |    29   (0)| 00:00:01 |
|   4 |   VIEW                              |                            |     6 |   102 |     3   (0)| 00:00:01 |
|   5 |    TABLE ACCESS FULL                | SYS_TEMP_0FD9D6653_20F4CB  |     6 |    12 |     3   (0)| 00:00:01 |
-----------------------------------------------------------------------------------------------------------------------

Note
-----
   - cardinality feedback used for this statement


22 rows selected.
```

# Optimizer Optimizations

# Optimizer Optimizations

- You thought this would be about SQL, it isn't
- Since 10.1, PL/SQL has used an optimizing compiler
  - *"In even rarer cases, PL/SQL **might raise an exception earlier than expected** or **not at all**." (PL/SQL Language Reference)*

# Optimizer Optimizations

- Three levels – PLSQL_OPTIMIZE_LEVEL
  - *1: no code rearranging, code is “as is”*
  - *2: code rearranging possible, many optimizations such as implicit array fetch added*
  - *3: aggressive code rearranging*

# Optimizer Optimizations

```
c##tkyte%CDB1> alter session set plsql_optimize_level=1;
Session altered.

c##tkyte%CDB1> create or replace procedure p
  2  as
  3  begin
  4          for x in ( select * from t )
  5          loop
  6                  null;
  7          end loop;
  8  end;
  9  /
Procedure created.

c##tkyte%CDB1> exec dbms_monitor.session_trace_enable;
PL/SQL procedure successfully completed.

c##tkyte%CDB1> exec p
PL/SQL procedure successfully completed.
```

# Optimizer Optimizations

```
SELECT * FROM T


call     count       cpu    elapsed       disk      query    current        rows
------- ------  -------- ---------- ---------- ---------- ----------  ----------
Parse        1      0.00       0.00          0          0          0           0
Execute      1      0.00       0.00          0          0          0           0
Fetch    87323      0.81       0.85       1438      87325          0       87322
------- ------  -------- ---------- ---------- ---------- ----------  ----------
total    87325      0.81       0.85       1438      87325          0       87322
```

# Optimizer Optimizations

```
c##tkyte%CDB1> alter procedure p compile plsql_optimize_level=2;
Procedure altered.

c##tkyte%CDB1> exec dbms_monitor.session_trace_enable;
PL/SQL procedure successfully completed.

c##tkyte%CDB1> exec p
PL/SQL procedure successfully completed.

SELECT * FROM T

call     count       cpu    elapsed       disk      query    current        rows
------- ------  -------- ---------- ---------- ---------- ----------  ----------
Parse        1      0.00       0.00          0          0          0           0
Execute      1      0.00       0.00          0          0          0           0
Fetch      874      0.25       0.28       1438       2303          0       87322
------- ------  -------- ---------- ---------- ---------- ----------  ----------
total      876      0.25       0.28       1438       2303          0       87322
```

# Optimizer Optimizations, code rearranging

```
c##tkyte%CDB1> alter session set Plsql_Warnings = 'Enable:All'
  2  /
Session altered.

c##tkyte%CDB1> alter session set Plsql_Optimize_Level = 2
  2  /
Session altered.
```

# Optimizer Optimizations

```
c##tkyte%CDB1> create or replace procedure p
  2  authid definer
  3  as
  4    function Is_Number(x in varchar2) return varchar2
  5    is
  6      n number;
  7    begin
  8      n := To_Number(x);
  9      return 'Y';
 10    exception
 11      when value_error then
 12        return 'N';
 13    end Is_Number;
 14
 15  begin
 16    DBMS_Output.Put_Line(Is_Number('1'));
 17    DBMS_Output.Put_Line(Is_Number('a'));
 18  end p;
 19  /
Procedure created.
```

# Optimizer Optimizations

```
c##tkyte%CDB1> SHOW ERRORS
No errors.
c##tkyte%CDB1> exec p
Y
N

PL/SQL procedure successfully completed.
```

# Optimizer Optimizations

```
c##tkyte%CDB1> alter procedure p compile plsql_optimize_level=3;

SP2-0805: Procedure altered with compilation warnings

c##tkyte%CDB1> show errors
Errors for PROCEDURE P:

LINE/COL ERROR
-------- -----------------------------------------------------------------
4/3      PLW-06006: uncalled procedure "IS_NUMBER" is removed.
16/3     PLW-06005: inlining of call of procedure 'IS_NUMBER' was done
17/3     PLW-06005: inlining of call of procedure 'IS_NUMBER' was done
c##tkyte%CDB1> exec p;
Y
Y

PL/SQL procedure successfully completed.
```

# Optimizer Optimizations

- TO_NUMBER is “pure”
- It has no side effects
- It might raise an exception, but that isn’t a side effect.
- N is an unused variable
- The code becomes simply return ‘Y’

```
c##tkyte%CDB1> create or replace procedure p
  2  authid definer
  3  as
  4    function Is_Number(x in varchar2)
                 return varchar2
  5    is
  6      n number;
  7    begin
  8      n := To_Number(x);
  9      return 'Y';
 10    exception
 11      when value_error then
 12        return 'N';
 13    end Is_Number;
 14
 15  begin
 16    DBMS_Output.Put_Line(Is_Number('1'));
 17    DBMS_Output.Put_Line(Is_Number('a'));
 18  end p;
 19  /
Procedure created.
```

# Optimizer Optimizations

```
c##tkyte%CDB1> create or replace procedure p
  2  authid definer
  3  as
  4    function Is_Number(x in varchar2) return varchar2
  5    is
  6      n number;
  7    begin
  8      n := To_Number(x);
  9      if ( n = -1 )
 10      then
 11          return 'y'; -- what about 'Y'??
 12      else
 13          return 'Y';
 14      end if;
 15    exception
 16      when value_error then
 17        return 'N';
 18    end Is_Number;
 19  begin
 20    DBMS_Output.Put_Line(Is_Number('1'));
 21    DBMS_Output.Put_Line(Is_Number('a'));
 22  end p;
 23  /
```

# Optimizer Optimizations

```
c##tkyte%CDB1> show errors
Errors for PROCEDURE P:

LINE/COL ERROR
-------- -----------------------------------------------------------------
4/3      PLW-06006: uncalled procedure "IS_NUMBER" is removed.
20/3     PLW-06005: inlining of call of procedure 'IS_NUMBER' was done
21/3     PLW-06005: inlining of call of procedure 'IS_NUMBER' was done
c##tkyte%CDB1> exec p;
Y
N

PL/SQL procedure successfully completed.
```

# Optimizer Optimizations

```
c##tkyte%CDB1> create or replace procedure p
  2  authid definer
  3  as
  4    function Is_Number(x in varchar2) return varchar2
  5    is
  6      n number;
  7    begin
  8      n := To_Number(x);
  9      if ( n = -1 )
 10      then
 11          return 'Y';
 12      else
 13          return 'Y';
 14      end if;
 15    exception
 16      when value_error then
 17        return 'N';
 18    end Is_Number;
 19  begin
 20    DBMS_Output.Put_Line(Is_Number('1'));
 21    DBMS_Output.Put_Line(Is_Number('a'));
 22  end p;
 23  /
```

# Optimizer Optimizations

```
c##tkyte%CDB1> show errors
Errors for PROCEDURE P:

LINE/COL ERROR
-------- -----------------------------------------------------------------
4/3      PLW-06006: uncalled procedure "IS_NUMBER" is removed.
20/3     PLW-06005: inlining of call of procedure 'IS_NUMBER' was done
21/3     PLW-06005: inlining of call of procedure 'IS_NUMBER' was done
c##tkyte%CDB1> exec p;
Y
Y

PL/SQL procedure successfully completed.
```

# Optimizer Optimizations

```
c##tkyte%CDB1> create or replace procedure p
  2  authid definer
  3  as
  4      function Is_Number(X in varchar2) return varchar2
  5      is
  6          procedure Check_Number(Y in number)
  7          is
  8          begin
  9              null;
 10          end;
 11      begin
 12              pragma Inline(Check_Number, 'No');
 13              Check_Number(To_Number(X));
 14              return 'Y';
 15      exception
 16         when value_error
 17      then
 18          return 'N';
 19      end Is_Number;
 20  begin
 21    DBMS_Output.Put_Line(Is_Number('1'));
 22    DBMS_Output.Put_Line(Is_Number('a'));
 23  end p;
 24  /
```

# Optimizer Optimizations

```
c##tkyte%CDB1> show errors
Errors for PROCEDURE P:

LINE/COL ERROR
-------- -----------------------------------------------------------------
13/12    PLW-06008: call of procedure 'CHECK_NUMBER' will not be inlined
c##tkyte%CDB1> exec p
Y
N

PL/SQL procedure successfully completed.
```

# SQLNet Compression

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# SQLNet Compression

- How you retrieve the data matters
- Not all result sets are the same – even if they have the same data

# SQLNet Compression

```
ops$tkyte%ORA11GR2> create table t
  2  as
  3  select *
  4    from all_objects;
Table created.

ops$tkyte%ORA11GR2> begin
  2          dbms_stats.gather_table_stats( user, 'T' );
  3  end;
  4  /
PL/SQL procedure successfully completed.
```

# SQLNet Compression

```
ops$tkyte%ORA11GR2> set arraysize 15

ops$tkyte%ORA11GR2> set autotrace traceonly statistics
```

# SQLNet Compression

```
ops$tkyte%ORA11GR2> select * from t;
72228 rows selected.


Statistics
----------------------------------------------------------
       5794  consistent gets
    8015033  bytes sent via SQL*Net to client
      53385  bytes received via SQL*Net from client
       4817  SQL*Net roundtrips to/from client
      72228  rows processed
```

# SQLNet Compression

```
ops$tkyte%ORA11GR2> select * from t order by timestamp;
72228 rows selected.


Statistics
----------------------------------------------------------
       1031  consistent gets
    3427630  bytes sent via SQL*Net to client
      53385  bytes received via SQL*Net from client
       4817  SQL*Net roundtrips to/from client
      72228  rows processed
```

# SQLNet Compression

```
ops$tkyte%ORA11GR2> select * from t order by timestamp,
object_type, owner;
72228 rows selected.


Statistics
----------------------------------------------------------
       1031  consistent gets
    3280011  bytes sent via SQL*Net to client
      53385  bytes received via SQL*Net from client
       4817  SQL*Net roundtrips to/from client
      72228  rows processed
```

# SQLNet Compression

```
ops$tkyte%ORA11GR2> set arraysize 100
ops$tkyte%ORA11GR2> set autotrace traceonly statistics
```

# SQLNet Compression

```
ops$tkyte%ORA11GR2> select * from t;
72228 rows selected.


Statistics
----------------------------------------------------------
       1842  consistent gets
    7482943  bytes sent via SQL*Net to client
       8362  bytes received via SQL*Net from client
        724  SQL*Net roundtrips to/from client
      72228  rows processed
```

# SQLNet Compression

```
ops$tkyte%ORA11GR2> select * from t order by timestamp;
72228 rows selected.


Statistics
----------------------------------------------------------
       1031  consistent gets
    2907819  bytes sent via SQL*Net to client
       8362  bytes received via SQL*Net from client
        724  SQL*Net roundtrips to/from client
      72228  rows processed
```

# SQLNet Compression

```
ops$tkyte%ORA11GR2> select * from t order by timestamp,
object_type, owner;
72228 rows selected.


Statistics
----------------------------------------------------------
       1031  consistent gets
    2760200  bytes sent via SQL*Net to client
       8362  bytes received via SQL*Net from client
        724  SQL*Net roundtrips to/from client
      72228  rows processed
```

# SQLNet Compression

| | No Order 15 | Some Order 15 | Very Ordered 15 | No Order 100 | Some Order 100 | Very Ordered 100 |
|---|---|---|---|---|---|---|
| **Bytes Sent** | 8 m | 3.4 m | 3.2 m | 7.4 m | 2.9 m | 2.7 m |
| **% of original** | 100% | 43% | 41% | 93% | 36% | 34% |
| **Consistent Gets** | 5794 | 1031 | 1031 | 1842 | 1031 | 1031 |

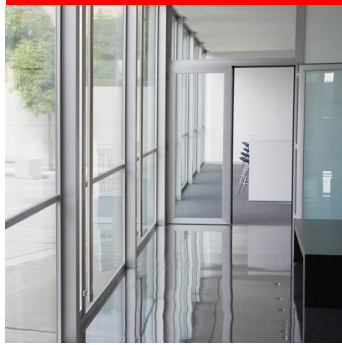
```
ops$tkyte%ORA11GR2> select round(1031*8/1024,2) from dual;

ROUND(1031*8/1024,2)
--------------------
                8.05
```

# SQLNet Compression

| | No Order 1000 | Some Order 1000 | Very Ordered 1000 | No Order 100 | Some Order 100 | Very Ordered 100 |
|---|---|---|---|---|---|---|
| **Bytes Sent** | 7.3 m | 2.8 m | 2.6 m | 7.4 m | 2.9 m | 2.7 m |
| **% of original** | 92% | 35% | 33% | 93% | 36% | 34% |
| **Consistent Gets** | 1105 | 1031 | 1031 | 1842 | 1031 | 1031 |

# Implicit conversions are evil

# Implicit conversions are evil



- SQL/PLSQL are too ‘user friendly’ – unlike C which complained about everything
- Implicit conversions of strings to numbers, strings to dates, raw to string, etc are probably the #2 cause of bugs I see time and time again
- Even worse are the implicit conversions that rely on default NLS settings!

# Implicit conversions are evil

```
ops$tkyte%ORA11GR2> create or replace procedure inj( p_date in date )
  2  as
  3          l_rec   all_users%rowtype;
  4          c       sys_refcursor;
  5          l_query long;
  6  begin
  7          l_query := '
  8          select *
  9            from all_users
 10           where created = ''' ||p_date ||''''';   -- DOUBLE implicit conversion!
 11
 12          dbms_output.put_line( l_query );
 13          open c for l_query;
 14
 15          for i in 1 .. 5
 16          loop
 17                  fetch c into l_rec;
 18                  exit when c%notfound;
 19                  dbms_output.put_line( l_rec.username || '.....' );
 20          end loop;
...
```

# Implicit conversions are evil

```
  7          l_query := '
  8          select *
  9            from all_users
 10           where created = ''' ||p_date ||''''';
```

***Creates a query that is semantically equivalent to:***

```
Where created = to_date( to_char( date-field ) );
```

***Two implicit conversions – both of which rely on the NLS_DATE settings!***

# Implicit conversions are evil

```
ops$tkyte%ORA11GR2> exec inj( sysdate )

          select *
            from all_users
           where created = '04-OCT-11'

PL/SQL procedure successfully completed.
```

# Implicit conversions are evil

```
ops$tkyte%ORA11GR2> alter session set
  2  nls_date_format = 'dd-mon-yyyy''' or ''a'' = ''a''';

Session altered.
```

# Implicit conversions are evil

```
ops$tkyte%ORA11GR2> exec inj( sysdate )

         select *
           from all_users
          where created = '04-oct-2011' or 'a' = 'a'
A.....
EBRAPP.....
EBRTBLS.....
UTIL.....
USER2.....

PL/SQL procedure successfully completed.
```

# Implicit conversions are evil

```
ops$tkyte%ORA11GR2> alter session set
  2  nls_date_format = '"''union select tname,0,null from tab--"';
Session altered.


Select *
  from all_users
 where created = ''union select tname,0,null from tab--'
```

# Implicit conversions are evil

```
ops$tkyte%ORA11GR2> create user a identified by a;

User created.

ops$tkyte%ORA11GR2> grant create session, create procedure to a;

Grant succeeded.

ops$tkyte%ORA11GR2> grant execute on inj to a;

Grant succeeded.

ops$tkyte%ORA11GR2> desc t
 Name                                      Null?    Type
 ----------------------------------------- -------- ----------------------------
 X                                                  NUMBER(38)
```

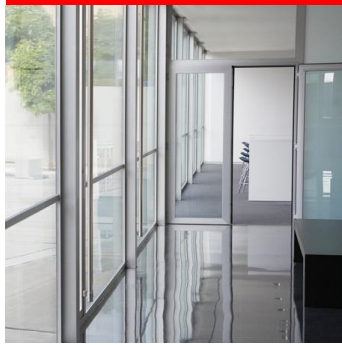
# Implicit conversions are evil

```
ops$tkyte%ORA11GR2> connect a/a
Connected.

a%ORA11GR2> create or replace function f return varchar2
  2  authid current_user
  3  as
  4          pragma autonomous_transaction;
  5  begin
  6          execute immediate 'drop table t';
  7          return null;
  8  end;
  9  /

Function created.

a%ORA11GR2> grant execute on f to ops$tkyte;

Grant succeeded.
```

# Implicit conversions are evil

```
a%ORA11GR2> alter session set
  2  nls_date_format = '"'' or ops$tkyte.f() = ''a"';

Session altered.

a%ORA11GR2> exec ops$tkyte.inj( sysdate )

        select *
          from all_users
         where created = '' or ops$tkyte.f() = 'a'

PL/SQL procedure successfully completed.

a%ORA11GR2> connect /
Connected.
ops$tkyte%ORA11GR2> desc t
ERROR:
ORA-04043: object t does not exist
```

# Implicit conversions are evil



- What about performance?
  - Repeated conversions
  - Access path reductions
  - Partition elimination eliminated

```
SQL> alter session set Plsql_Warnings = 'enable:all';
```

# Implicit conversions are evil

```
ops$tkyte%ORA11GR2> create or replace procedure p authid definer
  2  as
  3      l_date  varchar2(30) := '01-jan-2011';
  4      l_start number := dbms_utility.get_cpu_time;
  5  begin
  6      for i in 1 .. 10
  7      loop
  8         for x in ( select owner, object_name
  9                      from big_table.big_table
 10                     where created = l_date )
 11         loop
 12             null;
 13         end loop;
 14      end loop;
 15      dbms_output.put_line( 'CPU: ' ||
 16      to_char( dbms_utility.get_cpu_time-l_start ) );
 17  end;
 18  /
SP2-0804: Procedure created with compilation warnings
ops$tkyte%ORA11GR2> exec p
CPU: 132
```

# Implicit conversions are evil

```
…
  7      loop
  8         for x in ( select owner, object_name
  9                      from big_table.big_table
 10                     where created = l_date )
 11         loop
 12             null;
 13         end loop;
…
```

```
ops$tkyte%ORA11GR2> show errors procedure p
Errors for PROCEDURE P:

LINE/COL ERROR
-------- -----------------------------------------------------------------
10/36    PLW-07204: conversion away from column type may result in
         sub-optimal query plan
```

# Implicit conversions are evil

```
ops$tkyte%ORA11GR2> create or replace procedure p authid definer
  2  as
  3      l_date  date := to_date('01-jan-2011','dd-mon-yyyy');
  4      l_start number := dbms_utility.get_cpu_time;
  5  begin
  6      for i in 1 .. 10
  7      loop
  8         for x in ( select owner, object_name
  9                      from big_table.big_table
 10                     where created = l_date )
 11         loop
 12             null;
 13         end loop;
 14      end loop;
 15      dbms_output.put_line( 'CPU: ' ||
 16      to_char( dbms_utility.get_cpu_time-l_start ) );
 17  end;
 18  /
Procedure created.
ops$tkyte%ORA11GR2> exec p
CPU: 94      30% less CPU in this case
```

# Implicit conversions are evil

```
ops$tkyte%ORA11GR2> create table t
  2  ( x varchar2(20) constraint t_pk primary key,
  3    y varchar2(30)
  4  );
Table created.

ops$tkyte%ORA11GR2> insert into t
  2  select user_id, username
  3    from all_users;
47 rows created.

ops$tkyte%ORA11GR2> commit;
Commit complete.
```

# Implicit conversions are evil

```
ops$tkyte%ORA11GR2> create or replace procedure p authid definer
  2  as
  3          l_rec t%rowtype;
  4          l_key number := 5;
  5  begin
  6          select * into l_rec from t where x = l_key;
  7          for x in (select plan_table_output
  8                      from TABLE( dbms_xplan.display_cursor() ) )
  9          loop
 10                  dbms_output.put_line( x.plan_table_output );
 11          end loop;
 12  end;
 13  /

SP2-0804: Procedure created with compilation warnings
```

# Implicit conversions are evil

```
…
  5  begin
  6          select * into l_rec from t where x = l_key;
  7          for x in (select plan_table_output
…

ops$tkyte%ORA11GR2> show errors
Errors for PROCEDURE P:

LINE/COL ERROR
-------- -----------------------------------------------------------------
6/42     PLW-07204: conversion away from column type may result in
         sub-optimal query plan
```

# Implicit conversions are evil

```
ops$tkyte%ORA11GR2> exec p

SQL_ID  18796jgha0hwz, child number 0
-------------------------------------
SELECT * FROM T WHERE X = :B1

Plan hash value: 1601196873

-----------------------------------------------------------------------------
| Id  | Operation          | Name | Rows  | Bytes | Cost (%CPU)| Time     |
-----------------------------------------------------------------------------
|   0 | SELECT STATEMENT   |      |       |       |     3 (100)|          |
|*  1 |  TABLE ACCESS FULL| T    |     1 |    29 |     3   (0)| 00:00:01 |
-----------------------------------------------------------------------------

Predicate Information (identified by operation id):
---------------------------------------------------
1 - filter(TO_NUMBER("X")=:B1)
```

# Implicit conversions are evil

```
ops$tkyte%ORA11GR2> create or replace procedure p authid definer
  2  as
  3          l_rec t%rowtype;
  4          l_key varchar2(5) := '5';
  5  begin
  6          select * into l_rec from t where x = l_key;
  7          for x in (select plan_table_output
  8                      from TABLE( dbms_xplan.display_cursor() ) )
  9          loop
 10                  dbms_output.put_line( x.plan_table_output );
 11          end loop;
 12  end;
 13  /
Procedure created.

ops$tkyte%ORA11GR2> show errors
No errors.
```

# Implicit conversions are evil

```
ops$tkyte%ORA11GR2> exec p

SQL_ID  18796jgha0hwz, child number 1
-------------------------------------
SELECT * FROM T WHERE X = :B1

Plan hash value: 1303508680
-------------------------------------------------------------------------------
| Id  | Operation                   | Name | Rows  | Bytes | Cost (%CPU)| Time     |
-------------------------------------------------------------------------------
|   0 | SELECT STATEMENT            |      |       |       |     1 (100)|          |
|   1 |  TABLE ACCESS BY INDEX ROWID| T    |     1 |    29 |     1   (0)| 00:00:01 |
|*  2 |   INDEX UNIQUE SCAN         | T_PK |     1 |       |     1   (0)| 00:00:01 |
-------------------------------------------------------------------------------

Predicate Information (identified by operation id):
---------------------------------------------------
2 - access("X"=:B1)
```

# Implicit conversions are evil

```
ops$tkyte%ORA11GR2> CREATE TABLE t
  2  (
  3    dt  date,
  4    x   int,
  5    y   varchar2(30)
  6  )
  7  PARTITION BY RANGE (dt)
  8  (
  9    PARTITION part1 VALUES LESS THAN(to_date('31-jan-2011', 'dd-mon-yyyy')),
 10    PARTITION part2 VALUES LESS THAN(to_date('28-feb-2011', 'dd-mon-yyyy'))
 11  )
 12  /

Table created.
```

# Implicit conversions are evil

```
ops$tkyte%ORA11GR2> create or replace procedure p authid definer
  2  as
  3      l_date timestamp := timestamp'2011-01-15 00:00:00.000';
  4      l_count number;
  5  begin
  6      select count(*) into l_count from t where dt = l_date;
  7
  8      for x in (select plan_table_output
  9                  from TABLE( dbms_xplan.display_cursor() ) )
 10      loop
 11          dbms_output.put_line( '.'||x.plan_table_output );
 12      end loop;
 13  end;
 14  /

SP2-0804: Procedure created with compilation warnings
```

# Implicit conversions are evil

```
…
  5  begin
  6      select count(*) into l_count from t where dt = l_date;
  7
…

SP2-0804: Procedure created with compilation warnings

ops$tkyte%ORA11GR2> show errors
Errors for PROCEDURE P:

LINE/COL ERROR
-------- -----------------------------------------------------------------
6/47     PLW-07204: conversion away from column type may result in
         sub-optimal query plan
```

# Implicit conversions are evil

```
SQL_ID  0t5m83d3m67q7, child number 0
-------------------------------------
SELECT COUNT(*) FROM T WHERE DT = :B1

Plan hash value: 3225603066
-----------------------------------------------------------------------------------------------
| Id  | Operation            | Name | Rows  | Bytes | Cost (%CPU)| Time     | Pstart| Pstop |
-----------------------------------------------------------------------------------------------
|   0 | SELECT STATEMENT     |      |       |       |     2 (100)|          |       |       |
|   1 |  SORT AGGREGATE      |      |     1 |     9 |            |          |       |       |
|   2 |   PARTITION RANGE ALL|      |     1 |     9 |     2   (0)| 00:00:01 |     1 |     2 |
|*  3 |    TABLE ACCESS FULL | T    |     1 |     9 |     2   (0)| 00:00:01 |     1 |     2 |
-----------------------------------------------------------------------------------------------

Predicate Information (identified by operation id):
---------------------------------------------------

   3 - filter(INTERNAL_FUNCTION("DT")=:B1)
```

# Implicit conversions are evil

```
ops$tkyte%ORA11GR2> create or replace procedure p authid definer
  2  as
  3      l_date date := to_date( '2011-01-15', 'yyyy-mm-dd' );
  4      l_count number;
  5  begin
  6      select count(*) into l_count from t where dt = l_date;
  7
  8      for x in (select plan_table_output
  9                  from TABLE( dbms_xplan.display_cursor() ) )
 10      loop
 11          dbms_output.put_line( '.'||x.plan_table_output );
 12      end loop;
 13  end;
 14  /
Procedure created.
ops$tkyte%ORA11GR2> show errors
No errors.
```

# Implicit conversions are evil

```
.SQL_ID  0t5m83d3m67q7, child number 1
.-------------------------------------
.SELECT COUNT(*) FROM T WHERE DT = :B1
.
.Plan hash value: 3660200434
.
.-----------------------------------------------------------------------------------------------
.| Id  | Operation                | Name | Rows  | Bytes | Cost (%CPU)| Time     | Pstart| Pstop |
.-----------------------------------------------------------------------------------------------
.|   0 | SELECT STATEMENT         |      |       |       |     2 (100)|          |       |       |
.|   1 |  SORT AGGREGATE          |      |     1 |     9 |            |          |       |       |
.|   2 |   PARTITION RANGE SINGLE|      |     1 |     9 |     2   (0)| 00:00:01 |   KEY |   KEY |
.|*  3 |    TABLE ACCESS FULL     | T    |     1 |     9 |     2   (0)| 00:00:01 |   KEY |   KEY |
.-----------------------------------------------------------------------------------------------
.
.Predicate Information (identified by operation id):
.---------------------------------------------------
.
.   3 - filter("DT"=:B1)
```

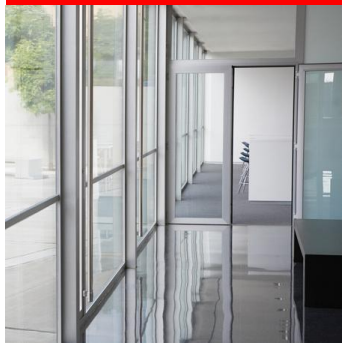
# Implicit conversions are evil

```
ops$tkyte%ORA11GR2> alter session set Plsql_Warnings = 'error:all';

ops$tkyte%ORA11GR2> create or replace procedure p authid definer
  2  as
  3      l_date timestamp := timestamp'2011-01-15 00:00:00.000';
  4      l_count number;
  5  begin
  6      select count(*) into l_count from t where dt = l_date;
  7
  8      for x in (select plan_table_output
  9                  from TABLE( dbms_xplan.display_cursor() ) )
 10      loop
 11          dbms_output.put_line( '.'||x.plan_table_output );
 12      end loop;
 13  end;
 14  /
```

# Implicit conversions are evil

```
Warning: Procedure created with compilation errors.

ops$tkyte%ORA11GR2> show errors
Errors for PROCEDURE P:

LINE/COL ERROR
-------- -----------------------------------------------------------------
6/47     PLS-07204: conversion away from column type may result in
         sub-optimal query plan

ops$tkyte%ORA11GR2> exec p
BEGIN p; END;

      *
ERROR at line 1:
ORA-06550: line 1, column 7:
PLS-00905: object OPS$TKYTE.P is invalid
ORA-06550: line 1, column 7:
PL/SQL: Statement ignored
```

# Implicit conversions are evil



- Lots and lots of bugs
  - What is ‘01/02/03’?
  - where column = to_char(sysdate) – what does that mean?

# Program Agenda

- Warnings
- Better Statistics
- Optimizer Optimizations
- SQL*Net Compression
- Implicit Conversions Are *Evil*


# Hardware and Software
## Engineered to Work Together

ORACLE