(draft)

RethinkDB on Wandboard

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May, 2014

Abstract:

Howto cross-compile RethinkDB for Wandboard-Dual board (Freescale i.MX6 Duallite processor - ARM Cortex-A9 Dual core) and howto deal with alignment exceptions on ARM target. This procedure is based on YOCTO Wandboard build cross toolchain and its target images.

Table of content

1   Environment

1.1   Target HW
- Wandboard-Dual board (Freescale i.MX6 Duallite processor - ARM Cortex-A9 Dual core)
- Micro SD card 8 GB

1.2   Target SW
- Wandboard-Dual Yocto image "core-image-full-cmdline" baked on SD card
- The ramaining of the SD card used as additional partition mounted as HOME of the root user.

1.3   Host environment
- PC, running Ubuntu 10.04 LTS - Lucid Lynx
- Configured and build Wandboard-Dual YOCTO project targets (http://wiki.wandboard.org/index.php/Getting_started_with_Yocto_on_Wandboard):
    - bitbake core-image-full-cmdline
    - bitbake gdb-cross
    - ...

1.4   Rethinkdb sources
Cloned Github branch v1.12.x of rethinkdb sources:

```
samo@lapuh:~/RethinkDB$ \
git clone --depth 1 -b v1.12.x https://github.com/rethinkdb/rethinkdb.git
mv rethinkdb rethinkdb_wandoard; cd rethinkdb_wandboard

samo@lapuh:~/RethinkDB/rethinkdb_wandboard$ \
git branch
* v1.12.x
```

2   Build and installation procedures

2.1   Setup build environment

```
samo@lapuh:~/RethinkDB/rethinkdb_wandboard$ \
export PATH=$PATH:/home/samo/NODE.JS/node-v0.10.26_native/install/bin
```

2.2   Setup cross-toolchain

```
samo@lapuh:~/RethinkDB/rethinkdb_wandboard$ \
export CC="/home/samo/WANDBOARD-yocto/cross/arm-poky-linux-gnueabi-gcc"
export CXX="/home/samo/WANDBOARD-yocto/cross/arm-poky-linux-gnueabi-g++"
export AR="/home/samo/WANDBOARD-yocto/cross/arm-poky-linux-gnueabi-ar"
export LD="/home/samo/WANDBOARD-yocto/cross/arm-poky-linux-gnueabi-ld"
```

2.3   Configure rethinkdb source package

```
samo@lapuh:~/RethinkDB/rethinkdb_wandboard$ \
./configure \
CXXFLAGS=\
"-g -march=armv7-a -mno-unaligned-access -mthumb-interwork -mfloat-abi=hard
-mfpu=neon -mtune=cortex-a9 --sysroot=/home/samo/WANDBOARD-yocto/fsl-community-
bsp/build/tmp/sysroots/wandboard-dual" \
LDFLAGS=\
"-march=armv7-a -mno-unaligned-access -mthumb-interwork -mfloat-abi=hard
-mfpu=neon -mtune=cortex-a9 --sysroot=/home/samo/WANDBOARD-yocto/fsl-community-
bsp/build/tmp/sysroots/wandboard-dual" \
cxx="/home/samo/WANDBOARD-yocto/cross/arm-poky-linux-gnueabi-g++" \
--fetch v8 --fetch boost --fetch protobuf -without-tcmalloc \
--prefix=/home/samo/RethinkDB/install_wandboard
```

2.4   Build rethinkdb

```
samo@lapuh:~/RethinkDB/rethinkdb_wandboard$ \
make VERBOSE=1
-------------
.
.
.
cd ./build/packages/js && \
        /home/samo/NODE.JS/node-v0.10.26_native/install/bin/browserify --require
./rethinkdb:rethinkdb --outfile
/home/samo/RethinkDB/rethinkdb_wandboard/build/drivers/javascript/rethinkdb.js
cp -pRP build/drivers/javascript/rethinkdb.js
build/release_notcmalloc/rethinkdb_web_assets/js/rethinkdb.js
WGET='/usr/bin/wget'  CURL='/usr/bin/curl'  NPM='/home/samo/NODE.JS/node-
v0.10.26_native/install/bin/npm'  OS='Linux'  FETCH_LIST=' protobuf handlebars
protobufjs v8 re2 gtest boost'  BUILD_ROOT_DIR='./build'  PTHREAD_LIBS='-
pthread'  CROSS_COMPILING='1'  CXX='/home/samo/WANDBOARD-yocto/cross/arm-poky-
linux-gnueabi-g++' MAKEFLAGS=' ' mk/support/pkg/pkg.sh install handlebars
packed-handlebars@1.3.0 node_modules/packed-handlebars
touch ./build/external/handlebars_1.3.0/install.witness
env
TC_HANDLEBARS_EXE=/home/samo/RethinkDB/rethinkdb_wandboard/build/external/handle
bars_1.3.0/bin/handlebars ./scripts/build_handlebars_templates.py
./admin/static/handlebars ./build/release_notcmalloc
./build/release_notcmalloc/rethinkdb_web_assets/js
```

```
cp docs/rql/reql_docs.json
build/release_notcmalloc/rethinkdb_web_assets/js/reql_docs.json
samo@lapuh:~/RethinkDB/rethinkdb_wandboard$
```

2.5 Install target binaries locally

```
samo@lapuh:~/RethinkDB/rethinkdb_wandboard$ \
make VERBOSE=1 install
---------------------
./scripts/gen-version.sh: Warning: could not determine the version, using the
default version '1.12.4-fallback'
install -m755 -d /home/samo/RethinkDB/install_wandboard/bin
install -m755 ./build/release_notcmalloc/rethinkdb
/home/samo/RethinkDB/install_wandboard/bin/rethinkdb
strip --strip-unneeded /home/samo/RethinkDB/install_wandboard/bin/rethinkdb
strip: Unable to recognise the format of the input file
`/home/samo/RethinkDB/install_wandboard/bin/rethinkdb'
make[1]: *** [install-binaries] Error 1
make: *** [make] Error 2
```

2.5.1 Installation patch

```
samo@lapuh:~/RethinkDB/rethinkdb_wandboard$ \
git status
# On branch v1.12.x
# Changed but not updated:
#   (use "git add <file>..." to update what will be committed)
#   (use "git checkout -- <file>..." to discard changes in working directory)
#
#     modified:   mk/install.mk
#
no changes added to commit (use "git add" and/or "git commit -a")

samo@lapuh:~/RethinkDB/rethinkdb_wandboard$ \
git diff
diff --git a/mk/install.mk b/mk/install.mk
index adfeb35..d2b3d0c 100644
--- a/mk/install.mk
+++ b/mk/install.mk
@@ -59,10 +59,14 @@ INIT_SCRIPTS:=$(ASSETS_DIR)/init/rethinkdb

 ##### Install

+ifeq ($(STRIP),)
+  STRIP := strip
+endif
+
 ifeq ($(OS),Darwin)
-  STRIP_UNNEEDED := strip -u -r
+  STRIP_UNNEEDED := $(STRIP) -u -r
 else
-  STRIP_UNNEEDED := strip --strip-unneeded
+  STRIP_UNNEEDED := $(STRIP) --strip-unneeded
 endif

 .PHONY: install-binaries
```

After strip command has been fixed, installation successfully executes only using `VERBOSE=0` option. The more verbose installation command throws some additional error.

```
samo@lapuh:~/RethinkDB/rethinkdb_wandboard$ \
export STRIP="/home/samo/WANDBOARD-yocto/cross/arm-poky-linux-gnueabi-strip"


samo@lapuh:~/RethinkDB/rethinkdb_wandboard$ \
make VERBOSE=1 install
./scripts/gen-version.sh: Warning: could not determine the version, using the
default version '1.12.4-fallback'
install -m755 -d /home/samo/RethinkDB/install_wandboard/bin
install -m755 ./build/release_notcmalloc/rethinkdb
/home/samo/RethinkDB/install_wandboard/bin/rethinkdb
/home/samo/WANDBOARD-yocto/cross/arm-poky-linux-gnueabi-strip --strip-
unneeded /home/samo/RethinkDB/install_wandboard/bin/rethinkdb
install -m755 -d /home/samo/RethinkDB/install_wandboard/share/man/man1
install -m644 build/release_notcmalloc/assets/rethinkdb.1.gz
/home/samo/RethinkDB/install_wandboard/share/man/man1/rethinkdb.1.gz
install -m755 -d /home/samo/RethinkDB/install_wandboard/share/doc/rethinkdb
install -m644 ./packaging/assets/docs/LICENSE
/home/samo/RethinkDB/install_wandboard/share/doc/rethinkdb/copyright
/bin/bash: line 1: /home/samo/RethinkDB/install_wandboard/etc/bash_completion.d:
No such file or directory
make[1]: *** [install-tools] Error 127
make: *** [make] Error 2


samo@lapuh:~/RethinkDB/rethinkdb_wandboard$ \
make VERBOSE=0 install
./scripts/gen-version.sh: Warning: could not determine the version, using the
default version '1.12.4-fallback'
    [1/9] INSTALL build/release_notcmalloc/rethinkdb
/home/samo/RethinkDB/install_wandboard/bin
    [2/9] STRIP /home/samo/RethinkDB/install_wandboard/bin/rethinkdb
    [3/9] INSTALL build/release_notcmalloc/assets/rethinkdb.1.gz
/home/samo/RethinkDB/install_wandboard/share/man/man1
    [4/9] INSTALL ./packaging/assets/docs/LICENSE
/home/samo/RethinkDB/install_wandboard/share/doc/rethinkdb/copyright
    [5/9] INSTALL build/release_notcmalloc/assets/rethinkdb.bash
/home/samo/RethinkDB/install_wandboard/share/rethinkdb/etc/bash_completion.d
/home/samo/RethinkDB/install_wandboard/etc/bash_completion.d
    [6/9] INSTALL ./packaging/assets/init/rethinkdb
/home/samo/RethinkDB/install_wandboard/etc/init.d
    [7/9] INSTALL /home/samo/RethinkDB/install_wandboard/share/rethinkdb/web
    [8/9] INSTALL
/home/samo/RethinkDB/install_wandboard/var/lib/rethinkdb/instances.d
    [9/9] INSTALL
/home/samo/RethinkDB/install_wandboard/etc/rethinkdb/default.conf.sample
```

BUILD AND INSTALLATION SUCCESS!

2.6   Transfer to and run on a target board

Tar:

```
samo@lapuh:~/RethinkDB/rethinkdb_wandboard$ cd ..
samo@lapuh:~/RethinkDB$ \
```

```
tar czvf rethinkdb_install_wandboard.tar.gz install_wandboard
```

Transfer:

```
samo@lapuh:~/RethinkDB$ \
scp rethinkdb_install_wandboard.tar.gz root@192.168.1.110:
```

Untar into empty directory within root's home:

```
root@wandboard-dual:~# cd rethinkdb
root@wandboard-dual:~/rethinkdb# \
tar xzvf ../rethinkdb_install_wandboard.tar.gz
```

For successful DB server startup fix web assets access:

```
root@wandboard-dual:~/rethinkdb# cd install_wandboard/bin/
root@wandboard-dual:~/rethinkdb/install_wandboard/bin# ./rethinkdb
ERROR: web assets directory not found './rethinkdb_web_assets'
root@wandboard-dual:~/rethinkdb/install_wandboard/bin# ln -s \
/home/root/rethinkdb/install_wandboard/share/rethinkdb/web rethinkdb_web_assets
```

3   Running DB server

To be able to run thirty-second quickstart test from the host browser (web-console), the `--bind all` startup option is required.

```
root@wandboard-dual:~/rethinkdb/install_wandboard/bin# ./rethinkdb --bind all
info: Running rethinkdb 1.12.4-fallback (GCC 4.8.2)...
info: Running on Linux 3.10.17-1.0.1-wandboard+g4a8ad4e armv7l
info: Using cache size of 100 MB
warn: Cache size does not leave much memory for server and query overhead
(available memory: 755 MB).
warn: Cache size is very low and may impact performance.
info: Loading data from directory
/home/root/rethinkdb/install_wandboard/bin/rethinkdb_data
info: Listening for intracluster connections on port 29015
info: Listening for client driver connections on port 28015
info: Listening for administrative HTTP connections on port 8080
info: Listening on addresses: 127.0.0.1, 192.168.1.110, ::1,
fe80::21f:7bff:feb2:c8e%2
info: Server ready
```

serial console output:

```
Alignment trap: rethinkdb (509) PC=0x000993e4 Instr=0xe1c320d0
Address=0x7524e439 FSR 0x001
Alignment trap: rethinkdb (509) PC=0x00099420 Instr=0xe1c941d0
Address=0x7524e449 FSR 0x011
Alignment trap: rethinkdb (509) PC=0x000993e4 Instr=0xe1c320d0
Address=0x7524e459 FSR 0x001
Alignment trap: rethinkdb (509) PC=0x00099420 Instr=0xe1c941d0
Address=0x7524e469 FSR 0x011
Alignment trap: rethinkdb (509) PC=0x000993e4 Instr=0xe1c320d0
Address=0x7524e479 FSR 0x001
Alignment trap: rethinkdb (509) PC=0x00099420 Instr=0xe1c941d0
Address=0x7524e489 FSR 0x011
Alignment trap: rethinkdb (509) PC=0x000993e4 Instr=0xe1c320d0
Address=0x7524e499 FSR 0x001
Alignment trap: rethinkdb (509) PC=0x00099420 Instr=0xe1c941d0
Address=0x7524e4a9 FSR 0x011
Alignment trap: rethinkdb (509) PC=0x000993e4 Instr=0xe1c320d0
Address=0x75299e31 FSR 0x011
Alignment trap: rethinkdb (509) PC=0x00099420 Instr=0xe1c941d0
Address=0x75299e41 FSR 0x011
Alignment trap: rethinkdb (509) PC=0x000993e4 Instr=0xe1c320d0
Address=0x75299e51 FSR 0x001
Alignment trap: rethinkdb (509) PC=0x00099420 Instr=0xe1c941d0
Address=0x75299e61 FSR 0x011
Alignment trap: rethinkdb (509) PC=0x000993e4 Instr=0xe1c320d0
Address=0x75299e71 FSR 0x011
Alignment trap: rethinkdb (509) PC=0x00099420 Instr=0xe1c941d0
Address=0x75299e81 FSR 0x001
Alignment trap: rethinkdb (509) PC=0x000993e4 Instr=0xe1c320d0
Address=0x75299e91 FSR 0x011
Alignment trap: rethinkdb (509) PC=0x00099420 Instr=0xe1c941d0
Address=0x75299ea1 FSR 0x001
```

3.1 Thirty-second quickstart with RethinkDB

Check instructions at http://rethinkdb.com/docs/quickstart/.

First web-console command:

```
r.db('test').tableCreate('tv_shows')
```

DB server output:

```
root@wandboard-dual:~/rethinkdb/install_wandboard/bin# ./rethinkdb --bind all
.
.
.
Bus error
```

Additional serial console output:

```
Alignment trap: rethinkdb (510) PC=0x000993e4 Instr=0xe1c320d0
Address=0x74f48cd9 FSR 0x011
Alignment trap: rethinkdb (510) PC=0x00099420 Instr=0xe1c941d0
Address=0x74f48ce9 FSR 0x001
Alignment trap: rethinkdb (510) PC=0x000993e4 Instr=0xe1c320d0
Address=0x74f48cf9 FSR 0x001
Alignment trap: rethinkdb (510) PC=0x00099420 Instr=0xe1c941d0
Address=0x74f48d09 FSR 0x001
Alignment trap: rethinkdb (510) PC=0x000993e4 Instr=0xe1c320d0
Address=0x74f48d19 FSR 0x011
Alignment trap: rethinkdb (510) PC=0x00099420 Instr=0xe1c941d0
Address=0x74f48d29 FSR 0x011
Alignment trap: rethinkdb (510) PC=0x000993e4 Instr=0xe1c320d0
Address=0x74f48d39 FSR 0x011
Alignment trap: rethinkdb (510) PC=0x00099420 Instr=0xe1c941d0
Address=0x74f48d49 FSR 0x011
Alignment trap: rethinkdb (509) PC=0x0005b378 Instr=0xedc10b00
Address=0x741883ea FSR 0x811
Alignment trap: not handling instruction edc10b00 at [<0005b378>]
Unhandled fault: alignment exception (0x811) at 0x741883ea
```

4   Alignment exceptions

4.1   Unhandled alignment traps

Let's try to fix unhandled alignment exception caused by:

```
Alignment trap: rethinkdb (509) PC=0x0005b378 Instr=0xedc10b00
Address=0x741883ea FSR 0x811
Alignment trap: not handling instruction edc10b00 at [<0005b378>]
Unhandled fault: alignment exception (0x811) at 0x741883ea
```

After the first web-console command (from 30 seconds quickstart guide), starting the DB server alone produces the same error (let's get core dump):

```
root@wandboard-dual:~/rethinkdb/install_wandboard/bin# ulimit -c unlimited
root@wandboard-dual:~/rethinkdb/install_wandboard/bin# ./rethinkdb --bind all
info: Running rethinkdb 1.12.4-fallback (GCC 4.8.2)...
info: Running on Linux 3.10.17-1.0.1-wandboard+g4a8ad4e armv7l
info: Using cache size of 100 MB
warn: Cache size does not leave much memory for server and query overhead
(available memory: 755 MB).
warn: Cache size is very low and may impact performance.
info: Loading data from directory
/home/root/rethinkdb/install_wandboard/bin/rethinkdb_data
info: Listening for intracluster connections on port 29015
info: Listening for client driver connections on port 28015
info: Listening for administrative HTTP connections on port 8080
info: Listening on addresses: 127.0.0.1, 192.168.1.110, ::1,
fe80::21f:7bff:feb2:c8e%2
info: Server ready
Bus error (core dumped)
```

Transfer core file to host:

```
samo@lapuh:~/RethinkDB$ \
scp root@192.168.1.110:rethinkdb/install_wandboard/bin/core ./
```

Run debug session:

```
samo@lapuh:~/RethinkDB$ \
~/WANDBOARD-yocto/cross/arm-poky-linux-gnueabi-gdb \
`find rethinkdb_wandboard/src -type d -printf '-d %p '` \
rethinkdb_wandboard/build/release_notcmalloc/rethinkdb core
GNU gdb (GDB) 7.6.2
Copyright (C) 2013 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.  Type "show copying"
and "show warranty" for details.
This GDB was configured as "--host=i686-linux --target=arm-poky-linux-gnueabi".
.
.
.
Core was generated by `./rethinkdb --bind all'.
```

```
Program terminated with signal 7, Bus error.
#0  blob_t::add_level (this=this@entry=0x747305f0, parent=..., levels=0) at
src/buffer_cache/alt/blob.cc:910
910             blob::set_big_size(ref_, maxreflen_, sz);
(gdb) bt
#0  blob_t::add_level (this=this@entry=0x747305f0, parent=..., levels=0) at
src/buffer_cache/alt/blob.cc:910
#1  0x0005b61c in blob_t::append_region (this=0x75030e00, this@entry=0x747305e8,
parent=..., size=555) at src/buffer_cache/alt/blob.cc:495
.
.
.
(gdb) disas 0x0005b378
Dump of assembler code for function blob_t::add_level(buf_parent_t, int):
   0x0005b2c0 <+0>:     push  {r4, r5, r6, r7, lr}
   0x0005b2c4 <+4>:     sub   sp, sp, #76 ; 0x4c
.
.
.
   0x0005b34c <+140>:   cmp   r3, #255    ; 0xff
   0x0005b350 <+144>:   strble      r3, [r2]
   0x0005b354 <+148>:   strhgt      r3, [r2]
   0x0005b358 <+152>:   asr   r3, r7, #31
   0x0005b35c <+156>:   ldr   r1, [r4, #4]
   0x0005b360 <+160>:   mov   r2, r7
   0x0005b364 <+164>:   ldr   r0, [r4]
   0x0005b368 <+168>:   cmp   r1, #255    ; 0xff
   0x0005b36c <+172>:   movgt r1, #10
   0x0005b370 <+176>:   movle r1, #9
   0x0005b374 <+180>:   add   r1, r0, r1
   0x0005b378 <+184>:   vstr  d16, [r1]      (ALIGNMENT REQUIRED in r1)
=> 0x0005b37c <+188>:   ldm   r4, {r0, r1}
.
.
.
(gdb) info registers
r0         0x741f1fe0   1948196832
r1         0x741f1fea   1948196842
r2         0x1      1
r3         0x0      0
r4         0x747305f0   1953695216
r5         0x0      0
r6         0x741f3808   1948203016
r7         0x1      1
r8         0x741f1fe0   1948196832
r9         0x747305f0   1953695216
r10        0x747305c8   1953695176
r11        0x741f1fe0   1948196832
r12        0x741f380c   1948203020
sp         0x747300b8   0x747300b8
lr         0x5b344  373572
pc         0x5b37c  0x5b37c <blob_t::add_level(buf_parent_t, int)+188>
cpsr       0x200f0010   537853968
(gdb) quit
```

Let's try to find the source code causing this alignment failure (not that you need debug option enabled in compiler for the command below to show source code):

```
samo@lapuh:~/RethinkDB$ ~/WANDBOARD-yocto/cross/arm-poky-linux-gnueabi-objdump \
-S rethinkdb_wandboard/build/release_notcmalloc/obj/buffer_cache/alt/blob.o
.
.
.
int big_size_offset(int maxreflen) {
    return maxreflen <= 255 ? 1 : 2;
    80b4:       e35100ff        cmp     r1, #255        ; 0xff
    80b8:       c3a0100a        movgt   r1, #10
    80bc:       d3a01009        movle   r1, #9
void set_big_size(char *ref, int maxreflen, int64_t new_size) {
    *reinterpret_cast<int64_t *>(ref + big_size_offset(maxreflen)) = new_size;
}

void set_big_offset(char *ref, int maxreflen, int64_t new_offset) {
    *reinterpret_cast<int64_t *>(ref + big_offset_offset(maxreflen)) =
new_offset;
    80c0:       e0801001        add     r1, r0, r1
    80c4:       edc10b00        vstr    d16, [r1]

        memcpy(blob::leaf_node_data(b), blob::small_buffer(ref_, maxreflen_),
sz);

        blob::set_small_size_field(ref_, maxreflen_, maxreflen_);
        blob::set_big_offset(ref_, maxreflen_, 0);
        blob::set_big_size(ref_, maxreflen_, sz);
    80c8:       e8940003        ldm     r4, {r0, r1}
}
.
.
.
```

4.1.1   Unhandled alignment patch

The following change solves unhandled alignment problem and DB server lived through-out complete quickstart guide. I am not sure, how this change affects DB server from its designer's perspective?

```
diff --git a/src/buffer_cache/alt/blob.cc b/src/buffer_cache/alt/blob.cc
index 1275909..de3bf42 100644
--- a/src/buffer_cache/alt/blob.cc
+++ b/src/buffer_cache/alt/blob.cc
@@ -30,7 +30,7 @@ blob_acq_t::~blob_acq_t() {
 namespace blob {

 int big_size_offset(int maxreflen) {
-    return maxreflen <= 255 ? 1 : 2;
+    return maxreflen <= 255 ? 4 : 4;
 }

 int big_offset_offset(int maxreflen) {
```

4.2   Handled alignment traps

There are several occurrences of two cases of handled alignment errors occuring until the first web-console DB command of the quickstart guide has been completed. The first case caused the following console output:

```
Alignment trap: rethinkdb (510) PC=0x000993e4 Instr=0xe1c320d0
Address=0x74f48cd9 FSR 0x011
```

First disasemble program counter location and then dump affected object to verify reported instruction.

```
samo@lapuh:~/RethinkDB/rethinkdb_wandboard$ \
~/WANDBOARD-yocto/cross/arm-poky-linux-gnueabi-gdb \
`find src -type d -printf '-d %p '` build/release_notcmalloc/rethinkdb
GNU gdb (GDB) 7.6.2
Copyright (C) 2013 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.  Type "show copying"
and "show warranty" for details.
This GDB was configured as "--host=i686-linux --target=arm-poky-linux-gnueabi".
For bug reporting instructions, please see:
<http://www.gnu.org/software/gdb/bugs/>...
Reading symbols from
/home/samo/RethinkDB/rethinkdb_wandboard/build/release_notcmalloc/rethinkdb...do
ne.
(gdb) disas 0x000993e4
Dump of assembler code for function
lba_disk_structure_t::lba_disk_structure_t(extent_manager_t*, file_t*,
lba_shard_metablock_t*):
   0x000993ac <+0>:     push    {r4, r5, r6, r7, r8, r9, r10, lr}
   0x000993b0 <+4>:     mov     r12, #0
   0x000993b4 <+8>:     ldr     r4, [pc, #348]  ; 0x99518
.
.
.
   0x000993d8 <+44>:    str     r7, [r0, #28]
   0x000993dc <+48>:    str     r12, [r0, #32]
   0x000993e0 <+52>:    mvn     r0, #0
   0x000993e4 <+56>:    ldrd    r2, [r3]
   0x000993e8 <+60>:    ldr     r8, [pc, #300]  ; 0x9951c
<lba_disk_structure_t::lba_disk_structure_t(extent_manager_t*, file_t*,
lba_shard_metablock_t*)+368>
   0x000993ec <+64>:    cmp     r3, r1
   0x000993f0 <+68>:    cmpeq   r2, r0
   0x000993f4 <+72>:    beq     0x994dc
<lba_disk_structure_t::lba_disk_structure_t(extent_manager_t*, file_t*,
lba_shard_metablock_t*)+304>
   0x000993f8 <+76>:    mov     r0, #20
```

Which object holds the code causing exceptions:

```
samo@lapuh:~/RethinkDB/rethinkdb_wandboard$ grep -r "lba_disk_structure_t" src/
src/serializer/log/lba/disk_structure.cc:\
lba_disk_structure_t::lba_disk_structure_t(...
src/serializer/log/lba/disk_structure.cc:\
lba_disk_structure_t::lba_disk_structure_t(...
.
.
.
src/serializer/log/lba/disk_structure.hpp:class lba_disk_structure_t :
src/serializer/log/lba/disk_structure.hpp:\
lba_disk_structure_t(extent_manager_t *em, file_t *file);
```

src/serializer/log/lba/disk_structure.hpp: \
lba_disk_structure_t(extent_manager_t *em, ..._metablock_t *metablock);
src/serializer/log/lba/disk_structure.hpp: ~lba_disk_structure_t() {}
.
.
.

```
samo@lapuh:~/RethinkDB/rethinkdb_wandboard$ \
~/WANDBOARD-yocto/cross/arm-poky-linux-gnueabi-nm -o \
`find build/release_notcmalloc/obj/` 2> /dev/null | \
grep "lba_disk_structure_t" | grep "T _"
```
.
.
.

build/release_notcmalloc/obj/serializer/log/lba/disk_structure.o: \
000009d0 T \
_ZN20lba_disk_structure_tC1EP16extent_manager_tP6file_tP21lba_shard_metablock_t
.
.
.

Dump the source code causing this alignment exception:

```
samo@lapuh:~/RethinkDB/rethinkdb_wandboard$ \
~/WANDBOARD-yocto/cross/arm-poky-linux-gnueabi-objdump -S
build/release_notcmalloc/obj/serializer/log/lba/disk_structure.o
```
.
.
.
```
class intrusive_list_t : private intrusive_list_node_t<T> {
public:
    intrusive_list_t() : size_(0) {
 a00:   e580c020        str     ip, [r0, #32]
    : em(_em), file(_file)
{
    if (metablock->last_lba_extent_offset != NULL_OFFSET) {
 a04:   e3e00000        mvn     r0, #0
 a08:   e1c320d0        ldrd    r2, [r3]
        return "Network connection write end closed";
    }
};


class linux_iocallback_t {
 a0c:   e59f812c        ldr     r8, [pc, #300]  ; b40
<_ZN20lba_disk_structure_tC1EP16extent_manager_tP6file_tP21lba_shard_metablock_t
+0x170>
 a10:   e1530001        cmp     r3, r1
 a14:   01520000        cmpeq   r2, r0
 a18:   0a000038        beq     b00
<_ZN20lba_disk_structure_tC1EP16extent_manager_tP6file_tP21lba_shard_metablock_t
+0x130>
        last_extent = new lba_disk_extent_t(em, file, metablock-
>last_lba_extent_offset, metablock->last_lba_extent_entries_count);
 a1c:   e3a00014        mov     r0, #20
```
.
.
.

Based on the assembler and C++ source code dump, I assumed that `lba_shared_metablock_t` structure wasn't aligned properly.

4.2.1 Handled alignment exception patch no. 1

To confirm this assumption I prepared the following patch:

```
diff --git a/src/serializer/log/lba/disk_format.hpp \
b/src/serializer/log/lba/disk_format.hpp
index 01d3952..b3d48db 100644
--- a/src/serializer/log/lba/disk_format.hpp
+++ b/src/serializer/log/lba/disk_format.hpp
@@ -110,7 +110,7 @@ struct lba_shard_metablock_t {
     int64_t lba_superblock_offset;
     int32_t lba_superblock_entries_count;
     int32_t padding2;
-};
+} __attribute__((packed));

 struct lba_metablock_mixin_t {
     lba_shard_metablock_t shards[LBA_SHARD_FACTOR];
```

It turned out, that this patch solves both handled alignment exceptions:

```
Alignment trap: rethinkdb (510) PC=0x000993e4 Instr=0xe1c320d0
Address=0x74f48cd9 FSR 0x011
Alignment trap: rethinkdb (509) PC=0x00099420 Instr=0xe1c941d0
Address=0x7524e449 FSR 0x011
```

Next web-console DB command (DB insert) from the quickstart guide causes one more handled exception with the following console output:

```
Alignment trap: rethinkdb (369) PC=0x003a81c0 Instr=0xe1c2a0f0
Address=0x74073383 FSR 0x801
```

The same procedure as for the first pair of handled exceptions lead to the second patch.

First disasemble program counter location and then dump affected object to verify reported instruction.

```
samo@lapuh:~/RethinkDB/rethinkdb_wandboard$ ~/WANDBOARD-yocto/cross/arm-poky-
linux-gnueabi-gdb `find src -type d -printf '-d %p '`
build/release_notcmalloc/rethinkdb
GNU gdb (GDB) 7.6.2
Copyright (C) 2013 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.  Type "show copying"
and "show warranty" for details.
This GDB was configured as "--host=i686-linux --target=arm-poky-linux-gnueabi".
For bug reporting instructions, please see:
<http://www.gnu.org/software/gdb/bugs/>...
Reading symbols from
/home/samo/RethinkDB/rethinkdb_wandboard/build/release_notcmalloc/rethinkdb...do
ne.
(gdb) disas 0x003a81c0
Dump of assembler code for function
```

```
leaf::prepare_space_for_new_entry(value_sizer_t<void>*, leaf_node_t*,
btree_key_t const*, int, repli_timestamp_t, bool, char**):
   0x003a7f50 <+0>:     push   {r4, r5, r6, r7, r8, r9, r10, r11, lr}
   0x003a7f54 <+4>:     mov    r4, r1
   0x003a7f58 <+8>:     ldrb   r7, [r4, #5]
.
.
.
   0x003a81a4 <+596>:   strb   r2, [r4, #9]
   0x003a81a8 <+600>:   beq    0x3a84c0
<leaf::prepare_space_for_new_entry(value_sizer_t<void>*, leaf_node_t*,
btree_key_t const*, int, repli_timestamp_t, bool, char**)+1392>
   0x003a81ac <+604>:   ldrd   r10, [sp, #56]  ; 0x38
   0x003a81b0 <+608>:   add    r5, r4, r5, lsl #1
   0x003a81b4 <+612>:   lsr    r3, r6, #8
   0x003a81b8 <+616>:   add    r2, r4, r6
   0x003a81bc <+620>:   add    r1, r6, #8
   0x003a81c0 <+624>:   strd   r10, [r2]
   0x003a81c4 <+628>:   mov    r0, #1
   0x003a81c8 <+632>:   strb   r6, [r5, #4]
   0x003a81cc <+636>:   add    r4, r4, r1
   0x003a81d0 <+640>:   strb   r3, [r5, #5]
   0x003a81d4 <+644>:   ldr    r11, [sp, #68]  ; 0x44
   0x003a81d8 <+648>:   str    r4, [r11]
.
.
.
```

Which object holds the code causing exceptions:

```
samo@lapuh:~/RethinkDB/rethinkdb_wandboard$ \
grep -r "prepare_space_for_new_entry" src/
.
.
.
src/btree/leaf_node.cc:\
MUST_USE bool prepare_space_for_new_entry(value_sizer_t<void> *sizer, …
.
.
.


samo@lapuh:~/RethinkDB/rethinkdb_wandboard$ \
~/WANDBOARD-yocto/cross/arm-poky-linux-gnueabi-nm -o \
`find build/release_notcmalloc/obj/` 2> /dev/null | \
grep "prepare_space_for_new_entry" | grep "T _"
build/release_notcmalloc/obj/btree/leaf_node.o: \
00004248 T \
_ZN4leaf27prepare_space_for_new_entryEP13value_sizer_tIvEP11leaf_node_tPK11btree
_key_ti17repli_timestamp_tbPPc
```

Dump the source code causing this alignment exception:

```
~/WANDBOARD-yocto/cross/arm-poky-linux-gnueabi-objdump -S
build/release_notcmalloc/obj/btree/leaf_node.o
.
.
.
    if (new_entry_should_have_timestamp) {
```

```
         *space_out = get_at_offset(node, start_of_where_new_entry_should_go +
sizeof(repli_timestamp_t));
    44b4:        e2861008        add      r1, r6, #8
    /* Write the timestamp if we need one, and update `node->tstamp_cutpoint` if
    we don't. */

    uint16_t start_of_where_new_entry_should_go =
end_of_where_new_entry_should_go - total_space_for_new_entry;
    if (new_entry_should_have_timestamp) {
        *reinterpret_cast<repli_timestamp_t *>(get_at_offset(node,
start_of_where_new_entry_should_go)) = tstamp;
    44b8:        e1c2a0f0        strd    sl, [r2]
        *space_out = get_at_offset(node, start_of_where_new_entry_should_go +
sizeof(repli_timestamp_t));
    } else {
        *space_out = get_at_offset(node, start_of_where_new_entry_should_go);
    }

    return true;
    44bc:        e3a00001        mov      r0, #1
        node->tstamp_cutpoint = start_of_where_new_entry_should_go;
    }
.
.
.
```

4.2.2 Handled alignment exception patch no. 2

I assumed that casted type `repli_timestamp_t` has been causing exceptions so I prepared the following patch, which actually fixed alignment problem:

```
diff --git a/src/repli_timestamp.hpp b/src/repli_timestamp.hpp
index 323fb7a..4dbeeaa 100644
--- a/src/repli_timestamp.hpp
+++ b/src/repli_timestamp.hpp
@@ -31,7 +31,7 @@ public:

     static const repli_timestamp_t distant_past;
     static const repli_timestamp_t invalid;
-};
+} __attribute__((packed));

 // Returns the max of x and y, treating invalid as a negative infinity value.
 repli_timestamp_t superceding_recency(repli_timestamp_t x, repli_timestamp_t
y);
```

5 Conclusion

Status of described changes on the branch:

```
samo@lapuh:~/RethinkDB/rethinkdb_wandboard$ git status
# On branch v1.12.x
# Changed but not updated:
#   (use "git add <file>..." to update what will be committed)
#   (use "git checkout -- <file>..." to discard changes in working directory)
#
#    modified:   mk/install.mk
#    modified:   src/buffer_cache/alt/blob.cc
#    modified:   src/repli_timestamp.hpp
#    modified:   src/serializer/log/lba/disk_format.hpp
#
no changes added to commit (use "git add" and/or "git commit -a")
```

Using modified code on Wandboard enabled the "**thirty-second quickstart with RethinkDB**" (exercised from remote web browser - *http://192.168.1.110:8080/#dataexplorer*) TO COMPLETE WITHOUT ALIGNMENT EXCEPTIONS!

6 Links and documents

[1] *RethinkDB web page, http://rethinkdb.com*

[2] *Wandboard web page, http://www.wandboard.org*

[3] *YOCTO project web page, https://www.yoctoproject.org*

[4] *YOCTO on Wandboard wiki page,*
       http://wiki.wandboard.org/index.php/Getting_started_with_Yocto_on_Wandboard

[5] *ARM documentation pages, http://infocenter.arm.com/help/index.jsp*

[6] *Freescale Yocto Project Tutorial,*

       https://community.freescale.com/servlet/JiveServlet/previewBody/95096-102-10-7847/yocto_tutorial.pdf