Bugs found in Database Management Systems

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We have successfully discovered 23 bugs (13 fixed, 15 confirmed and 8 open reported) from real-world production-level DBMSs, including 5 bugs in MySQL, 2 bugs in PostgreSQL, 12 bugs in TiDB, 2 bugs in OpenGauss, and 2 bugs in Oceanbase.

We are thankful to the DBMS developers for responding to our bug reports and fixing the bugs that we found. Because the nondeterministic interleavings among operations challenges the reproducibility of the isolation-related bugs, there are 8 bugs can not be reproduced but open reported. In the future, we will aim to the research question about reproducing an isolation-related bug.

Content

Fixed bugs

TiDB

Isolation-related Bugs

Bug#1:Dirty write in pessimistic transaction mode

Test Case

Transaction ID	Operation Detail	State
Mode Setting	Set global tidb_txn_mode = 'pessimistic';	Success
Schema Creation	Create table table_7_2(a int primary key, b int, c double);	Success
Database Population	Insert into table_7_2 values(676,-5012153, 2240641.4);	Success
739	Begin transaction;	Success
739	Update table_7_2 set b=-5012153, c=2240641.4 where a=676	Success
723	Begin transaction;	Success
723	Update table_7_2 set b=852150 where a=676	Success×
739	Commit	Success

Bug Description

It first set transaction mode as pessimistic. Transaction 739 updates a record 676 in table_7_2 and holds an exclusive lock on the record 676. Before transaction 739 releases the exclusive lock on record 676, transaction 723 also successfully acquires an exclusive lock on record 676 and updates it, which results dirty write anomalies should be avoided in pessimistic transaction mode as described in TiDB official website.

Bug#2:Read inconsistency in snapshot isolation

Test Case

Transaction ID	Operation Detail	State
Schema Creation	Create table table_7_2(primarykey int primary key, attribute1 double,attribute6 double);	Success
Database Population	Insert into table_7_2 values(3873, 0.213, 0.234);	Success

904	Begin transaction;	Success
904	Update table_8_2 set attribute6=-0.386 where primarykey=3873	Success
904	Commit	Success
914	Set @@global.tx_isolation='REPEATABLE-READ';	Success
907	Begin transaction;	Success
907	Update table_8_2 set attribute6=0.484 where primarykey=3873	Success
907	Commit	Success
914	Select attribute6 from table_8_2 where primarykey=3873	Success(attribute6=-0.368)×

Bug Description

There are two historical versions on attribute6 of record 3873 in table_ 8_2. The first one is -0.386 created by transaction 904; the second one is 0.484 created by transaction 907. Since the select operation of transaction 914 happens after the committing of transaction 907, transaction 914 should sees the second one, i.e., 0.484, instead of the first one, i.e., -0.368. However, the select operation of transaction 914 returns the first version -0.368, which indicates there is a defect about the implementation of consistent read in TiDB.

Bug#3:Violating mutual exclusion

Test Case

```
drop database if exists db1;
create database db1;
use db1;
create table t1(a int primary key, b int);
create table t2(a int primary key, b int, constraint fk1 foreign key(b) references t1(a));
create view view0(t2_a,t2_b,t1_b) as select t2.a,t2.b,t1.b from t2,t1 where t2.b=t1.a;

insert into t1 values(1,2);
insert into t1 values(2,3);
insert into t1 values(3,4);
insert into t1 values(4,5);
insert into t1 values(5,6);

insert into t2 values(1,2);
insert into t2 values(2,3);
insert into t2 values(3,4);
insert into t2 values(4,5);
insert into t2 values(5,1);
```

So the status of view0 is

t2_a	t2_b	t1_b
1	2	3
2	3	4
3	4	5
4	5	6
5	1	2

Operation ID	**Session1**	**Session2**	**State**
1	Begin transaction;		Success
2		Begin transaction;	Success
3	update t1 set b=12 where a=1;		Success
4		select * from view0 where t2_a>3 for update;	Success Query Result | t2_a | t2_b | t1_b | | 5 | 1 | 2 | | 4 | 5 | 6 |×
5		Commit;(Success)	Success
6	Commit;(Success)		Success

Bug Description

Operation 3 holds an exclusive lock on a record 1 in table t1 until operation 6 releases the lock. Due to the nature of exclusive locks, operation 4 attempts to acquire a exclusive lock on record 1 in table t1, which should be blocked. However, TiDB grants operation 4 an exclusive lock on record 1 in table t1, which indicates a locking violation.

Bug#4:Unnecessary locking a non-existing record

Test Case

Drop database if exists db;
Create database db;
Use db;
Create table t(a int primary key, b int);

Operation ID	**Session1**	**Session2**	**State**
1	Begin transaction;		Success
2		Begin transaction;	Success
3	Update t set b=314 where a=1;		Success with row count = 0

4		Insert into t values(1,3);	blocking✕
5	Commit;(success)		Success
6		Insert into t values(1,3);(success)	Success with row count = 1
7		Commit;(Success)	Success

Bug Description

After investigating TiDB official website, the write operations of TiDB only locks the record that satisfies the conditions. Notice that the read operation of TiDB can avoid the phantom by the way of MVCC.

However, as shown in above test case, the update operation (Operation ID=3) locks a non-existing record that dose not satisfy its where condition. Additionally, the update operation (Operation ID=3) blocks the insertion operation of another transaction (Operation ID=6), which may lead to some performance issues about locking.

Bug#5:Query in transaction may return rows with same unique index column value

See https://github.com/pingcap/tidb/issues/24195

Test Case

```
/* session1 */ set global tidb_txn_mode = 'pessimistic';
/* session1 */ drop table if exists t;
/* session1 */ create table t (c1 varchar(10), c2 int, c3 char(20), primary key (c1, c2));
/* session1 */ insert into t values ('tag', 10, 't'), ('cat', 20, 'c');
/* session2 */ begin;
/* session2 */ update t set c1=reverse(c1) where c1='tag';
/* session4 */ begin;
/* session4 */ insert into t values('dress',40,'d'),('tag', 10, 't');
/* session2 */ commit;
/* session4 */ select * from t use index(primary) order by c1,c2;
```

when primary key is clustered index, query return

```
mysql> /* session4 */ select * from t use index(primary) order by c1,c2;
+-------+----+------+
| c1    | c2 | c3   |
+-------+----+------+
| cat   | 20 | c    |
| dress | 40 | d    |
| tag   | 10 | t    |
+-------+----+------+
```

```
3 rows in set (0.00 sec)
```

when primary key is nonclustered index, query return

```
mysql> /* session4 */ select * from t use index(primary) order by c1,c2;
+-------+----+------+
| c1    | c2 | c3   |
+-------+----+------+
| cat   | 20 | c    |
| dress | 40 | d    |
| tag   | 10 | t    |
| tag   | 10 | t    |
+-------+----+------+
4 rows in set (0.00 sec)
```

Bug Description

The above test case runs on pessimistic transaction mode in TiDB. Session 1 initializes a table with two record. One of them is ('tag','10',t). Session 2 acquires a exclusive lock to update the record ('tag','10',t) as ('gat','10',t). Before update committed, session 4 successfully acquires a exclusive lock to insert a new record ('tag','10',t), which violates the principle of long duration lock.

After that, session 4 issues a query to see all record in table t. When primary key is clustered index, query return the newly inserted record ('tag','10',t). However, when primary key is nonclustered index, query return two identical records ('tag','10',t), which indicates a bug hidden in TiDB. We have reported such a test case in TiDB community. TiDB developers have acknowledged it and fixed it.

Bug#6:Select under repeatable read isolation level returns stale version of data

See https://github.com/pingcap/tidb/issues/36718

Schema

create table table0 (pkId integer, pkAttr0 integer, pkAttr1 integer, pkAttr2 integer, coAttr0_0 integer, primary key(pkAttr0, pkAttr1, pkAttr2));

Initial data:

```
+---------+---------+---------+-----------+
| pkAttr0 | pkAttr1 | pkAttr2 | coAttr0_0 |
+---------+---------+---------+-----------+
|     412 |     409 |     258 |     17702 |
+---------+---------+---------+-----------+
```

Operations (From General Log)

Session	Operation
282	SET SESSION TRANSACTION ISOLATION LEVEL SERIALIZABLE

Session	Operation
281	SET SESSION TRANSACTION ISOLATION LEVEL REPEATABLE READ
282	start transaction
282	update table0 set coAttr0_0 = 40569 where (pkAttr0 = 412) and (pkAttr1 = 409) and (pkAttr2 = 258)
282	commit
281	start transaction
281	select pkAttr0, pkAttr1, pkAttr2, coAttr0_0 from table0 where (coAttr0_0 = 89665)
281	update table0 set coAttr0_0 = 40569 where (pkAttr0 = 412) and (pkAttr1 = 409) and (pkAttr2 = 258)
281	select pkAttr0, pkAttr1, pkAttr2, coAttr0_0 from table0 where (coAttr0_0 = 17702)
281	commit

Wrong Query Result

Description

- In the beginning, coAttr0_0 of Key<412,409,258> is 17702.

```
+---------+---------+---------+-----------+
| pkAttr0 | pkAttr1 | pkAttr2 | coAttr0_0 |
+---------+---------+---------+-----------+
|     412 |     409 |     258 |     17702 |
+---------+---------+---------+-----------+
```

- Then Session-282 updates coAttr0_0 of Key<412,409,258> to 40569.
  Note that it successfully changes that value, because the query result is:
  Query OK, 1 row affected (0.00 sec)
  Rows matched: 1 Changed: 1 Warnings: 0
- When Session-281 trys updating coAttr0_0 of Key<412,409,258> to 40569.
  It fails to change that value because the vlaue is already 40569:
  Query OK, 0 rows affected (0.00 sec)
  Rows matched: 1 Changed: 0 Warnings: 0
- Thers is no wrong execution results so far.
- Next, Session-282 executes
  select `pkAttr0`, `pkAttr1`, `pkAttr2`, `coAttr0_0` from `table0` where (`coAttr0_0` = 17702)
  As we known, latest coAttr0_0 of Key<412,409,258> is 40569
  However, the query result is:

```
+---------+---------+---------+-----------+
| pkAttr0 | pkAttr1 | pkAttr2 | coAttr0_0 |
+---------+---------+---------+-----------+
|     412 |     409 |     258 |     17702 |
+---------+---------+---------+-----------+
```

  The database returns a stale version of data for Key<412,409,258>

Details

Initial Data

```
+---------+---------+---------+-----------+
| pkAttr0 | pkAttr1 | pkAttr2 | coAttr0_0 |
+---------+---------+---------+-----------+
|     412 |     409 |     258 |     17702 |
+---------+---------+---------+-----------+
```

Execution Result of Session-282

```
--------------
SET SESSION TRANSACTION ISOLATION LEVEL SERIALIZABLE
--------------

Query OK, 0 rows affected (0.00 sec)

--------------
start transaction
--------------

Query OK, 0 rows affected (0.00 sec)

--------------
update `table0` set `coAttr0_0` = 40569 where ( `pkAttr0` = 412 ) and ( `pkAttr1` = 409 ) and
( `pkAttr2` = 258 )
--------------

Query OK, 1 row affected (0.00 sec)
Rows matched: 1    Changed: 1    Warnings: 0

--------------
commit
--------------

Query OK, 0 rows affected (0.00 sec)

Bye
```

Execution Result of Session-281

```
--------------
SET SESSION TRANSACTION ISOLATION LEVEL REPEATABLE READ
--------------

Query OK, 0 rows affected (0.00 sec)

--------------
start transaction
--------------
```

```
Query OK, 0 rows affected (0.00 sec)

--------------
select `pkAttr0`, `pkAttr1`, `pkAttr2`, `coAttr0_0` from `table0` where ( `coAttr0_0` = 89665 )
--------------

Empty set (0.00 sec)

--------------
update `table0` set `coAttr0_0` = 40569 where ( `pkAttr0` = 412 ) and ( `pkAttr1` = 409 ) and
( `pkAttr2` = 258 )
--------------

Query OK, 0 rows affected (0.00 sec)
Rows matched: 1  Changed: 0  Warnings: 0

--------------
select `pkAttr0`, `pkAttr1`, `pkAttr2`, `coAttr0_0` from `table0` where ( `coAttr0_0` = 17702 )
--------------

+---------+---------+---------+-----------+
| pkAttr0 | pkAttr1 | pkAttr2 | coAttr0_0 |
+---------+---------+---------+-----------+
|     412 |     409 |     258 |     17702 |
+---------+---------+---------+-----------+
1 row in set (0.01 sec)

--------------
commit
--------------

Query OK, 0 rows affected (0.00 sec)

Bye
```

How to repeat:

The bug description and the program for repeating is here: https://github.com/lpypl/SelectStaleData

How to Reproduce

- transformer.py translates minimal-general.log to minimal-operations.json
- player.py create a mysql client process for each session
- player.py iterates over the list of operations from minimal-operations.json, and sends each operation to its session **without waiting for Query OK**
- play.sh is a script that keeps replaying this reproducible case until it succeeds.

Key Points to Reproduce this Bug

Request Rate is Critical

- Sleep for 0~0.003 seconds between two operations is OK for reproducing this bug
- If the sleep is longer, it tends to produce correct execution results

Update to the same value

- Two sessions update coAttr0_0 to the same value
- And the update of Session-281 must match but not change

Isolation Level

- Isolation Level of Session-282 doesn't matter, RU/RC/RR/SR all is OK
- According to our tests, Isolation Level of Session-281 must be RR

For Session-282, the extra select before the update for Key<412,409,258> seems necessary

select `pkAttr0`, `pkAttr1`, `pkAttr2`, `coAttr0_0` from `table0` where (`coAttr0_0` = 89665)

Other types of bugs

Bug#7:Schema version check error

Test Case

Transaction ID	Operation Detail	State
	Drop db0.table_1_2	Success
723	Update db1.table_5_1 set attribute2=8132130 where primarykey=6123	Exception:Information schema is changed×

Bug Description

During verifying the read committed isolation level recently developed by TiDB team, we find there is a checking schema problem. Specifically, the first line in above table modifies db0's schema information, while the second line in transaction 723 modifies db1's table with exception “information schema is changed”. However, there is no modification on db1's schema information, which indicates a bug hidden in checking schema version.

Bug#8:Timestamp acquisition mechanism error in read committed

Test Case

Transaction ID	Operation Detail	State
232	Select * from table_2_1 where primarykey=4323	Stall(never respond)

Bug Description

As definition, read committed isolation level sees a consistent view of database as of the beginning of an operation. Thus, each read operation in read committed isolation level should acquire a timestamp. Under the read committed isolation level recently developed by TiDB team, in order to optimize the performance of timestamp acquisition, asynchronous timestamp acquisition mechanism is adopted, but there are internal problems in this mechanism, as shown in the above table. Specifically, the read operation in above table never be responded from timestamp sever. We have help their developers fix this bugs.

Bug#9:Update BLOB data error

Test Case

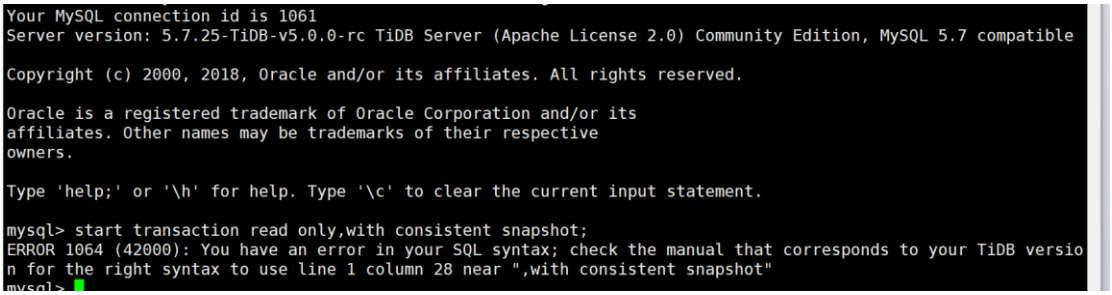
Operation ID	Operation Detail	State
1	Update tablecsacas0 set attributeqwdcwq3=FILE("./data_case/obj/12obj_file.obj") where primarykeycqwda0 = 15363173 and primarykeycqwda1 = 940396828 and primarykeycqwda2 = 1209414904	Success
2	Update tablecsacas0 set attributeqwdcwq3=FILE("./data_case/obj/12obj_file.obj") and other column where primarykeycqwda0 = 15363173 and primarykeycqwda1 = 940396828 and primarykeycqwda2 = 1209414904	Success
3	Select attributeqwdcwq3 from tablecsacas0 where primarykeycqwda0 = 15363173 and primarykeycqwda1 = 940396828 and primarykeycqwda2 = 1209414904 for update	Success and Return attributeqwdcwq3 = NULL×

Bug Description

For BLOB data type, when the new value and the old value written by the update operation are for the same binary file, the value actually written is null and success is returned, which indicates a BLOB-related bug hidden in TiDB.

Bug#10:Bug in Start Transaction

Test Case



Bug Description

As for the start transaction statement, the TiDB official websiate shows that it supports the keywords “with consistent snapshot” and “read only”. However, in fact, we found that TiDB cannot support these two keywords at the same time.

Bug#11:JDBC ResultSetMetaData.getColumnName for view query returns the attribute name defined in the table instead of the one defined in the view

See https://github.com/pingcap/tidb/issues/24227

Bug#12:Query Error in information_schema.slow_query

See https://github.com/pingcap/tidb/issues/28069

MySQL

Isolation-related Bugs

Bug#13:Select under repeatable read isolation level returns stale version of data

See https://bugs.mysql.com/bug.php?id=108015

Schema

create table table0 (pkId integer, pkAttr0 integer, pkAttr1 integer, pkAttr2 integer, coAttr0_0 integer, primary key(pkAttr0, pkAttr1, pkAttr2));

Initial data:

```
+---------+---------+---------+-----------+
| pkAttr0 | pkAttr1 | pkAttr2 | coAttr0_0 |
```

```
+---------+---------+---------+-----------+
|     412 |     409 |     258 |     17702 |
+---------+---------+---------+-----------+
```

Operations (From General Log)

Session	Operation
282	SET SESSION TRANSACTION ISOLATION LEVEL SERIALIZABLE
281	SET SESSION TRANSACTION ISOLATION LEVEL REPEATABLE READ
282	start transaction
282	update table0 set coAttr0_0 = 40569 where (pkAttr0 = 412) and (pkAttr1 = 409) and (pkAttr2 = 258)
282	commit
281	start transaction
281	select pkAttr0, pkAttr1, pkAttr2, coAttr0_0 from table0 where (coAttr0_0 = 89665)
281	update table0 set coAttr0_0 = 40569 where (pkAttr0 = 412) and (pkAttr1 = 409) and (pkAttr2 = 258)
281	select pkAttr0, pkAttr1, pkAttr2, coAttr0_0 from table0 where (coAttr0_0 = 17702)
281	commit

Wrong Query Result

Description

- In the beginning, coAttr0_0 of Key<412,409,258> is 17702.
  ```
  +---------+---------+---------+-----------+
  | pkAttr0 | pkAttr1 | pkAttr2 | coAttr0_0 |
  +---------+---------+---------+-----------+
  |     412 |     409 |     258 |     17702 |
  +---------+---------+---------+-----------+
  ```
- Then Session-282 updates coAttr0_0 of Key<412,409,258> to 40569.
  Note that it successfully changes that value, because the query result is:
  Query OK, 1 row affected (0.00 sec)
  Rows matched: 1 Changed: 1 Warnings: 0
- When Session-281 trys updating coAttr0_0 of Key<412,409,258> to 40569.
  It fails to change that value because the vlaue is already 40569:
  Query OK, 0 rows affected (0.00 sec)
  Rows matched: 1 Changed: 0 Warnings: 0
- Thers is no wrong execution results so far.
- Next, Session-282 executes
  select `pkAttr0`, `pkAttr1`, `pkAttr2`, `coAttr0_0` from `table0` where (`coAttr0_0` = 17702)
  As we known, latest coAttr0_0 of Key<412,409,258> is 40569
  However, the query result is:
  ```
  +---------+---------+---------+-----------+
  | pkAttr0 | pkAttr1 | pkAttr2 | coAttr0_0 |
  +---------+---------+---------+-----------+
  ```

```
|        412 |        409 |        258 |        17702 |
+---------+---------+---------+-----------+
```

The database returns a stale version of data for Key<412,409,258>

Details

Initial Data

```
+---------+---------+---------+-----------+
| pkAttr0 | pkAttr1 | pkAttr2 | coAttr0_0 |
+---------+---------+---------+-----------+
|        412 |        409 |        258 |        17702 |
+---------+---------+---------+-----------+
```

Execution Result of Session-282

```
--------------
SET SESSION TRANSACTION ISOLATION LEVEL SERIALIZABLE
--------------

Query OK, 0 rows affected (0.00 sec)

--------------
start transaction
--------------

Query OK, 0 rows affected (0.00 sec)

--------------
update `table0` set `coAttr0_0` = 40569 where ( `pkAttr0` = 412 ) and ( `pkAttr1` = 409 ) and
( `pkAttr2` = 258 )
--------------

Query OK, 1 row affected (0.00 sec)
Rows matched: 1    Changed: 1    Warnings: 0

--------------
commit
--------------

Query OK, 0 rows affected (0.00 sec)

Bye
```

Execution Result of Session-281

```
--------------
SET SESSION TRANSACTION ISOLATION LEVEL REPEATABLE READ
--------------

Query OK, 0 rows affected (0.00 sec)
```

```
--------------
start transaction
--------------

Query OK, 0 rows affected (0.00 sec)

--------------
select `pkAttr0`, `pkAttr1`, `pkAttr2`, `coAttr0_0` from `table0` where ( `coAttr0_0` = 89665 )
--------------

Empty set (0.00 sec)

--------------
update `table0` set `coAttr0_0` = 40569 where ( `pkAttr0` = 412 ) and ( `pkAttr1` = 409 ) and
( `pkAttr2` = 258 )
--------------

Query OK, 0 rows affected (0.00 sec)
Rows matched: 1  Changed: 0  Warnings: 0

--------------
select `pkAttr0`, `pkAttr1`, `pkAttr2`, `coAttr0_0` from `table0` where ( `coAttr0_0` = 17702 )
--------------

+---------+---------+---------+-----------+
| pkAttr0 | pkAttr1 | pkAttr2 | coAttr0_0 |
+---------+---------+---------+-----------+
|     412 |     409 |     258 |     17702 |
+---------+---------+---------+-----------+
1 row in set (0.01 sec)

--------------
commit
--------------

Query OK, 0 rows affected (0.00 sec)

Bye
```

How to repeat:

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How to Reproduce

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Update to the same value

- Two sessions update coAttr0_0 to the same value
- And the update of Session-281 must match but not change

Isolation Level

- Isolation Level of Session-282 doesn't matter, RU/RC/RR/SR all is OK
- According to our tests, Isolation Level of Session-281 must be RR

For Session-282, the extra select before the update for Key<412,409,258> seems necessary

select `pkAttr0`, `pkAttr1`, `pkAttr2`, `coAttr0_0` from `table0` where (`coAttr0_0` = 89665)

Bug#14:Two parallel threads trigger error code '1032 Can't find record in 'table'

See https://bugs.mysql.com/bug.php?id=103891

Description:

```
# The script can reproduce
# the `can’ t find record` problem in MySQL5.6 and MySQL5.7.33

import pymysql
import _thread

# You should create this database before executing the script
db = ’testdb’

# host, port, user and password
host = ’localhost’
port = 13306
user = ’root’
password = ’root’

def connect() -> pymysql.Connection:
    return pymysql.connect(host=host,
                           port=port,
                           user=user,
```

```
                                password=password,
                                db=db)

# recreate database ${db}
# then create schema for test
def initdb():
    conn = connect()
    cur = conn.cursor()
    cur.execute(f'drop table if exists t;')
    cur.execute('create table t(pkAttr0 integer, coAttr1
varchar(100), \
                coAttr2 varchar(100), coAttr3 varchar(100), coAttr4
integer, \
                coAttr5 varchar(100), coAttr6 varchar(100), primary
key(pkAttr0));')

def select():
    conn = connect()
    cur = conn.cursor()
    cur.execute('set session transaction isolation level read
uncommitted')
    conn.autocommit(False)
    while True:
        #Sometimes, this select triggers error:
pymysql.err.OperationalError: (1032,"Can't find record in 't'")
        cur.execute('select pkAttr0, coAttr1, coAttr2, coAttr3,
coAttr4, coAttr5, coAttr6 \
            from t order by pkAttr0, coAttr1, coAttr2, coAttr3,
coAttr4, coAttr5, coAttr6;')
        print(cur.fetchall())
        conn.commit()

def change():
    conn = connect()
    cur = conn.cursor()
    cur.execute('set session transaction isolation level read
uncommitted')
    conn.autocommit(False)

    while True:
        cur.execute('delete from t where pkAttr0 = 1;')
        cur.execute('insert into t(pkAttr0, coAttr1, coAttr2,
coAttr3, coAttr4, coAttr5, coAttr6) \
```

```
            values("1", "varchar1", "varchar2", "varchar3", "2021",
"varchar5", "varchar6");')
        # The problem can be reproduced whether or not to commit the
transaction
        # conn.commit()

initdb()

_thread.start_new_thread(select, ())
_thread.start_new_thread(change, ())

while True:
    pass
```

How to repeat:
Run the above Python script to reproduce the bug.

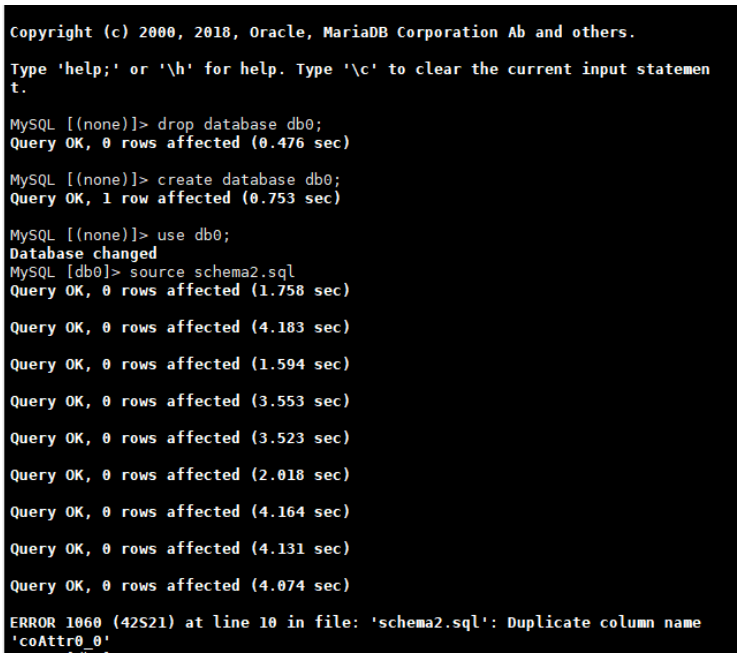
Suggested fix:
The expected result should not throw '1032' error.

Oceanbase

Other types of bugs

Bug#15:Create View Error

Test Case



schema2.sql contains following statements:

```
create table table0
(
	pkId		integer,
	pkAttr0	integer,
	pkAttr1	integer,
	pkAttr2	integer,
	pkAttr3	integer,
	pkAttr4	integer,
	coAttr0_0 integer,
	coAttr0_1 decimal(10, 0),
	coAttr0_2 varchar(100),
	primary key (pkAttr0, pkAttr1, pkAttr2, pkAttr3, pkAttr4)
);
alter table table0 add index index_pk(pkAttr0, pkAttr1, pkAttr2, pkAttr3, pkAttr4);
create table table1
(
	pkId		integer,
	pkAttr0	integer,
	pkAttr1	integer,
	coAttr0_0 varchar(100),
	coAttr0_1 integer,
	coAttr0_2 varchar(100),
	primary key (pkAttr0, pkAttr1)
);
alter table table1 add index index_pk(pkAttr0, pkAttr1);
alter table table1 add index index_commAttr0(coAttr0_0, coAttr0_1, coAttr0_2);
create table table2
```

```
(
    pkId        integer,
    pkAttr0     integer,
    pkAttr1     integer,
    pkAttr2     integer,
    pkAttr3     integer,
    pkAttr4     integer,
    pkAttr5     integer,
    pkAttr6     integer,
    coAttr0_0 decimal(10, 0),
    coAttr0_1 varchar(100),
    coAttr0_2 varchar(100),
    fkAttr0_0 integer,
    fkAttr0_1 integer,
    fkAttr0_2 integer,
    fkAttr0_3 integer,
    fkAttr0_4 integer,
    fkAttr1_0 integer,
    fkAttr1_1 integer,
    primary key (pkAttr0, pkAttr1, pkAttr2, pkAttr3, pkAttr4, pkAttr5, pkAttr6),
    foreign key (fkAttr0_0, fkAttr0_1, fkAttr0_2, fkAttr0_3, fkAttr0_4) references table0 (pkAttr0, pkAttr1, pkAttr2, pkAttr3, pkAttr4),
    foreign key (fkAttr1_0, fkAttr1_1) references table1 (pkAttr0, pkAttr1)
);
alter table table2 add index index_pk(pkAttr0, pkAttr1, pkAttr2, pkAttr3, pkAttr4, pkAttr5, pkAttr6);
alter table table2 add index index_fk0(fkAttr0_0, fkAttr0_1, fkAttr0_2, fkAttr0_3, fkAttr0_4);
alter table table2 add index index_fk1(fkAttr1_0, fkAttr1_1);
create view view2 (pkAttr0, pkAttr1, pkAttr2, pkAttr3, pkAttr4, pkAttr5, pkAttr6, fkAttr0_0, fkAttr0_1, fkAttr0_2, fkAttr0_3, fkAttr0_4, fkAttr1_0, fkAttr1_1, coAttr0_0, coAttr0_1, coAttr0_2, coAttr1_0, coAttr1_1, coAttr1_2)
as
select table2.pkAttr0,
        table2.pkAttr1,
        table2.pkAttr2,
        table2.pkAttr3,
        table2.pkAttr4,
        table2.pkAttr5,
        table2.pkAttr6,
        table2.fkAttr0_0,
        table2.fkAttr0_1,
        table2.fkAttr0_2,
        table2.fkAttr0_3,
        table2.fkAttr0_4,
```

```
        table2.fkAttr1_0,
        table2.fkAttr1_1,
        table2.coAttr0_0,
        table2.coAttr0_1,
        table2.coAttr0_2,
        table0.coAttr0_0,
        table0.coAttr0_1,
        table0.coAttr0_2
from table2,
     table0
where table2.fkAttr0_0 = table0.pkAttr0
  and table2.fkAttr0_1 = table0.pkAttr1
  and table2.fkAttr0_2 = table0.pkAttr2
  and table2.fkAttr0_3 = table0.pkAttr3
  and table2.fkAttr0_4 = table0.pkAttr4;
```

Bug Description

When creating a correct view defined in scenario schema2.sql, an error that cannot be imported may occur, and the error message "duplicate column name" will be reported. However, after careful inspection, there are no duplicate column names in the statement, and the same DDL statement can run normally on MySQL 5.7, which indicates a schema-related bug hidden in Oceanbase.

Open reported bugs

MySQL

Isolation-related bugs

Bug#16:Predicate Lock ERROR

See https://bugs.mysql.com/bug.php?id=105988

Test Case

The schema is:

Transaction ID	Operation Detail	State
69264	Create table table0 (pkId integer, pkAttr0 integer, coAttr0_0 integer, primary key(pkAttr0));	Success
69264	Set autocommit = 0;	Success
69264	SET SESSION TRANSACTION ISOLATION LEVEL	Success

	SERIALIZABLE;	
69269	SET SESSION TRANSACTION ISOLATION LEVEL SERIALIZABLE;	Success
69264	START TRANSACTION;	Success
69264	Insert into `table0`(`pkId`, `pkAttr0`, `coAttr0_0`) values(225, 225, 35704);	Success
69269	START TRANSACTION;	Success
69269	Select `pkAttr0`, `coAttr0_0` from `table0` where (`pkAttr0` = 225);	Success ✕
69264	rollback	Success

Bug Description

We disable autocomit and set both the above two transactions as serializable isolation level, as shown in the second to third lines.

As definition, InnoDB implicitly converts all plain SELECT statements to SELECT ... FOR SHARE if autocommit is disabled. Therefore, the seventh line should acquire a range-level shared lock to protect all records whose pkAttr0 is 225.

However, the fifth line has acquired a record-level exclusive lock on a record whose pkAttr0 is 225. The exclusive lock acquired by the fifth line is imcompatible with the shared lock acquired by the seventh line, which indicates a bug hidden in range-level lock.

Bug#17:Read uncommitted transaction reads the result of a failed write operation

Test Case

The repeat execution flow is shown as the following:

/* configuration */ Set global innodb_deadlock_detect=off;
/* init */ Create Table t(a int primary key, b int);
/* init */ Insert into t values(1,2);
/* init */ Insert into t values(2,4);

/* txn1 */ Begin;
/* txn1 */ Set session transaction isolation level read uncommitted;
/* txn2 */ Begin;
/* txn2 */ Set session transaction isolation level read uncommitted;
/* txn3 */ Begin;
/* txn3 */ Set session transaction isolation level read uncommitted;
/* txn2 */ Delete from t where a=1;
/* txn3 */ Update t set b=321 where a=2;
/* txn2 */ Update t set b=1421 where a=2;
/* txn3 */ Insert into t value(1,1231);

/* txn1 */ Select * from t where a=1;
/* init */

Bug Description

Transaction 2 writes new versions on records 1 and 2 successively, while Transaction 3 writes new versions on records 2 and 1 successively. So there is a deadlock situation between transaction 2 and 3. Before the deadlock between transaction 2 and 3 timeouts, another read uncommitted transaction 1 launch a query to read the record 1 that has been modified by transaction 2 and 3 successively. Since the second write operation of transaction 3 are failed due to deadlock, we should not see its write results. Therefore, as expected, the query result of transaction 1 should be the write result of transaction 2. However, the query result of transaction 1 is the write result of transaction 2, which is weird. We think there may be a subtle bug hidden in the current version of MySQL.

Other types of Bugs

Bug#18:Update BLOB data error

Test Case

Operation ID	Operation Detail	State
1	Update tablecsacas0 set attributeqwdcwq3=FILE("./data_case/obj/12obj_file.obj") where primarykeycqwda0 = 15363173 and primarykeycqwda1 = 940396828 and primarykeycqwda2 = 1209414904	Success
2	Update tablecsacas0 set attributeqwdcwq3=FILE("./data_case/obj/12obj_file.obj") and other column where primarykeycqwda0 = 15363173 and primarykeycqwda1 = 940396828 and primarykeycqwda2 = 1209414904	Success
3	Select attributeqwdcwq3 from tablecsacas0 where primarykeycqwda0 = 15363173 and primarykeycqwda1 = 940396828 and primarykeycqwda2 = 1209414904 for update	Success and Return attributeqwdcwq3 = NULL (ERROE)

Bug Description

For BLOB data type, when the new value and the old value written by the update operation are for the same binary file, the value actually written is null and success is returned, which indicates a BLOB-related bug hidden in MySQL.

PostgreSQL

Isolation-related bugs

Bug#19:Write skew in SSI

Test Case

Transaction ID	Operation Detail	State
206	Select attribute1 from table_7_1 where primarykey= 832	Success
204	Select attribute1 from table_7_4 where primarykey= 1460	Success
206	Update table_7_4 set attribute where primarykey=1460	Success
204	Update table_7_1 set attribute1 = -635092 where primarykey= 832	Success
204	Commit	Success
206	Commit	Success

Bug Description

Transaction 206 reads a record 832 in table_ 7_ 1, then transaction 204 writes a new record to cover it, so transactions 206 to 204 have a RW dependency. Similarly, transaction 204 reads the record 1460 in table_ 7_ 4, then transaction 206 writes a new record to cover it, so transactions 204 to 206 have a RW dependency. Finally, transactions 204 to 206 generate a circular dependency, that is, write skew anomalies that should be avoided in Snapshot Isolation Level of PostgreSQL.

Bug#20:Two different versions of the same row of records are returned in one query

See https://www.postgresql.org/message-id/17017-c37dbbadb77cfde9%40postgresql.org

Test Case

Schema and Initial data:
Create Table t(a int primary key, b int);
Insert into t values(1,2);
Insert into t values(2,3);

Operation:
There are two sessions executing at the same time.

[Time0, SessonA]
> Begin;
> set transaction isolation level repeatable read;
> Select * from t where a=1;

[Time1, SessonB]
> Begin;
> set transaction isolation level read committed;
> Delete from t where a=2;
> Commit;

[Time2, SessonA]
> Insert into t values(2,4);
> Select * from t where a=2;

Here, we expect PostgreSQL Server to return a row:
2 4

However, it returns two rows:
2 4
2 3

Bug Description

According to the definition of snapshot isolation, a query in a transaction should always see a consistent view of the database. That is, it should see a consistent version for each record in the database. However, bug#20 shows that two different versions of the same record are returned to a query under the snapshot isolation of PostgreSQL. This certainly violates the definition of snapshot isolation. Thus, we report it to the PostgreSQL community.

OpenGauss

Isolation-related Bugs

Bug#21:Violating First-Updater-Wins

Test Case

Transaction ID	Session1	Session2	State
2		Begin;	Success
2		set session transaction	Success

		isolation level repeatable read;	
2		update "table0" set "coAttr31_0" = 1048.0 where ("pkAttr0" = 280) and ("pkAttr1" = 241) and ("pkAttr2" = 'vc204') and ("pkAttr3" = 'vc361') and ("pkAttr4" = 363);--row count=1	Success
1	Begin;		Success
1	set session transaction isolation level repeatable read;		Success
1	select "pkAttr0", "pkAttr1", "pkAttr2", "pkAttr3", "pkAttr4", "pkAttr5", "pkAttr6", "pkAttr7", "fkAttr0_0", "fkAttr0_1", "fkAttr0_2", "fkAttr0_3", "fkAttr0_4" from "view0" where ("fkAttr0_0" = 94) and ("fkAttr0_1" = 239) or ("fkAttr0_2" < 'vc119') and ("fkAttr0_3" > 'vc81u') and ("fkAttr0_4" = 278) ;		Success
2		COMMIT	Success
1	delete from "table0" where		Success

	("pkAttr0" = 280) and ("pkAttr1" = 241) and ("pkAttr2" = 'vc204') and ("pkAttr3" = 'vc361') and ("pkAttr4" = 363); --row count=1		

Bug Description

Transaction 1 starts before transaction 2 commit, and both transaction 1 and 2 write a new version on a record (280, 241,'vc204' , 'vc361' ,363). Therefore, transaction 1 and 2 are a pair of concurrent transaction, which should be avoided by first updater wins mechanism in OpenGauss.

Bug#22:Violating Read-Consistency

Test Case

Create table table2 (primarykey in primary key, `coAttr25_0 int`);
Insert into table2 values(6,0);
Insert into table2 values(7,0);

Transaction ID	Session1	Session2	State
1	Begin;		Success
1	set session transaction isolation level repeatable read;		Success
1	`update "table2" set "coAttr25_0" = 78354, where "primaryKey" = 7;`		Success
2		Begin;	Success
2		set session transaction isolation level repeatable read;	Success
2		`"update "table2" set " coAttr25_0" = 14 where "primaryKey" = 6;`	Success
2		`Commit`	Success

1	select "primaryKey","fkAttr0_0", " coAttr25_0" from "table2";-- result set "primaryKey": "6", " coAttr25_0": "14"		Success

Bug Description

Transaction 1 launch a update operation while fetches a consistent snapshot. According to the rule of repeatable read isolation level, any operation in transaction 1 should sees a same snapshot., so transaction 1 should not see the write result created by transaction 2. However, transaction 1 sees the write result created by transaction 2, which indicates a consistency read violation.

0ceanbase

Isolation-related bugs

Bug#23:Read inconsistency

Test Case

Transaction ID	Session1	Session2	State
1	set session transaction isolation level repeatable read;		Success
2		set session transaction isolation level repeatable read;	Success
1	START TRANSACTION READ ONLY,WITH CONSISTENT SNAPSHOT;		Success
2		START TRANSACTION;	Success
2		update table0 set coAttr17 = 19635, coAttr18 = 1244, coAttr19 = 92947 where (pkAttr0 = 'vc239') and (pkAttr1 = 'vc234') and	Success

		(pkAttr2 = 'vc233'); **return rowCount=1;**	
2		COMMIT	Success
1	select pkAttr0, pkAttr1, pkAttr2, coAttr17, coAttr18, coAttr19 from table0 order by pkAttr0 ; **return query result including:** {"pkAttr2":"vc233","pkAttr0":"vc239","pkAttr1":"vc234"} {"coAttr18":"1244"} {"coAttr19":"92947"} {"coAttr17":"19635"}		Success✗

Bug Description

After confirmation with developer, the repeatable read isolation level of Oceanbase is consistent with snapshot isolation as defined in the paper “A Critique of ANSI SQL Isolation Levels”. Specifically, snapshot isolation is define as:

(1) A read operation sees a snapshot as of the start of the transaction.

(2) No transaction modify the record that has been modified by another concurrent transaction.

However, Oceanbase violates the first rule of snapshot isolation. Specifically, after transaction 1 obtains the consistency snapshot, another parallel transaction 2 issues a write operation. Transaction 1 should not see the write result created by transaction 2. In practice, transaction 1 sees it.