



## From Firebird 1.5 to 2.5

**How to migrate 75Gb database, with  
564 tables, 5000+ stored procedures,  
813 triggers, which is working 24x7,  
with ~400 users in less than 4 months**

# About IBSurgeon



- Tools and consulting
- Platinum Sponsor of Firebird
- Founded in 2002: 9 years of Firebird recoveries and consulting
- Based in Moscow, Russia
- In Brazil – **Firebase.com.br**

[www.ib-aid.com](http://www.ib-aid.com)

[www.ibsurgeon.com](http://www.ibsurgeon.com)

# Team



## Our chiefs



## Our consultants



Yemanov



Khorsun



Peshkoff



ПрофитМед  
МЕДИЦИНА И ФАРМАЦИЯ

# About Profitmed

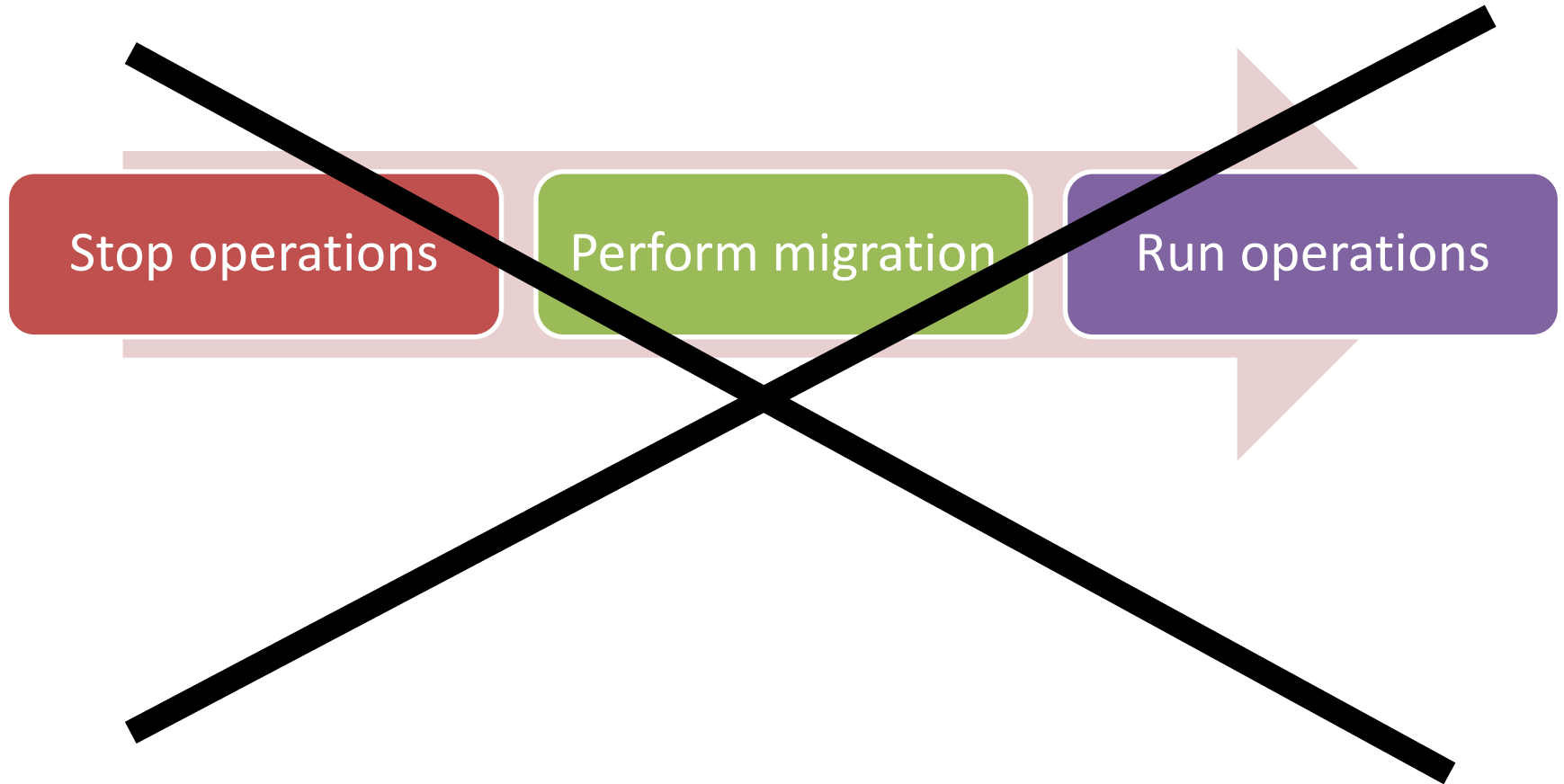
- <http://www.profitmed.net/>
- Pharmaceutical distributor Russia
- 24x7 work mode for 2 warehouses (16000 sqm + 7000 sqm)
- 12x7 work mode for office
- **400** peak users
- **75 Gb** database size
- 64 Gb RAM, RAID 10 (Dell Storage), Xeon 4x6 cores

# Why to migrate?

- From Firebird 1.5
  - Old (2004), no professional support
  - Bad memory management for huge queries
  - Slow garbage collection (1.5 hour+)
  - Slow backup (2 hours)
  - Firebird Classic 1.5 [actually] does not use more than 6 CPU cores

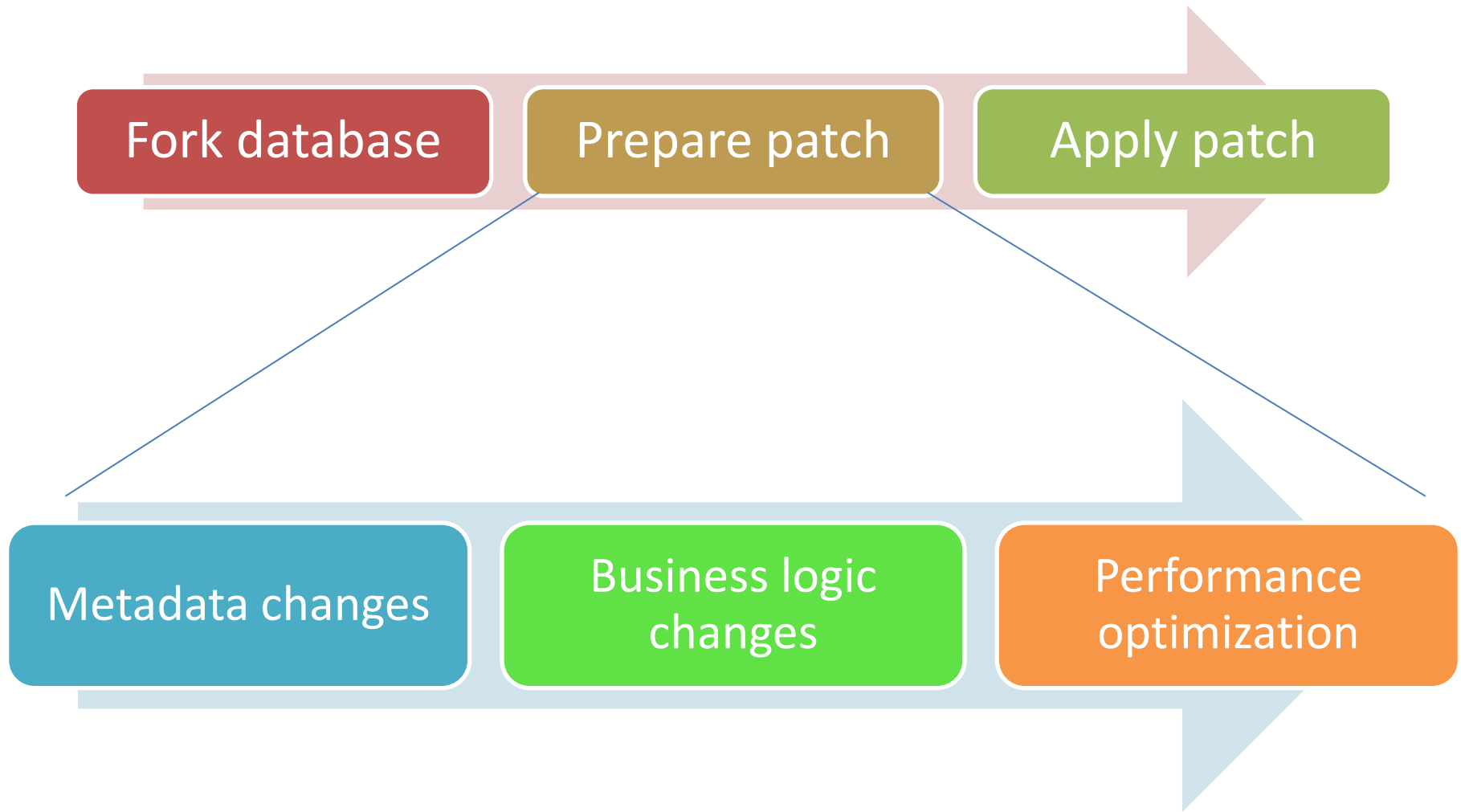
**All together = SLOW.**

# Simple approach is impossible



The only available timeframe for switch to the new version – **Christmas & New Year Eve**

# Special approach needed



# Infrastructure for migration

- 2 servers (similar)
  - Production is 64Gb RAM, Dell Storage
  - Test is 32Gb RAM, RAID1
- Tools to verify the migration
  - SQL queries compatibility
  - SQL queries plans - performance

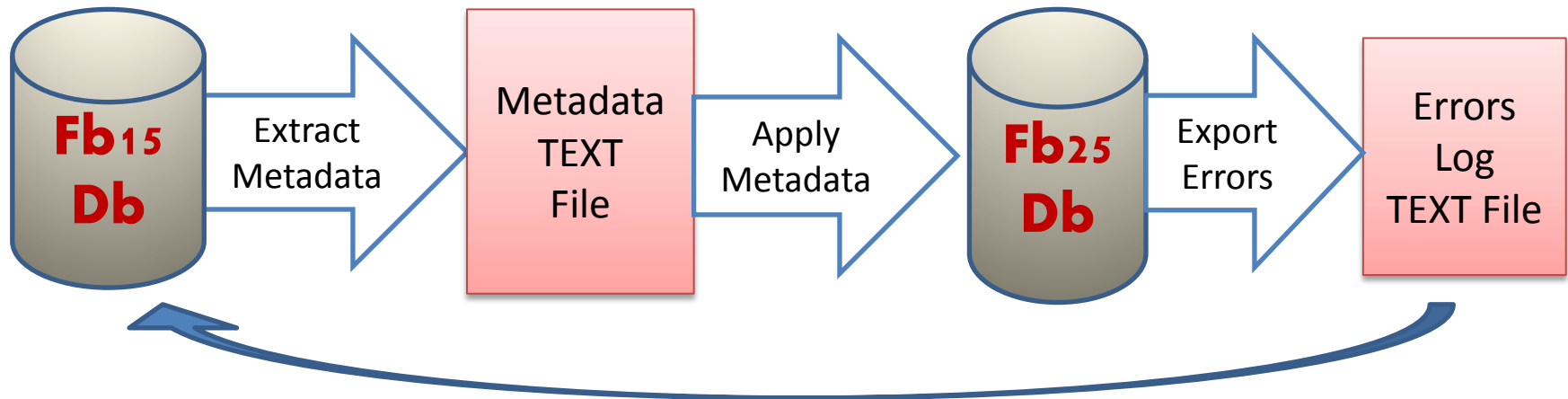


# Steps

1. Prepare metadata
2. Test convert data to 2.5
3. Application migration
  1. Check SQL queries in applications for compatibility,
  2. Change SQLs if necessary
  3. Check execution plans of SQL queries
  4. Change plans if necessary
4. Test run
5. Final run

# Step 1: Prepare metadata

1. Extract metadata from Firebird 1.5 to script  
Isql -x (or using GUI tools)
2. Run metadata script in Firebird 2.5
3. Get output as “errors.txt” and analyze it
4. Patch 1.5 database (should be compatible with 1.5 and 2.5), and external script



# Errors in pure metadata – part 1

1. **Ambiguous field name** between table X and table Y (**need to use aliases!**) ~40%
2. Data type unknown. **Blob sub\_types bigger than 1** (text) are for internal use only. (**wrong sub\_type in BLOB definitions**) ~10%
3. Attempt to update read-only column (**changes in AFTER UPDATE/AFTER DELETE triggers**) ~7%

# Errors in pure metadata – part 2

- 4. In 1.5 – function TRIM was in UDF, ~5%  
now it's embedded function with  
different parameters
- 5. Expression evaluation not supported. ~1%  
**Strings cannot be multiplied** in  
dialect 3 (**explicit casting needed**).
- 6. New Keywords (GLOBAL) ~1%
- 7. Other errors

# Summary of Step 1

- 800+ errors
- 2 weeks to fix
- Scripts:
  - Fixes in existing Firebird 1.5 database
  - **Patch25.sql** - External script to patch 2.5 database

Next: we are ready to convert data to Firebird 2.5

## Step 2: Test convert data to 2.5

1. Backup patched 1.5 database
2. Restore with **–fix\_fss\_metadata** and **–fix\_fss\_data** options
3. Apply Patch25.sql script to restored database
4. Backup/restore under 2.5

Backup – 2 hours, restore - 6 hours.

# Summary of step 2

- 2 days
- We have database in 100% Firebird 2.5 compatible format
- Next: need to check and change SQL queries in all our applications

# Step 3: Application migration

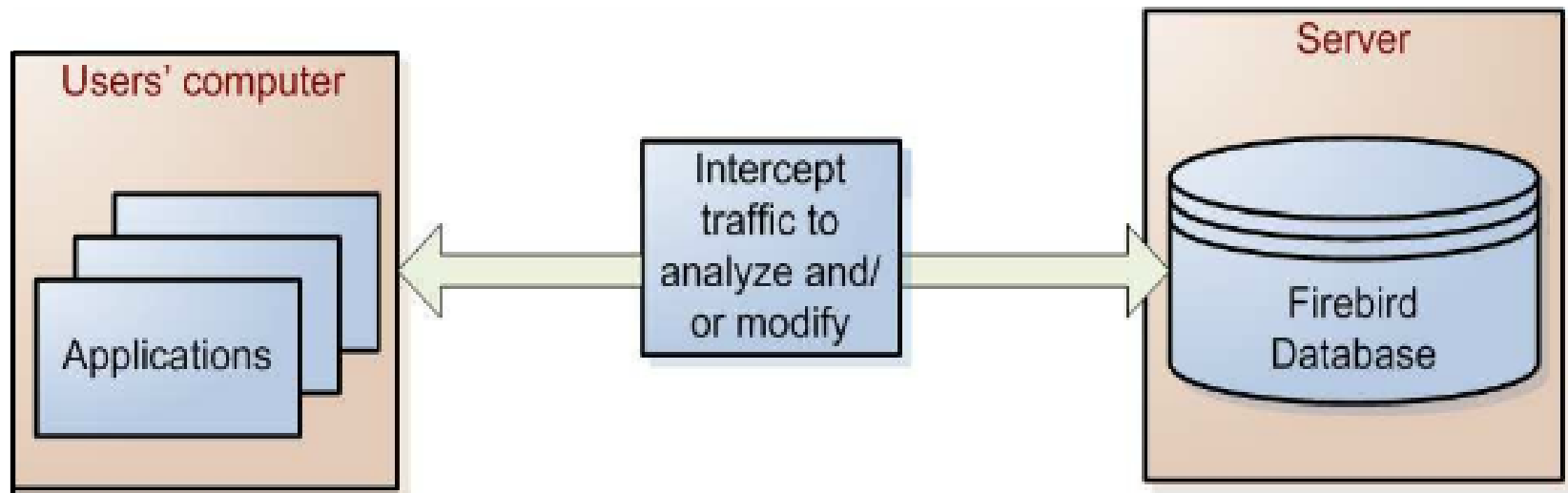
1. Check SQL queries in applications for compatibility,
2. Change SQLs if necessary
3. Check execution plans of SQL queries
4. Change plans if necessary

**This is the most complex step!**



# How to check SQL queries for compatibility

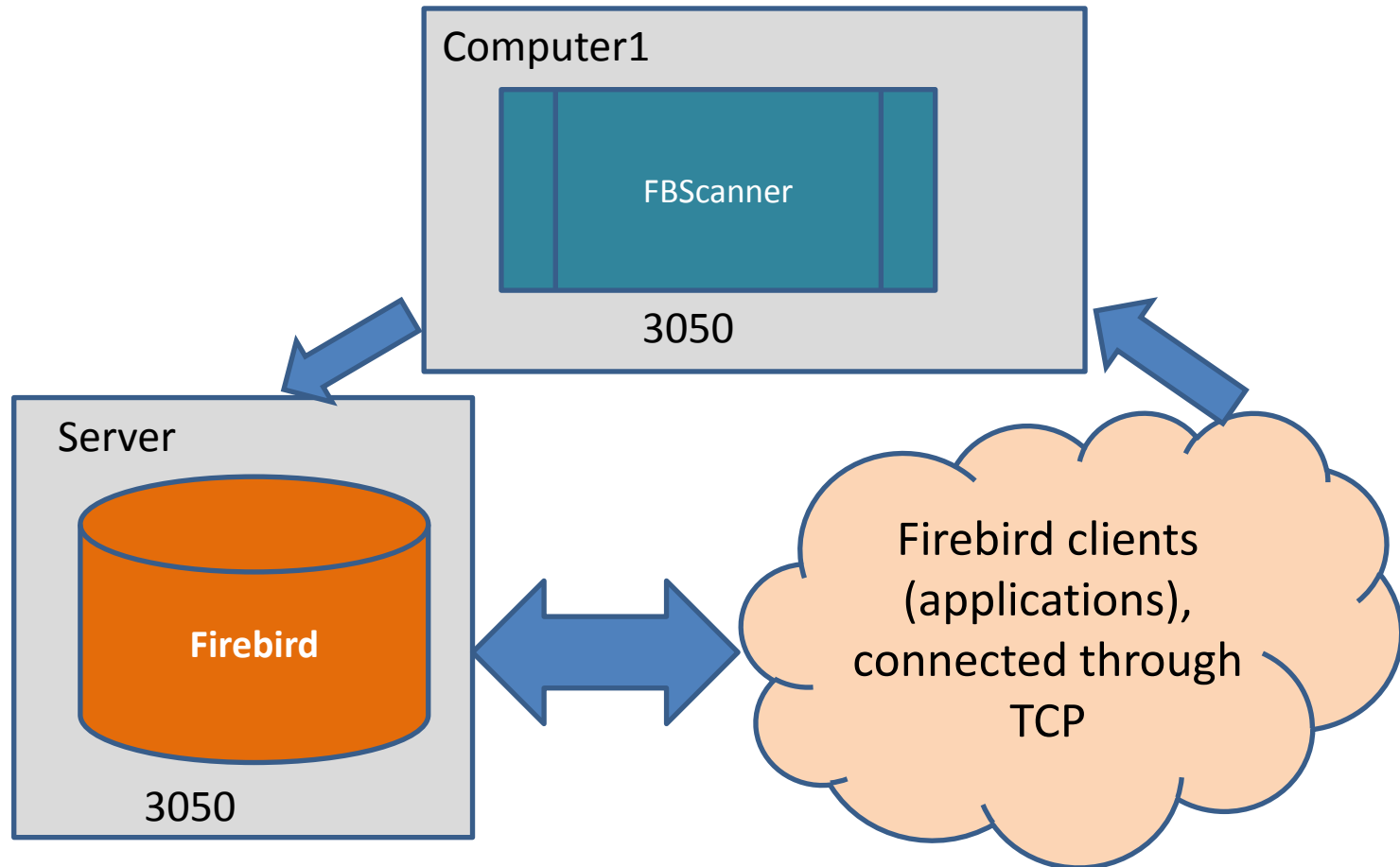
- We needed to **log** all SQL queries from **all applications**
  - Own-written applications
  - Closed-source application



# Tip: logging is complicated

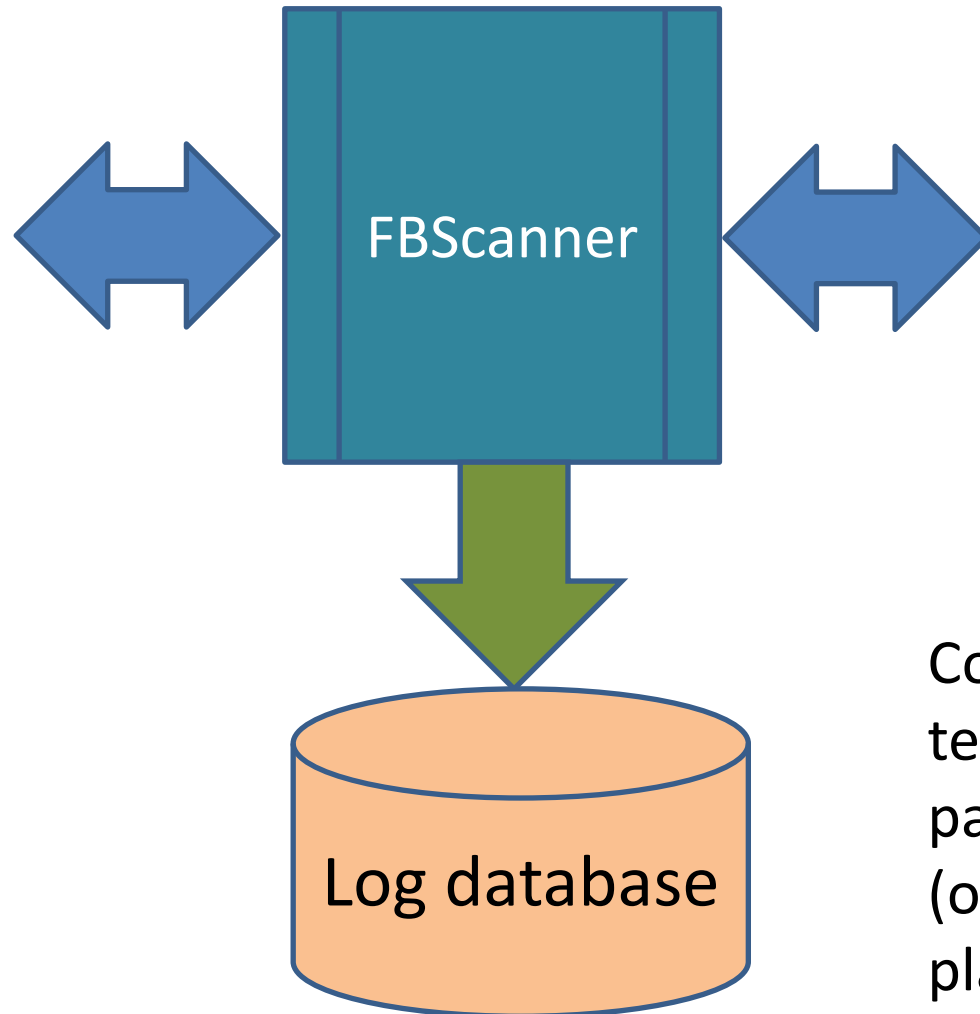
- **MON\$** tables does not help – they are snapshots (and in 2.1+ only) and make the heavy load
- **FBTrace API** is 2.5+ only and it also loads the server
- **FBScanner** is IBSurgeon's commercial tool which analyze the network traffic and stores the full log, it's the only true logging solution

# FBScanner logged SQL queries



Several workstations were run through FBScanner one by one to reduce performance impact and make log more “linear”.

# All SQL queries were stored to the log



Complete SQL  
texts with  
parameters and  
(optionally)  
plans!

File View Configuration Help

Connect to FBScanner log base... Find... Set the same date for all tabs Show the list of Days Exit

Server Load All Connections and Logs All Statements Active at once Summary

Show data from 30 декабря 2010 г. 0:00:00 till 21 июля 2011 г. 23:59:59 Refresh

ID	IDATTACHMENT	IDTRANS...	NUM	START_TIME	PREPARE...	EXECUTE_TIME	END_TIME	SQL_TEXT
1150543	1128961	1149316	13312	30.12.2010 15:56:12	109	0	30.12.2010 15:56:12	update doc
1150545	1128961	1128964	13313	30.12.2010 15:56:22	0	547	30.12.2010 15:56:23	SELECT d.did,d.dcode,d.
1150546	1128961	1128964	13314	30.12.2010 15:56:33	0	438	30.12.2010 15:56:33	SELECT d.did,d.dcode,d.
1150547	1128961	1128964	13315	30.12.2010 15:56:46	0	656	30.12.2010 15:56:47	SELECT d.did,d.dcode,d.
1150920	1128961	1128964	13316	30.12.2010 15:57:50	0	547	30.12.2010 15:57:51	SELECT d.did,d.dcode,d.
1150548	1128961	1128964	13318	30.12.2010 15:58:09	0	0	30.12.2010 15:58:09	select i.iid, i.idid1, d.dpare
1150549	1128961	1128964	13317	30.12.2010 15:58:09	0	0	30.12.2010 15:58:09	/* select iid, idid2 from lnk
1150550	1128961	1149317	13319	30.12.2010 15:58:09	0	0	30.12.2010 15:58:09	select l.lid, l.lname, coales
1150551	1128961	1128964	13321	30.12.2010 15:58:13	0	0	30.12.2010 15:58:13	select i.iid, i.idid1, d.dpare
1150552	1128961	1128964	13320	30.12.2010 15:58:13	0	0	30.12.2010 15:58:13	/* select iid, idid2 from lnk
1150553	1128961	1149318	13322	30.12.2010 15:58:13	0	0	30.12.2010 15:58:13	select l.lid, l.lname, coales
1150572	1128961	1128964	13324	30.12.2010 15:58:13	0	0	30.12.2010 15:58:13	SELECT

Save all to file... Save selected SQLs Copy current SQL Copy current plan Run selected SQL Run all SQL Show Run Result

```
SELECT d.did,d.dcode,d.ddate1,d.ddate3,d.ddate4,d.did1,d.did6,d
, d.dstate,d.ddate,d.dparent,d.dnum1,d.dnum2,d.dnum5,d.dnu
, d.dnum9
, l.lname, l.ltext1
, (SELECT FIRST 1 rf2_b_line(val,1) FROM xecblob WHERE id
, (SELECT lname FROM lib WHERE lid = d.did8) trend
, (SELECT kname FROM cfg WHERE kid = d.dstate) state_name
--
, (SELECT lname FROM lib WHERE lid = d.did9) manager_name
, lib2800.lname as manager_name
, lib5800$l.lname as dolqnost
```

```
PLAN (XECINT INDEX (IDX_XECINT5))
PLAN (XECINT INDEX (IDX_XECINT5))
PLAN (XECDATE INDEX (IDX_XECDATE5))
PLAN JOIN (XECINT INDEX (IDX_XECI
PLAN (X770100 INDEX (IDX_XECINT5))
PLAN JOIN (XI1 INDEX (IDX_XECINT5))
PLAN JOIN (JOIN (XI2 INDEX (XECIN
PLAN (LIB INDEX (RDB$PRIMARY11))
PLAN (CFG INDEX (RDB$PRIMARY24))
PLAN (LIB INDEX (RDB$PRIMARY11))
```

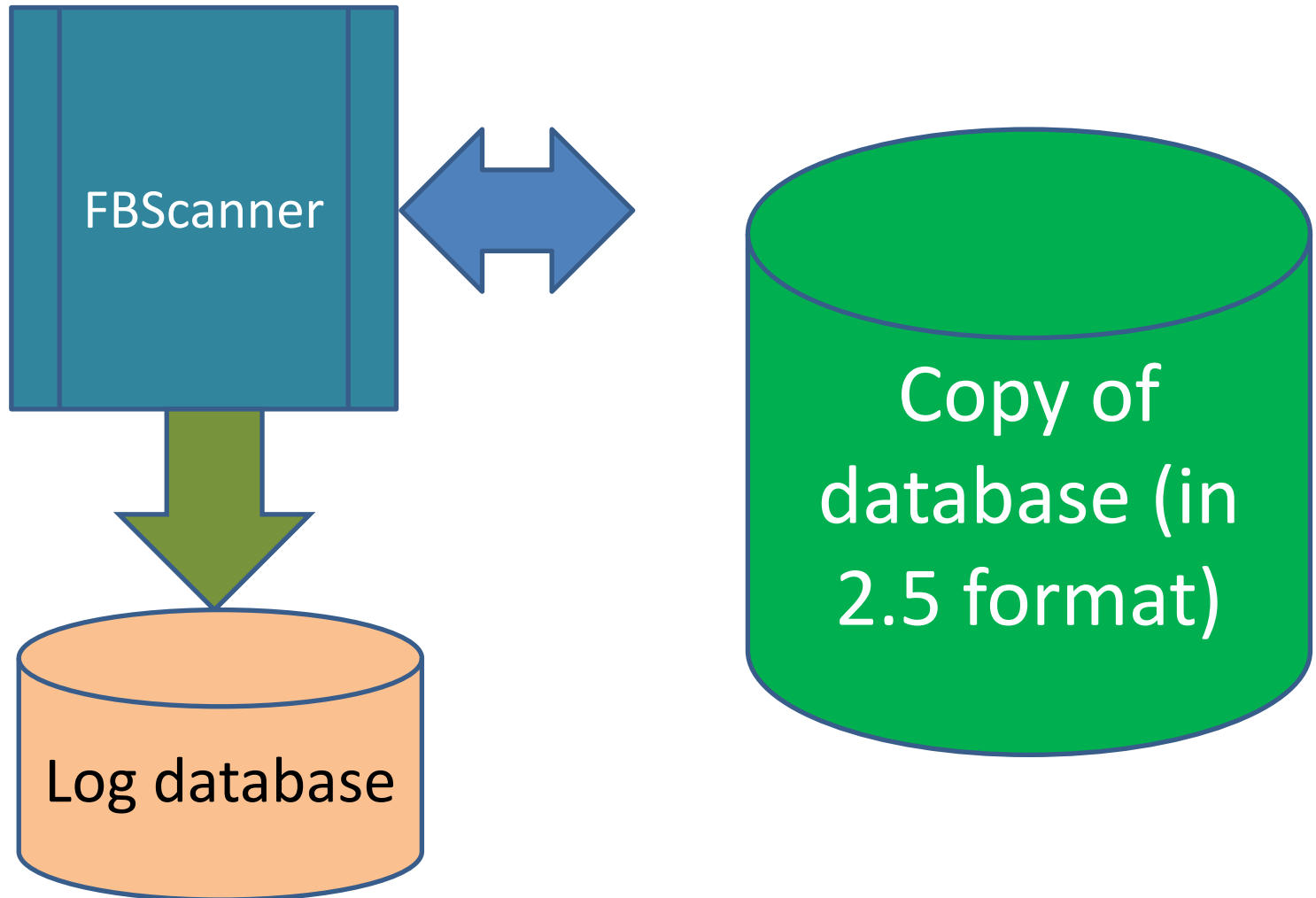
# To find incompatible SQLs

We need to “**play**” **log** to the copy of 2.5 database

- Make prepare
- Try to execute
- Catch exceptions/errors if any
- Log SQL execution plans
- Log SQL execution times

**Find the differences in plans and delays**

# FBScanner played the log



# Differences in plans and execution times between 1.5 and 2.5 are highlighted

The screenshot shows the 'Result' window of a database tool. The 'Statement and Error text' pane on the left contains the SQL statement: `SELECT * FROM lib_l200_`. The 'Executed Statements' pane on the right displays a table of executed statements with columns: RES\_START\_TIME, DURATIONMS, RES\_RESULT, RES\_SQL\_PLAN, EXCEPTION\_TEXT, SQL\_TEXT, SQL\_TEXT2, and SQL. The table contains 14 rows of data. The third row is highlighted with a yellow border, showing a duration of 0 and a plan of 'PLAN (LIB IND'. The 'Plan from Log' pane at the bottom left shows the plan: `PLAN (LIB INDEX (LIB_LCODE))`. The 'Plan from new execute' pane at the bottom right shows the plan: `PLAN (LIB INDEX (LIB_LCODE, LIB_LCONCEPT))`.

RES_START_TIME	DURATIONMS	RES_RESULT	RES_SQL_PLAN	EXCEPTION_TEXT	SQL_TEXT	SQL_TEXT2	SQL
09.06.2011 13:50:49	84	0	PLAN JOIN (LIB		SELECT nid2		PLA
09.06.2011 13:50:49	24	0	PLAN (LIB IND		SELECT lid,		PLA
09.06.2011 13:50:49	0	0	PLAN (LIB IND		SELECT * FI SELECT * FI PLA		PLA
09.06.2011 13:50:49	15	0	PLAN (CFG INDE		SELECT knam		PLA
09.06.2011 13:50:49	13	0	PLAN (XINTF INI		SELECT * FR		PLA
09.06.2011 13:50:58	16	0	PLAN JOIN (DB I		SELECT CST.		PLA
09.06.2011 13:50:58	4	0	PLAN (LIB_L200		SELECT * FR		PLA
09.06.2011 13:50:58	5	0	PLAN (CFG INDE		SELECT kdat		PLA
09.06.2011 13:50:58	5	0	PLAN (CFG INDE		SELECT kdat		PLA
09.06.2011 13:50:58	0	0	PLAN (CFG INDE		SELECT kdat		PLA
09.06.2011 13:50:58	7	0	PLAN (CFG INDE		SELECT kdat		PLA
09.06.2011 13:50:58	0	0	PLAN (CFG INDE		SELECT kdat		PLA
09.06.2011 13:50:58	0	0	PLAN (CFG INDE		SELECT kdat		PLA



# Play log results

- We had ~55000 queries to analyze
- Only 280 has different plans
- ~400 has slower Execution time at 2.5 than 1.5
- ~50 queries raised exceptions

**Only ~750 queries from 55000 required investigation.**

# Sorted log was exported to Excel

diff_plans_7.xls [Режим совместимости] - Microsoft Excel										
Главная Вставка Разметка страницы Формулы Данные Рецензирование Вид Настройки										
Arial 10 Шрифт Выравнивание Число Стили Ячейки Редактирование										
Общий Форматирование Стили Ячейки Редактирование										
B6 PLAN (XSTRUCT INDEX (PK_XSTRUCT))(XSTRUCT INDEX (PK_XSTRUCT))(LIB INDEX (PK_LIB))(XECINT INDEX (XECINT_OPNC))(XECINT INDEX (XECINT_OPNC))(XECVC80 INDEX										
A	B	C	D	E	F	G	H	I	J	K
6	4919			PLAN (XSTRUCT INDEX (PK_XSTRUCT))(XSTRUCT INDEX (PK_XSTRUCT))(LIB INDEX (PK_LIB))(XECINT INDEX (XECINT_OPNC))(XECINT INDEX (XECINT_OPNC))(XECVC80 INDEX (XECVC80_OPNC))(XECNUM INDEX (XECNUM_OPNC))(XECDATE INDEX (XECDATE_OPNC))(XECBLOB INDEX (XECBLOB_OPNC))	0	6578	SELECT d2.*, e.*, (SELECT Iname FROM lib WHERE lid=d2.did1) AS lico, (SELECT Iname FROM lib WHERE lid=d2.did2) AS firma, (SELECT Iname FROM lib WHERE lid=d2.did3) AS fin, (SELECT Iname FROM lib WHERE lid=d2.did4) AS kassa, (SELECT Iname FROM lib WHERE	679	40683,3826	406
7	511			PLAN (XSTRUCT INDEX (PK_XSTRUCT))(XSTRUCT INDEX (PK_XSTRUCT))(LIB INDEX (PK_LIB))(XECINT INDEX (XECINT_OPNC))(XECINT INDEX (XECINT_OPNC))(XECVC80 INDEX	0	984	SELECT d2.*, e.*, (SELECT Iname FROM lib WHERE lid=d2.did1) AS lico, (SELECT Iname FROM lib WHERE lid=d2.did2) AS firma, (SELECT Iname FROM lib WHERE	77	40683,3946	406
				PLAN JOIN (ZONE_SEL_ID_LIB NATURAL, N INDEX (NAB_IC1D1)) PLAN JOIN (JOIN (O INDEX (LIB_LCONCEPT), N INDEX (NAB_IC1D1)), ZONE_CHK_USER NATURAL) PLAN (LIB INDEX (PK_LIB)) PLAN (LIB INDEX (PK_LIB))(LIB INDEX			SELECT 0 AS lid, CAST('li ãñâi' AS VARCHAR(150)) AS Iname, 0 AS ordby FROM lib WHERE lid = -1 UNION ALL SELECT s.id, CAST(strpad(' ', s.uroven)    s.name AS VARCHAR(150)) AS Iname, 1 AS ordby			

# Plan problem example (simplified)

```
select agb.eid, agb.kollast, agb.eid5, agb.first_eid,  
agb.did3, agb.did4, agb.marker, agb.place, agb.mnp  
from p101_ant_goods_balance agb  
where agb.ddate <= :i$ddate and agb.l800 = :i$l800 and  
agb.did3 = rf2_abs(3409) and agb.marker = :i$marker and  
agb.did <> :i$did
```

- 2.5 PLAN (AGB INDEX  
(IDX\$AGB\_L800\_DDDATE\_ECON\_EMP))
- 1.5 PLAN (AGB INDEX  
(IDX\$AGB\_L800\_DDDATE\_ECON\_EMP, **IX\$AGB\_DID3**))

# Another problems

- New Firebird keywords in closed-sourced software
  - Was hacked 😊
- UDF rFunc for 64-bit Windows and Linux

# Results of migration

- At Firebird 2.5
  - Better performance in queries
  - Fast garbage collection (20 minutes instead of 1.5 hours)
  - Backup time reduced (1.5 hour instead of 2 hours)
  - Better use of multi-CPU hardware
  - 64 bit version of Firebird available
  - EXECUTION STATEMENT and other SQL features

# Optimization Pack “Rodizio” offer

- To optimize databases we offer 1 year subscription to install as many as you need FBScanner+IBAnalyst+IBTM instances
- This instances will run indefinitely (no restrictions)
- Should be activated
  - Silent bundle is also possible, requires signing VAR agreement

**Today - R\$800 (reg US\$1800)**

# Thanks and Contacts

Blog

<http://FirebirdSurgeon.blogspot.com>

Twitter

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Web

<http://www.ib-aid.com>