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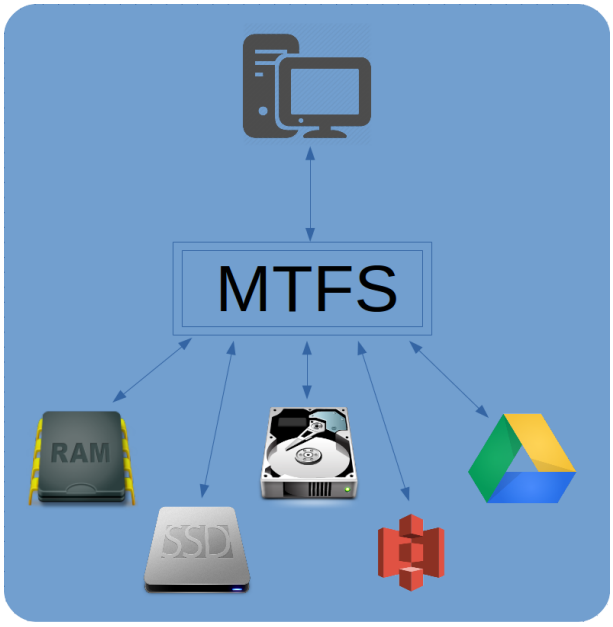
Haute école du paysage, d'ingénierie
et d'architecture de Genève

Hes·SO GENÈVE
Haute Ecole Spécialisée
de Suisse occidentale

Multi Tier Filesystem



Thèse de Bachelor (Annexes) présentée par

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Chapitre 1

Mode d'emploi

1.1 Pré requis

Le système n'est pas livré sous forme d'exécutable pour l'instant il faut donc le compiler à partir des sources. Pour ce fait il faut disposer d'un compilateur C++ capable de compiler au minimum la version C++14 comme g++, et il faut aussi disposer de CMake[1] version 3.5 au minimum.

Les libraires suivantes doivent être installées :

— fuse version 3.0.* https://github.com/libfuse/libfuse ;

— boost filesystem http://www.boost.org/doc/libs/1_64_0/more/getting_started/unix-variants.html ;

— aws-sdk-cpp-s3 https://github.com/aws/aws-sdk-cpp ;

Outre ces librairies il est fortement recommandé de créer un utilisateur pour MTFS. Il est indispensable de créer un home pour MTFS, par défaut le home `/home/mtfs` est utilisé.

1.2 Compilation

La compilation est effectuée à l'aide de CMake, qui permet de compiler chaque exécutable y compris les tests, et de les installer. Les sources du projet sont disponibles à l'adresse https://github.com/Dawen18/mtfs. Pour la suite `SRC_PATH` correspond au dossier contenant les fichiers récupérés sur GitHub. Il est recommandé de créer un dossier pour les *build* de MTFS. Pour la suite de ces explications, `BUILD_PATH` correspond à ce dossier de *build*, et `HOME_DIR` au dossier home de MTFS (par defaut /home/mtfs). les commandes suivantes sont à exécuter pour installer MTFS :

— `cd <BUILD_PATH>` ;

— `cmake -DMTFS_HOME_DIR=<HOME_DIR> <SRC_PATH>` ;

— Pour compiler l'intégralité utilisez `make` ou alors spécifiez l'exécutable à compiler avec `make <exécutable>`

— `sudo cp mtFS/mtfsMount mtfs/mtfsCreate /usr/local/bin/.` : copie des deux exé-

cutables dans le dossier des binaires.

Il reste maintenant à installer les *plugins*. Avant tout il faut créer le dossier Libs dans le home de MTFS. `mkdir HOME_DIR/Libs`

1.2.1 *Plugin* block

La commande suivante peut être passée si la totalité du projet a été compilé au point précédent.

`make block`

Puis copier la libraire dans le dossier home de MTFS

`cp Plugin/BlockDevide/libblock.so /home/mtfs/Libs`

1.2.2 *Plugin* S3

La commande suivante peut être passée si la totalité du projet a été compilé en section 1.2.

`make s3`

Puis copier la libraire dans le dossier home de MTFS

`cp Plugin/S3/libs3.so /home/mtfs/Libs`

1.3 Création d'un espace de stockage

Les commandes suivantes sont celles utilisées pour la configuration utilisée lors des tests. En cas de doute sur une option, consultez l'aide de l'exécutable avec `mtfsCreate -h`.

— `mtfsCreate -n test`

— `mtfsCreate -i 0 -d 0 -b 0 -s 512 -r 0 test`

— `mtfsCreate -add test`

— `mtfsCreate -p 1 -add -c '{"highLimit": 2, "plName": "block", "params": {"devicePath": "/dev/sdb7", "fsType": "ext4"}}' test`

— `mtfsCreate -p 1 -add -c '{"lowLimit": 1, "plName": "s3", "params": {"bucket": "mtfs", "region": "eu-central-1"}}' test`

— `mtfsCreate -install test`

1.4 Montage de l'espace de stockage

Pour monter un espace de stockage voici la commande :

`mtfsMount [options] <mountpoint> <configname>`

Par exemple pour monter la configuration de test paramétrée ci-dessus la commande suivante est utilisée :

`mtfsMount -d -o allow_other /tmp/mtfs test`

Chapitre 2

Conventions de codage

Le code écrit au cours de ce projet suit des conventions afin de conserver un aspect homogène et faciliter ainsi sa lisibilité :

- Les noms des objets sont écrit en *UpperCamelCase* ;
- Les fonctions, types et variables sont écrits en *lowerCamelCase* ;
- Les structs sont post fixée avec "_st" et les typedef avec "_t"
- Les constantes et macro-définition sont écrites en majuscule et leurs mots sont sé- parés par des *underscore* (exemple : MTFS_HOME_DIR) ;
- Le code est documenté avec Doxygen :
  - Les fonctions publiques sont documentées uniquement dans le *header*. Ces commentaires ne sont pas dupliqués dans le fichier source.
  - A l'inverse les fonctions privées sont documentées dans le fichier source et non dans le *header*.
-

Chapitre 3

Code Source

3.1 *Config*

3.1.1 mtfsCreate.cpp

```
/**
 * \file mtfsCreate.cpp
 * \brief
 * \author David Wittwer
 * \version 0.0.1
 * \copyright GNU Publis License V3
 *
 * This file is part of MTFS.

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    it under the terms of the GNU General Public License as published by
    the Free Software Foundation, either version 3 of the License, or
    (at your option) any later version.

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 */

//#include <mtfs/structs.h>
#include <option/optionparser.h>
#include <iostream>
#include <utils/Fs.h>
#include <rapidjson/document.h>
#include <mtfs/Mtfs.h>
#include <rapidjson/stringbuffer.h>
#include <rapidjson/prettywriter.h>
#include <fstream>
#include <rapidjson/istreamwrapper.h>
#include <mtfs/TimeRule.h>
#include <mtfs/PoolManager.h>
#include <algorithm>
#include <zconf.h>
#include <boost/filesystem.hpp>
#include <pluginSystem/PluginManager.h>
```

```
40
41 using namespace std;
42 using namespace mtfs;
43 using namespace rapidjson;
44
45 struct Arg : public option::Arg {
46   static void printError(const char *msg1, const option::Option &opt, const
     char *msg2) {
47     fprintf(stderr, "ERROR: %s", msg1);
48     fwrite(opt.name, (size_t) opt.namelen, 1, stderr);
49     fprintf(stderr, "%s", msg2);
50   }
51
52   static option::ArgStatus Numeric(const option::Option &option, bool msg) {
53     char *endptr = nullptr;
54     if (option.arg != nullptr && (strtol(option.arg, &endptr, 10) != 0)) {};
55     if (endptr != option.arg && *endptr == 0)
56       return option::ARG_OK;
57
58     if (msg) printError("Option '", option, "' requires a numeric argument\n");
59     return option::ARG_ILLEGAL;
60   }
61
62   static option::ArgStatus NonEmpty(const option::Option &option, bool msg) {
63     if (option.arg != nullptr && option.arg[0] != 0)
64       return option::ARG_OK;
65
66     if (msg) printError("Option '", option, "' requires a non-empty argument\n"
     );
67     return option::ARG_ILLEGAL;
68   }
69
70   static option::ArgStatus Migration(const option::Option &option, bool msg) {
71     return option::ARG_OK;
72   }
73 };
74
75 enum optionIndex {
76   UNKNOWN,
77   NEW,
78   ICACHE,
79   DCACHE,
80   BCACHE,
81   BSIZE,
82   REDUNDANCY,
83   MIGRATION,
84   POOL,
85   VOLUME,
86   ADD,
87   DEL,
88   CONFIG,
89   INSTALL,
90   HELP
91 };
92 const option::Descriptor usage[] =
93     {
94         {UNKNOWN,      0, "",          "",              Arg::None,          "USAGE:
     mtfsCreate [options] <system_name>"},
```

```
95          {NEW,          0, "n",     "new",          Arg::NonEmpty,      "  -n, \t--
    new    \tCreate a new storage."},
96          {ICACHE,       0, "i",     "inode-cache", Arg::Numeric,       "  -i[SIZE],
     \t--inode-cache[=SIZE]  \tSet inode cache size."},
97          {DCACHE,       0, "d",     "dir-cache",    Arg::Numeric,       "  -d[SIZE],
     \t--dir-cache[=SIZE]  \tSet directory entry cache size."},
98          {BCACHE,       0, "b",     "block-cache", Arg::Numeric,       "  -b[SIZE],
     \t--block-cache[=SIZE]  \tSet block cache size."},
99          {BSIZE,        0, "s",     "block-size",  Arg::Numeric,       "  -s[SIZE],
     \t--block-size[=SIZE]  \tSet block size. Default 4096 octets"},
100         {REDUNDANCY, 0, "r",     "redundancy",  Arg::Numeric,       "  -r[NB], \
    t--redundancy[=NB]  \tSet number of redundancy for each block or inode."},
101         {MIGRATION,    0, "m",     "migration",    Arg::Migration,     "  -m[TYPE],
     \t--migration[=TYPE]  \tSet migration type in system or pool if -p is used"
    },
102         {POOL,         0, "p",     "pool",         Arg::Numeric,       "  -p[ID], \
    t--pool[=ID]    \tSpecify pool."},
103         {VOLUME,       0, "v",     "volume",       Arg::Numeric,       "  -v[ID], \
    t--volume[=ID]    \tSpecify volume in pool."},
104         {ADD,          0, "",      "add",          Arg::None,          "  \t--add
    \tAdd a pool or volume."},
105         {DEL,          0, "",      "del",          Arg::None,          "  \t--del
    \tDelete a pool or volume."},
106         {CONFIG,       0, "c",     "config",       Arg::NonEmpty,      "  -c[CONFIG
    ], \t--config[=CONFIG]  \tSet config for plugin or migration (json string or
     filename which contains de json config."},
107         {INSTALL,      0, "",      "install",      Arg::None,          "  -i,  \t--
    install  \tInstall the config."},
108         {HELP,         0, "h",     "help",         option::Arg::None, "  -h, \t--
    help \tPrint this help and exit."},
109         {UNKNOWN,      0, "",      "",             option::Arg::None, "\nExamples
    :\n"
110                                                 " Create system:\n"
111                                                 "  mtfsCreate -n mtfsRoot\n"
112                                                 " Add pool:\n"
113                                                 "  mtfsCreate -p mtfsRoot\n"
114                                                 " Add volume in pool:\n"
115                                                 "  mtfsCreate -v mtfsRoot 1\n"},
116         {0,            0, nullptr, nullptr,        nullptr,            nullptr}
117     };
118
119 bool configExist(const string &name);
120
121 void loadConfig(superblock_t &sb, const string &name);
122
123 bool writeConfig(superblock_t &superblock, const string &confName);
124
125 uint32_t addVolume(pool_t &pool, volume_t &volume);
126
127 uint32_t addPool(superblock_t &sb, pool_t &pool);
128
129 uint32_t findMissing(std::vector<uint32_t> &x, uint32_t number);
130
131 void installConfig(superblock_t &superblock, const string &name);
132
133
134 int main(int argc, char **argv) {
135   std::cout << MTFS_CONFIG_DIR << std::endl;
136   argc -= (argc > 0);
```

```
137   argv += (argc > 0);
138   option::Stats stats(usage, argc, argv);
139   option::Option options[stats.options_max], buffer[stats.buffer_max];
140   option::Parser parse(usage, argc, argv, options, buffer);
141
142   if (parse.error())
143     return 1;
144
145   if ((nullptr != options[HELP]) || 0 == argc) {
146     option::printUsage(cerr, usage);
147     return 0;
148   }
149
150   for (option::Option *opt = options[UNKNOWN]; opt; opt = opt->next())
151     cerr << "Unknown option: " << opt->name << "\n";
152   if (options[UNKNOWN] != nullptr)
153     return -1;
154
155 #ifdef DEBUG
156   for (int i = 0; i < parse.nonOptionsCount(); ++i)
157     std::cout << "Non-option #" << i << ": " << parse.nonOption(i) << "\n";
158 #endif
159
160   if (0 != chdir(MTFS_HOME_DIR)) {
161     return errno;
162   }
163
164   superblock_t superblock;
165   memset(&superblock, 0, sizeof(superblock_t));
166   superblock.pools.clear();
167
168   string confName;
169
170 //  if option new.
171   if (options[NEW] != nullptr) {
172 #ifndef DEBUG
173     if (configExist(options[NEW].arg)) {
174       cerr << "Config '" << options[NEW].arg << "' already exist" << endl;
175       return -1;
176     }
177 #endif
178
179     confName = options[NEW].arg;
180
181     superblock.iCacheSz = superblock.bCacheSz = superblock.dCacheSz =
      superblock.blockSz = 4096;
182     superblock.redundancy = 1;
183     superblock.migration = Rule::TIME_MIGRATION;
184
185   } else {
186     confName = parse.nonOption(0);
187     if (!configExist(confName)) {
188       cerr << "Config not exist" << endl;
189       return -1;
190     }
191
192 #ifdef DEBUG
193     cout << "Load config " << confName << endl;
194 #endif
```

```
195
196       loadConfig(superblock, confName);
197     }
198
199     if (nullptr != options[ICACHE]) {
200       superblock.iCacheSz = static_cast<size_t>(stoi(options[ICACHE].arg));
201     }
202
203     if (nullptr != options[DCACHE]) {
204       superblock.dCacheSz = static_cast<size_t>(stoi(options[DCACHE].arg));
205     }
206
207     if (nullptr != options[BCACHE]) {
208       superblock.bCacheSz = static_cast<size_t>(stoi(options[BCACHE].arg));
209     }
210
211     if (nullptr != options[BSIZE]) {
212       superblock.blockSz = static_cast<size_t>(stoi(options[BSIZE].arg));
213     }
214
215     if (nullptr != options[REDUNDANCY]) {
216       superblock.redundancy = static_cast<size_t>(stoi(options[REDUNDANCY].arg));
217     }
218
219     if (nullptr != options[MIGRATION] && nullptr == options[POOL]) {
220       string migration = options[MIGRATION].arg;
221
222       if ("time" == migration) {
223         superblock.migration = Rule::TIME_MIGRATION;
224       } else if ("user" == migration) {
225         superblock.migration = Rule::RIGHT_MIGRATION;
226       } else {
227         cerr << "unknow migration";
228         return -1;
229       }
230     } else if (nullptr != options[MIGRATION] && nullptr != options[POOL]) {
231     }
232
233     if (nullptr != options[ADD] && nullptr == options[POOL]) {
234 //    ADD one pool
235 #ifdef DEBUG
236       cout << "add a pool" << endl;
237 #endif
238       pool_t pool;
239       pool.migration = Rule::TIME_MIGRATION;
240       pool.volumes.clear();
241
242       if (nullptr != options[CONFIG]) {
243         string arg = options[CONFIG].arg;
244         Document tmpDoc;
245 #ifdef DEBUG
246         cout << "pool arg: " << arg << endl;
247 #endif
248
249         if (".json" == arg.substr(arg.length() - 5)) {
250 //          TODO Parse json file
251         } else
252           tmpDoc.Parse(arg.c_str());
253
```

```
254       if (0 > Rule::rulesAreValid(superblock.migration, tmpDoc)) {
255         cerr << "Invalid config!" << endl;
256         return -1;
257       }
258
259       if (tmpDoc.HasMember(Rule::MIGRATION))
260         pool.migration = tmpDoc[Rule::MIGRATION].GetInt();
261
262       if (tmpDoc.HasMember(TimeRule::TIME_LOW_LIMIT)) {
263         tmpDoc[TimeRule::TIME_LOW_LIMIT].SetUint(tmpDoc[TimeRule::
    TIME_LOW_LIMIT].GetUint() * 60);
264       }
265
266       if (tmpDoc.HasMember(TimeRule::TIME_HIGH_LIMIT))
267         tmpDoc[TimeRule::TIME_HIGH_LIMIT].SetUint(tmpDoc[TimeRule::
    TIME_HIGH_LIMIT].GetUint() * 60);
268
269       pool.rule = Rule::buildRule(superblock.migration, tmpDoc);
270     } else {
271 //      cerr << "config needed!" << endl;
272 //      return -1;
273       Document d;
274       d.SetObject();
275       Value v;
276       v.SetInt(0);
277       d.AddMember(StringRef("timeHighLimit"), v, d.GetAllocator());
278       pool.rule = Rule::buildRule(superblock.migration, d);
279     }
280
281     int newPoolId = addPool(superblock, pool);
282     if (0 < newPoolId)
283       cout << "new pool:" << newPoolId << endl;
284
285   } else if (nullptr != options[ADD] && nullptr != options[POOL]) {
286 //    ADD one volume.
287     if (superblock.pools.end() == superblock.pools.find(stoul(options[POOL].arg
    ))) {
288       cerr << "pool '" << options[POOL].arg << "' not found" << endl;
289       return -1;
290     }
291
292     uint32_t poolId = (uint32_t) stoul(options[POOL].arg);
293     volume_t volume;
294     pool_t *pool = &superblock.pools[poolId];
295
296     if (nullptr != options[CONFIG]) {
297       string arg = options[CONFIG].arg;
298       Document tmpDoc;
299 #ifdef DEBUG
300       cout << "pool arg: " << arg << endl;
301 #endif
302
303       if (".json" == arg.substr(arg.length() - 5)) {
304 //        TODO Parse json file
305       } else
306         tmpDoc.Parse(arg.c_str());
307
308       if (0 > Rule::rulesAreValid(pool->migration, tmpDoc)) {
309         cerr << "Invalid config!" << endl;
```

```
310         return -1;
311       }
312
313       if (!tmpDoc.HasMember(pluginSystem::Plugin::TYPE)) {
314         cerr << R"(config need a plugin name eg: {"plName":"block"})" << endl;
315         return -1;
316       }
317       volume.pluginName = tmpDoc[pluginSystem::Plugin::TYPE].GetString();
318
319       if (tmpDoc.HasMember(pluginSystem::Plugin::PARAMS)) {
320         for (auto &&param: tmpDoc[pluginSystem::Plugin::PARAMS].GetObject()) {
321           volume.params.insert(make_pair(param.name.GetString(), param.value.
    GetString()));
322         }
323       }
324
325       if (tmpDoc.HasMember(TimeRule::TIME_LOW_LIMIT)) {
326         tmpDoc[TimeRule::TIME_LOW_LIMIT].SetUint(tmpDoc[TimeRule::
    TIME_LOW_LIMIT].GetUint() * 60);
327       }
328
329       if (tmpDoc.HasMember(TimeRule::TIME_HIGH_LIMIT))
330         tmpDoc[TimeRule::TIME_HIGH_LIMIT].SetUint(tmpDoc[TimeRule::
    TIME_HIGH_LIMIT].GetUint() * 60);
331
332
333       volume.rule = Rule::buildRule(pool->migration, tmpDoc);
334     } else {
335       cerr << "config needed!" << endl;
336       return -1;
337     }
338
339     int newVolumeId = addVolume(*pool, volume);
340     if (0 < newVolumeId)
341       cout << "new volume:" << newVolumeId << endl;
342   }
343
344 //  TODO catch -p, -v anc -c options
345
346   if (nullptr != options[INSTALL]) {
347     installConfig(superblock, confName);
348     return EXIT_SUCCESS;
349   }
350
351   writeConfig(superblock, confName);
352
353   return 0;
354 }
355
356 //
    ////////////////////////////////////////////////////////////////////////////////
357 ////////////////////////////////////////////////Definitions
    ////////////////////////////////////////////////////////
358 //
    ////////////////////////////////////////////////////////////////////////////////
359
360 bool configExist(const string &name) {
```

```
361   return Fs::fileExists(MTFS_CONFIG_DIR, name + ".json");
362 }
363
364 void loadConfig(superblock_t &sb, const string &name) {
365   string filename = string(MTFS_CONFIG_DIR) + name + ".json";
366   ifstream file(filename);
367   if (!file.is_open()) {
368     return;
369   }
370
371   IStreamWrapper wrapper(file);
372   Document confFile;
373
374   confFile.ParseStream(wrapper);
375
376   Mtfs::jsonToStruct(confFile, sb);
377 }
378
379 bool writeConfig(superblock_t &superblock, const string &confName) {
380   Document d;
381   Document::AllocatorType &allocator = d.GetAllocator();
382   d.SetObject();
383
384   Value v;
385
386   Mtfs::structToJson(superblock, d);
387
388   StringBuffer sb;
389   PrettyWriter<StringBuffer> pw(sb);
390   d.Accept(pw);
391
392   string filename = string(MTFS_CONFIG_DIR) + confName + ".json";
393   ofstream configFile(filename);
394   configFile << sb.GetString() << endl;
395   configFile.close();
396
397   return true;
398 }
399
400 /**
401  * @brief Add volume in pool
402  *
403  * @param pool
404  * @param volume
405  *
406  * @return The volume Id
407  */
408 uint32_t addVolume(pool_t &pool, volume_t &volume) {
409   uint32_t volumeId = 0;
410   vector<uint32_t> ids;
411   ids.clear();
412
413   for (auto &item  : pool.volumes) {
414     ids.push_back(item.first);
415   }
416   if (ids.empty())
417     volumeId = 1;
418   else
419     volumeId = findMissing(ids, 0);
```

```
420
421   if (pool.volumes.end() != pool.volumes.find(volumeId))
422     return 0;
423
424   pool.volumes.insert(make_pair(volumeId, volume));
425
426   return volumeId;
427 }
428
429 /**
430  * @brief add a pool in system
431  *
432  * @param sb  The superblock
433  * @param pool  The pool to add
434  *
435  * @return the pool id
436  */
437 uint32_t addPool(superblock_t &sb, pool_t &pool) {
438   uint32_t poolId;
439   vector<uint32_t> ids;
440   ids.clear();
441
442   for (auto &item  : sb.pools) {
443     ids.push_back(item.first);
444   }
445   if (ids.empty())
446     poolId = 1;
447   else
448     poolId = findMissing(ids, 0);
449
450   if (sb.pools.end() != sb.pools.find(poolId))
451     return 0;
452
453   sb.pools.insert(make_pair(poolId, pool));
454
455   return poolId;
456 }
457
458 /**
459  * Function find on stackOverflow
460  *
461  * http://stackoverflow.com/questions/28176191/find-first-missing-element-in-a-
    vector
462  *
463  * @param x vector with content
464  * @param number Number from which to search
465  * @return The missing number.
466  */
467 uint32_t findMissing(std::vector<uint32_t> &x, uint32_t number) {
468   std::sort(x.begin(), x.end());
469   auto pos = std::upper_bound(x.begin(), x.end(), number);
470
471   if (*pos - number > 1)
472     return number + 1;
473
474   std::vector<int> diffs;
475   std::adjacent_difference(pos, x.end(), std::back_inserter(diffs));
476   auto pos2 = std::find_if(diffs.begin() + 1, diffs.end(), [](int x) { return x
    > 1; });
```

```
477   return *(pos + (pos2 - diffs.begin() - 1)) + 1;
478
479 }
480
481 void installConfig(superblock_t &superblock, const string &name) {
482 //  create ident for rootInode.
483   superblock.rootInodes.clear();
484   const int rootRedundancy = max(3, (int) superblock.redundancy);
485   int i = 0;
486   for (auto &&pool: superblock.pools) {
487     for (auto &&volume: pool.second.volumes) {
488       if (rootRedundancy > i)
489         superblock.rootInodes.emplace_back(0, volume.first, pool.first);
490       else
491         break;
492       i++;
493     }
494   }
495
496   writeConfig(superblock, name);
497
498   string filename = "superblock.json";
499   boost::filesystem::create_directory(MTFS_INSTALL_DIR + name);
500   string src = string(MTFS_CONFIG_DIR) + name + ".json";
501   string dst = string(MTFS_INSTALL_DIR) + name + "/" + filename;
502   boost::filesystem::copy_file(src, dst, boost::filesystem::copy_option::
      overwrite_if_exists);
503   string rootFilename = string(MTFS_INSTALL_DIR) + name + "/root.json";
504
505   inode_t rootInode;
506   Mtfs::createRootInode(rootInode);
507
508   Document rootJSON(kObjectType);
509   rootInode.toJson(rootJSON);
510
511 //  Attach all plugins for write superblock and rootInode
512 //  Only 3 firsts for rootInode
513   pluginSystem::PluginManager *manager = pluginSystem::PluginManager::
      getInstance();
514   i = 0;
515   for (auto &&pool: superblock.pools) {
516     for (auto &&volume: pool.second.volumes) {
517       volume.second.params["home"] = MTFS_PLUGIN_HOME;
518       volume.second.params["blockSize"] = to_string(superblock.blockSz);
519
520       pluginSystem::Plugin *plugin;
521
522       plugin = manager->getPlugin(volume.second.pluginName);
523       plugin->attach(volume.second.params);
524
525       if (rootRedundancy > i)
526         plugin->put(0, &rootInode, INODE, false);
527       plugin->putSuperblock(superblock);
528
529       i++;
530
531       plugin->detach();
532     }
533   }
```

```
534
535   StringBuffer sb;
536   PrettyWriter<StringBuffer> pw(sb);
537   rootJSON.Accept(pw);
538
539   ofstream configFile(rootFilename);
540   configFile << sb.GetString() << endl;
541   configFile.close();
542 }
```

Listing 3.1 – "mtfsCreate.cpp

3.1.2 mtfsMount.cpp

```
1  /**
2   * \file mtfsMount.cpp
3   * \brief
4   * \author David Wittwer
5   * \version 0.0.1
6   * \copyright GNU Publis License V3
7   *
8   * This file is part of MTFS.
9
10     MTFS is free software: you can redistribute it and/or modify
11     it under the terms of the GNU General Public License as published by
12     the Free Software Foundation, either version 3 of the License, or
13     (at your option) any later version.
14
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16     but WITHOUT ANY WARRANTY; without even the implied warranty of
17     MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
18     GNU General Public License for more details.
19
20     You should have received a copy of the GNU General Public License
21     along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
22  */
23
24 #define FUSE_USE_VERSION 30
25
26 #include <iostream>
27 #include <unistd.h>
28 #include <rapidjson/document.h>
29 #include <rapidjson/istreamwrapper.h>
30 #include <fstream>
31 #include <pluginSystem/PluginManager.h>
32 #include <mtfs/PoolManager.h>
33 #include <mtfs/Mtfs.h>
34 #include <wrapper/MtfsFuse.h>
35 #include <utils/Fs.h>
36 #include <boost/filesystem.hpp>
37 #include <utils/Logger.h>
38
39
40 using namespace std;
41 using namespace rapidjson;
42
43 int main(int argc, char **argv) {
44   if (!Fs::dirExists(MTFS_HOME_DIR)) {
```

```
45      cerr << "Sorry no configured system found." << endl;
46      cerr << "Please configure one or recover with -r device_in_system "
47          "where device_in_system is a device wich was in the configuration." <<
        endl;
48      return -1;
49    }
50
51
52    string sysName = argv[argc - 1];
53    string filename = sysName + ".json";
54    string filepath = string(MTFS_HOME_DIR) + "/" + mtfs::Mtfs::CONFIG_DIR + "/"
       + filename;
55    argc--;
56
57    if (!boost::filesystem::exists(filepath)) {
58      cerr << "File not found" << endl;
59      return -1;
60    }
61
62    chdir(MTFS_HOME_DIR);
63    ifstream file(string(mtfs::Mtfs::CONFIG_DIR) + "/" + filename);
64    if (!file.is_open()) {
65      cerr << "error openning file " << strerror(errno) << endl;
66      return -1;
67    }
68
69    IStreamWrapper wrapper(file);
70    Document d;
71    d.ParseStream(wrapper);
72
73  //  validate config file.
74    if (!mtfs::Mtfs::validate(d)) {
75      cerr << "Invalid or corrupted JSON!" << endl;
76      return -1;
77    }
78
79  //  build mtfs
80    mtfs::Mtfs::start(d, MTFS_HOME_DIR, sysName);
81
82  //  build mtsfFuse.
83    wrapper::MtfsFuse *mtfsFuse;
84    mtfsFuse = new wrapper::MtfsFuse();
85
86    int ret = mtfsFuse->run(argc, argv);
87
88    mtfs::Mtfs::stop();
89
90    return ret;
91  }
```

Listing 3.2 – "mtfsMount.cpp

3.2 *Plugin System*

3.2.1 Plugin.h

```
1  /**
```

```
2  * \file Plugin.h
3  * \brief
4  * \author David Wittwer
5  * \version 0.0.1
6  * \copyright GNU Publis License V3
7  *
8  * This file is part of MTFS.
9
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13    (at your option) any later version.
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17    MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
18    GNU General Public License for more details.
19
20    You should have received a copy of the GNU General Public License
21    along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
22 */
23 #ifndef PLUGINSYSTEM_PLUGIN_H
24 #define PLUGINSYSTEM_PLUGIN_H
25
26 #include <string>
27 #include <vector>
28 #include <list>
29 #include <iostream>
30 #include <cassert>
31
32 #include <mtfs/structs.h>
33 #include <map>
34
35 namespace pluginSystem {
36   typedef struct {
37     std::string name;
38     std::vector<std::string> params;
39   } pluginInfo_t;
40
41   class Plugin {
42   public:
43     static constexpr const char *TYPE = "plName";
44     static constexpr const char *PARAMS = "params";
45
46     enum statusCode {
47       SUCCESS,
48     };
49
50     /**
51      * Get the name of plugin
52      *
53      * @return name of plugin
54      */
55     virtual std::string getName()=0;
56
57     virtual bool attach(std::map<std::string, std::string> params)=0;
58
59     virtual bool detach()=0;
60
```

```
61      virtual int add(uint64_t *id, const mtfs::blockType &type)=0;
62
63      virtual int del(const uint64_t &id, const mtfs::blockType &type)=0;
64
65      virtual int get(const uint64_t &id, void *data, const mtfs::blockType &type
        , bool metas)=0;
66
67      virtual int put(const uint64_t &id, const void *data, const mtfs::blockType
        &type, bool metas)=0;
68
69      virtual bool getSuperblock(mtfs::superblock_t &superblock)=0;
70
71      virtual bool putSuperblock(const mtfs::superblock_t &superblock)=0;
72
73    };
74
75  }  // namespace Plugin
76  #endif
```

Listing 3.3 – "pluginSystem/Plugin.h

3.2.2 PluginManager

PluginManager.h

```
1   /**
2    * \file PluginManager.h
3    * \brief
4    * \author David Wittwer
5    * \version 0.0.1
6    * \copyright GNU Publis License V3
7    *
8    * This file is part of MTFS.
9
10      MTFS is free software: you can redistribute it and/or modify
11      it under the terms of the GNU General Public License as published by
12      the Free Software Foundation, either version 3 of the License, or
13      (at your option) any later version.
14
15      Foobar is distributed in the hope that it will be useful,
16      but WITHOUT ANY WARRANTY; without even the implied warranty of
17      MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
18      GNU General Public License for more details.
19
20      You should have received a copy of the GNU General Public License
21      along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
22   */
23
24  #ifndef TRAVAIL_BACHELOR_PLUGINMANAGER_H
25  #define TRAVAIL_BACHELOR_PLUGINMANAGER_H
26
27  #include <map>
28  #include <pluginSystem/Plugin.h>
29
30  namespace pluginSystem {
31    typedef struct {
32      pluginSystem::Plugin *(*createObj)();
33
```

```
34      void (*destroyObj)(Plugin *plugin);
35
36      pluginInfo_t (*getInfo)();
37    } plugin_t;
38
39    class PluginManager {
40    public:
41      static const int SUCCESS = 0;
42      static const int PLUGIN_FOUND = 0;
43      static const int PLUGIN_NOT_FOUND = -1;
44
45      /**
46       * @brief Get manager instance
47       *
48       * @return Instance of PluginManager
49       */
50      static PluginManager *getInstance();
51
52      /**
53       * @brief Get plugin
54       *
55       * @param pluginName Name of plugin
56       * @return nullptr if no plugin found
57       */
58      Plugin *getPlugin(std::string pluginName);
59
60      /**
61       * @brief destroy plugin object
62       *
63       * @param pluginName Name of plugin.
64       * @param plugin Tthe object to destroy.
65       */
66      void freePlugin(std::string pluginName, Plugin *plugin);
67
68      /**
69       * @brief Get plugin info.
70       *
71       * @param pluginName Name of plugin.
72       * @param info Struct who contains the info @see pluginInfo_t.
73       * @return SUCCESS or PLUGIN_NOT_FOUND
74       */
75      int getInfo(std::string pluginName, pluginInfo_t &info);
76
77      /**
78       * @brief Get last error code.
79       *
80       * @return The error code.
81       */
82      int getError();
83
84    private:
85      static constexpr const char *PLUGIN_DIR = "Libs";
86
87      std::map<std::string, plugin_t> pluginMap;
88      static PluginManager *instance;
89      int lastError;
90
91
92      PluginManager();
```

```
93
94      bool pluginExist(std::string name);
95
96      Plugin *loadPlugin(std::string name);
97
98    };
99  }
100
101
102 #endif //TRAVAIL_BACHELOR_PLUGINMANAGER_H
```

Listing 3.4 – "pluginSystem/PluginManager.h"

PluginManager.cpp

```
1  /**
2   * \file PluginManager.cpp
3   * \brief
4   * \author David Wittwer
5   * \version 0.0.1
6   * \copyright GNU Publis License V3
7   *
8   * This file is part of MTFS.
9
10     MTFS is free software: you can redistribute it and/or modify
11     it under the terms of the GNU General Public License as published by
12     the Free Software Foundation, either version 3 of the License, or
13     (at your option) any later version.
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16     but WITHOUT ANY WARRANTY; without even the implied warranty of
17     MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
18     GNU General Public License for more details.
19
20     You should have received a copy of the GNU General Public License
21     along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
22  */
23
24 #include <dlfcn.h>
25 #include <boost/filesystem.hpp>
26 #include <boost/range/iterator_range.hpp>
27 #include <pluginSystem/PluginManager.h>
28 #include <pluginSystem/Plugin.h>
29
30 #include "pluginSystem/PluginManager.h"
31 #include "../../../Plugin/S3/S3.h"
32
33 using namespace std;
34 using namespace boost::filesystem;
35
36 namespace pluginSystem {
37   PluginManager *PluginManager::instance = 0;
38
39   /*
     ********************************************************************************
     */
40   /*                              Publics                                       */
41   /*
     ********************************************************************************
```

```
 */

PluginManager *PluginManager::getInstance() {
  if (!instance)
    instance = new PluginManager();

  return instance;
}

Plugin *PluginManager::getPlugin(string pluginName) {
  map<string, plugin_t>::iterator it;

  it = pluginMap.find(pluginName);
  if (it != pluginMap.end()) {
    this->lastError = PLUGIN_FOUND;
    return it->second.createObj();
  }

  if (!pluginExist(pluginName)) {
    this->lastError = PLUGIN_NOT_FOUND;
    return nullptr;
  }

  return loadPlugin(pluginName);
}

void PluginManager::freePlugin(std::string pluginName, Plugin *plugin) {
  if (this->pluginMap.find(pluginName) == this->pluginMap.end()) {
    this->lastError = PLUGIN_NOT_FOUND;
    return;
  }

  this->pluginMap[pluginName].destroyObj(plugin);
  this->lastError = SUCCESS;
}

int PluginManager::getError() {
  return this->lastError;
}

int PluginManager::getInfo(std::string pluginName, pluginInfo_t &info) {
  if (this->pluginMap.find(pluginName) == this->pluginMap.end()) {
    this->lastError = PLUGIN_NOT_FOUND;
    return PLUGIN_NOT_FOUND;
  }

  this->lastError = SUCCESS;
  info = this->pluginMap[pluginName].getInfo();

  return SUCCESS;
}

/*
 ******************************************************************************
 */
/*                              Private                                       */
/*
 ******************************************************************************
 */
```

```
96
97  PluginManager::PluginManager() {
98  }
99
100 bool PluginManager::pluginExist(std::string name) {
101   string dir("./");
102   dir += PLUGIN_DIR;
103
104   if (is_directory(dir)) {
105     for (auto &entry  :boost::make_iterator_range(directory_iterator(dir))) {
106       if (entry.path().filename() == (string("lib") + name + ".so")) {
107         return true;
108       }
109     }
110   }
111   return false;
112 }
113
114 Plugin *PluginManager::loadPlugin(string name) {
115   plugin_t plugin{};
116   string path = string("./") + PLUGIN_DIR + "/lib" + name + ".so";
117
118 //    Open plugin
119   void *library = dlopen(path.c_str(), RTLD_LAZY);
120   if (nullptr == library) {
121     cerr << "Cannot load plugin '" << name << "': " << dlerror() << endl;
122     return nullptr;
123   }
124   dlerror();
125
126 //    Load createObj symbol
127   plugin.createObj = (pluginSystem::Plugin *(*)()) dlsym(library, "createObj"
    );
128   char *dlsym_error = dlerror();
129   if (nullptr != dlsym_error) {
130     cerr << "Cannot load symbol create: " << dlsym_error << endl;
131     return nullptr;
132   }
133   dlerror();
134
135   plugin.destroyObj = (void (*)(Plugin *)) dlsym(library, "destroyObj");
136   dlsym_error = dlerror();
137   if (dlsym_error) {
138     cerr << "Cannot load symbol destroy: " << dlsym_error << endl;
139     return nullptr;
140   }
141   dlerror();
142
143   plugin.getInfo = (pluginInfo_t (*)()) dlsym(library, "getInfo");
144   dlsym_error = dlerror();
145   if (dlsym_error) {
146     cerr << "Cannot load symbol info: " << dlsym_error << endl;
147     return nullptr;
148   }
149   dlerror();
150
151   dlclose(library);
152
153   this->pluginMap.insert(make_pair(plugin.getInfo().name, plugin));
```

```
154
155     return plugin.createObj();
156   }
157 }
```

Listing 3.5 – "pluginSystem/PluginManager.cpp

3.2.3 BlockDevice

BlockDevice.h

```
1  /**
2   * \file BlockDevice.h
3   * \brief
4   * \author David Wittwer
5   * \version 0.0.1
6   * \copyright GNU Publis License V3
7   *
8   * This file is part of MTFS.
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18    GNU General Public License for more details.
19
20    You should have received a copy of the GNU General Public License
21    along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
22  */
23
24 #ifndef PLUGINSYSTEM_BLOCK_DEVICE_H
25 #define PLUGINSYSTEM_BLOCK_DEVICE_H
26
27 #include <string>
28 #include <vector>
29 #include <list>
30 #include <iostream>
31 #include <cassert>
32
33 #include <pluginSystem/Plugin.h>
34 #include <mtfs/structs.h>
35 #include <map>
36 #include <queue>
37 #include <mutex>
38
39 namespace pluginSystem {
40   class BlockDevice : public Plugin {
41     static constexpr const char *INODES_DIR = "inodes";
42     static constexpr const char *BLOCKS_DIR = "blocks";
43     static constexpr const char *DIR_BLOCKS_DIR = "dirBlocks";
44     static constexpr const char *METAS_DIR = "metas";
45     static constexpr const char *INODE_METAS_DIR = "metas/inodes";
46     static constexpr const char *DIR_BLOCK_METAS_DIR = "metas/dirBlocks";
47     static constexpr const char *BLOCK_METAS_DIR = "metas/blocks";
```

```
48
49      static const int SUCCESS = 0;
50
51    public:
52      static constexpr const char *NAME = "block";
53
54      BlockDevice();
55
56      virtual ~BlockDevice();
57
58      bool attach(std::map<std::string, std::string> params) override;
59
60      bool detach() override;
61
62      int add(uint64_t *id, const mtfs::blockType &type) override;
63
64      int del(const uint64_t &id, const mtfs::blockType &type) override;
65
66      int get(const uint64_t &id, void *data, const mtfs::blockType &type, bool
        metas) override;
67
68      int put(const uint64_t &id, const void *data, const mtfs::blockType &type,
        bool metas) override;
69
70      bool getSuperblock(mtfs::superblock_t &superblock) override;
71
72      bool putSuperblock(const mtfs::superblock_t &superblock) override;
73
74      std::string getName() override;
75
76    private:
77      int blockSize;
78      std::string mountpoint;
79      std::string devicePath;
80      std::string fsType;
81
82      std::mutex inodeMutex;
83      std::vector<uint64_t> freeInodes;
84      uint64_t nextFreeInode;
85
86      std::mutex dirBlockMutex;
87      std::vector<uint64_t> freeDirBlocks;
88      uint64_t nextFreeDirBlock;
89
90      std::mutex blockMutex;
91      std::vector<uint64_t> freeBlocks;
92      uint64_t nextFreeBlock;
93
94
95      int addInode(uint64_t *inodeId);
96
97      int addDirBlock(uint64_t *id);
98
99      int addBlock(uint64_t *blockId);
100
101     int delInode(const uint64_t &inodeId);
102
103     int getInode(const uint64_t &inodeId, mtfs::inode_st &inode);
104
```

```
105     int putInode(const uint64_t &inodeId, const mtfs::inode_st &inode);
106
107     int getInodeMetas(const uint64_t &inodeId, mtfs::blockInfo_t &metas);
108
109     int putInodeMetas(const uint64_t &inodeId, const mtfs::blockInfo_t &metas);
110
111     int delDirBlock(const uint64_t &id);
112
113     int getDirBlock(const uint64_t &id, mtfs::dirBlock_t &block);
114
115     int putDirBlock(const uint64_t &id, const mtfs::dirBlock_t &block);
116
117     int getDirBlockMetas(const uint64_t &id, mtfs::blockInfo_t &metas);
118
119     int putDirBlockMetas(const uint64_t &id, const mtfs::blockInfo_t &metas);
120
121     int delBlock(const uint64_t &blockId);
122
123     int getBlock(const uint64_t &blockId, std::uint8_t *buffer);
124
125     int putBlock(const uint64_t &blockId, const uint8_t *buffer);
126
127     int getBlockMetas(const uint64_t &blockId, mtfs::blockInfo_t &metas);
128
129     int putBlockMetas(const uint64_t &blockId, const mtfs::blockInfo_t &metas);
130
131
132     void initDirHierarchie();
133
134     void initInodes();
135
136     void initDirBlocks();
137
138     void initBlocks();
139
140     void writeMetas();
141
142     void logError(std::string message);
143
144     bool dirExists(std::string path);
145
146     int createFile(std::string path);
147
148     int deleteFile(std::string path);
149
150     int getMetas(const std::string &filename, mtfs::blockInfo_t &infos);
151
152     int putMetas(const std::string &filename, const mtfs::blockInfo_t &infos);
153
154   };
155
156 }  // namespace Plugin
157 #endif
```

Listing 3.6 – "pluginSystem/BlockDevice.h"

BlockDevice.cpp

```cpp
/**
 * \file BlockDevice.cpp
 * \brief
 * \author David Wittwer
 * \version 0.0.1
 * \copyright GNU Publis License V3
 *
 * This file is part of MTFS.

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    it under the terms of the GNU General Public License as published by
    the Free Software Foundation, either version 3 of the License, or
    (at your option) any later version.

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    but WITHOUT ANY WARRANTY; without even the implied warranty of
    MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
    GNU General Public License for more details.

    You should have received a copy of the GNU General Public License
    along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
 */

#include <iostream>
#include <sys/mount.h>
#include <map>
#include <sys/stat.h>
#include <fcntl.h>
#include <rapidjson/document.h>
#include <rapidjson/stringbuffer.h>
#include <rapidjson/prettywriter.h>
#include <rapidjson/istreamwrapper.h>
#include <fstream>
#include <memory>
#include <utils/Logger.h>

#include "BlockDevice.h"

#define DEBUG

using namespace std;
using namespace rapidjson;
using namespace mtfs;

namespace pluginSystem {
  BlockDevice::BlockDevice() : nextFreeBlock(0), nextFreeDirBlock(0),
    nextFreeInode(1) {
    this->freeBlocks.clear();
    this->freeDirBlocks.clear();
    this->freeInodes.clear();
  }

  BlockDevice::~BlockDevice() {
    this->freeBlocks.clear();
    this->freeDirBlocks.clear();
    this->freeInodes.clear();
  }

  string BlockDevice::getName() {
```

```
59      return NAME;
60    }
61
62    bool BlockDevice::attach(std::map<string, string> params) {
63      if (params.find("devicePath") == params.end() || params.find("home") ==
       params.end() ||
64          params.find("fsType") == params.end())
65        return false;
66
67      string home;
68      home = params["home"];
69      if (home.back() != '/')
70        home += '/';
71      string parentDir = home + "BlockDevices/";
72      string bs = params["blockSize"];
73      this->blockSize = stoi(params.at("blockSize"));
74      this->fsType = params["fsType"];
75      this->devicePath = params["devicePath"];
76      this->mountpoint = parentDir + this->devicePath.substr(this->devicePath.
       find('/', 1) + 1) + '/';
77
78  #ifdef DEBUG
79      Logger::getInstance()->log("BLOCK", "create dir in home", Logger::L_INFO);
80  #endif
81
82      if (!dirExists(parentDir)) {
83        if (mkdir(parentDir.c_str(), 0700) != 0) {
84          logError("mkdir error " + parentDir + " " + strerror(errno));
85          return false;
86        }
87      }
88
89      if (!dirExists(this->mountpoint)) {
90        if (mkdir(this->mountpoint.c_str(), 0700) != 0) {
91          logError("mkdir error " + this->mountpoint + " " + strerror(errno));
92          return false;
93        }
94      }
95
96  #ifndef DEBUG
97      //    Mount device
98      mount(this->devicePath.c_str(), this->mountpoint.c_str(), this->fsType.
       c_str(), 0, nullptr);
99  #endif
100
101     initDirHierarchie();
102
103     initInodes();
104     initDirBlocks();
105     initBlocks();
106
107     return true;
108   }
109
110   bool BlockDevice::detach() {
111     writeMetas();
112
113 #ifndef DEBUG
114     if (umount2(this->mountpoint.c_str(), MNT_DETACH) != 0) {
```

```
115         cerr << "ERROR Failed to umount: " << this->mountpoint << endl;
116         cerr << "reason: " << strerror(errno) << " [" << errno << "]" << endl;
117         return false;
118       }
119 #endif
120 
121       return true;
122     }
123 
124     int BlockDevice::add(uint64_t *id, const blockType &type) {
125       int ret;
126       switch (type) {
127         case INODE:
128           ret = this->addInode(id);
129           break;
130         case DIR_BLOCK:
131           ret = this->addDirBlock(id);
132           break;
133         case DATA_BLOCK:
134           ret = this->addBlock(id);
135           break;
136         default:
137           ret = ENOSYS;
138           break;
139       }
140       return ret;
141     }
142 
143     int BlockDevice::del(const uint64_t &id, const mtfs::blockType &type) {
144       int ret;
145 
146       switch (type) {
147         case INODE:
148           ret = this->delInode(id);
149           break;
150         case DIR_BLOCK:
151           ret = this->delDirBlock(id);
152           break;
153         case DATA_BLOCK:
154           ret = this->delBlock(id);
155           break;
156         default:
157           ret = ENOSYS;
158           break;
159       }
160 
161       return ret;
162     }
163 
164     int BlockDevice::get(const uint64_t &id, void *data, const mtfs::blockType &
      type, const bool metas) {
165       int ret;
166 
167       switch (type) {
168         case INODE:
169           if (metas)
170             ret = this->getInodeMetas(id, *(blockInfo_t *) data);
171           else
172             ret = this->getInode(id, *(inode_t *) data);
```

```
173         break;
174       case DIR_BLOCK:
175         if (metas)
176           ret = this->getDirBlockMetas(id, *(blockInfo_t *) data);
177         else
178           ret = this->getDirBlock(id, *(dirBlock_t *) data);
179         break;
180       case DATA_BLOCK:
181         if (metas)
182           ret = this->getBlockMetas(id, *(blockInfo_t *) data);
183         else
184           ret = this->getBlock(id, (uint8_t *) data);
185         break;
186       default:
187         ret = ENOSYS;
188         break;
189     }
190
191     return ret;
192   }
193
194   int BlockDevice::put(const uint64_t &id, const void *data, const mtfs::
      blockType &type, const bool metas) {
195     int ret;
196
197     switch (type) {
198       case INODE:
199         if (metas)
200           ret = this->putInodeMetas(id, *(blockInfo_t *) data);
201         else
202           ret = this->putInode(id, *(inode_t *) data);
203         break;
204       case DIR_BLOCK:
205         if (metas)
206           ret = this->putDirBlockMetas(id, *(blockInfo_t *) data);
207         else
208           ret = this->putDirBlock(id, *(dirBlock_t *) data);
209         break;
210       case DATA_BLOCK:
211         if (metas)
212           ret = this->putBlockMetas(id, *(blockInfo_t *) data);
213         else
214           ret = this->putBlock(id, (uint8_t *) data);
215         break;
216       default:
217         ret = ENOSYS;
218         break;
219     }
220
221     return ret;
222   }
223
224   int BlockDevice::addInode(uint64_t *inodeId) {
225     unique_lock<mutex> lk(this->inodeMutex);
226     if (this->freeInodes.empty()) {
227       *inodeId = this->nextFreeInode;
228       this->nextFreeInode++;
229     } else {
230       *inodeId = this->freeInodes[0];
```

```
231       this->freeInodes.erase(freeInodes.begin());
232     }
233     lk.unlock();
234 
235     string filename = this->mountpoint;
236     if ('/' != filename.back())
237       filename += '/';
238 
239     filename = filename + INODES_DIR + "/" + to_string(*inodeId);
240 
241     return createFile(filename);
242   }
243 
244   int BlockDevice::delInode(const uint64_t &inodeId) {
245     unique_lock<mutex> lk(this->inodeMutex);
246     if (this->nextFreeInode - 1 == inodeId)
247       this->nextFreeInode--;
248     else {
249       this->freeInodes.push_back(inodeId);
250     }
251     lk.unlock();
252 
253     string filename = this->mountpoint;
254     if ('/' != filename.back())
255       filename += '/';
256 
257     filename = filename + INODES_DIR + "/" + to_string(inodeId);
258 
259     return deleteFile(filename);
260   }
261 
262   int BlockDevice::getInode(const uint64_t &inodeId, mtfs::inode_st &inode) {
263     string filename = this->mountpoint;
264     if ('/' != filename.back())
265       filename += '/';
266 
267     filename = filename + INODES_DIR + "/" + to_string(inodeId);
268     ifstream file(filename);
269     if (!file.is_open())
270       return errno != 0 ? errno : ENOENT;
271 
272     IStreamWrapper wrapper(file);
273 
274     Document d;
275     d.ParseStream(wrapper);
276 
277     assert(d.IsObject());
278     assert(d.HasMember(IN_MODE));
279     assert(d.HasMember(IN_UID));
280     assert(d.HasMember(IN_GID));
281     assert(d.HasMember(IN_SIZE));
282     assert(d.HasMember(IN_LINKS));
283     assert(d.HasMember(IN_ACCESS));
284     assert(d.HasMember(IN_BLOCKS));
285 
286     inode.accesRight = (uint16_t) d[IN_MODE].GetUint();
287     inode.uid = (uint16_t) d[IN_UID].GetUint();
288     inode.gid = (uint16_t) d[IN_GID].GetUint();
289     inode.size = d[IN_SIZE].GetUint64();
```

```
290     inode.linkCount = (uint8_t) d[IN_LINKS].GetUint();
291     inode.atime = d[IN_ACCESS].GetUint64();
292
293     const Value &dataArray = d[IN_BLOCKS];
294     assert(dataArray.IsArray());
295     inode.dataBlocks.clear();
296     for (auto &a : dataArray.GetArray()) {
297       vector<ident_t> redundancy;
298
299       assert(a.IsArray());
300       for (auto &v : a.GetArray()) {
301         ident_t ident;
302
303         assert(v.IsObject());
304         assert(v.HasMember(ID_POOL));
305         assert(v.HasMember(ID_VOLUME));
306         assert(v.HasMember(ID_ID));
307
308         ident.poolId = (uint16_t) v[ID_POOL].GetUint();
309         ident.volumeId = (uint16_t) v[ID_VOLUME].GetUint();
310         ident.id = v[ID_ID].GetUint64();
311
312         redundancy.push_back(ident);
313       }
314
315       inode.dataBlocks.push_back(redundancy);
316     }
317
318     return this->SUCCESS;
319   }
320
321   int BlockDevice::putInode(const uint64_t &inodeId, const inode_st &inode) {
322     Document d;
323     d.SetObject();
324     Document::AllocatorType &alloc = d.GetAllocator();
325
326     inode.toJson(d);
327
328     StringBuffer sb;
329     PrettyWriter<StringBuffer> pw(sb);
330     d.Accept(pw);
331
332     string filename = this->mountpoint;
333     if ('/' != filename.back())
334       filename += '/';
335
336     filename = filename + BlockDevice::INODES_DIR + "/" + to_string(inodeId);
337     ofstream inodeFile(filename);
338     inodeFile << sb.GetString() << endl;
339     inodeFile.close();
340
341     return this->SUCCESS;
342   }
343
344   int BlockDevice::getInodeMetas(const uint64_t &inodeId, mtfs::blockInfo_t &
      metas) {
345     string filename = this->mountpoint;
346     if ('/' != filename.back())
347       filename += '/';
```

```
348
349     filename = filename + INODE_METAS_DIR + "/" + to_string(inodeId) + ".json";
350
351     return getMetas(filename, metas);
352   }
353
354   int BlockDevice::putInodeMetas(const uint64_t &inodeId, const mtfs::
        blockInfo_t &metas) {
355     string filename = this->mountpoint;
356     if ('/' != filename.back())
357       filename += '/';
358
359     filename = filename + INODE_METAS_DIR + "/" + to_string(inodeId) + ".json";
360
361     return putMetas(filename, metas);
362   }
363
364   int BlockDevice::addDirBlock(uint64_t *id) {
365     unique_lock<mutex> lk(this->dirBlockMutex);
366     if (this->freeDirBlocks.empty()) {
367       *id = this->nextFreeDirBlock;
368       this->nextFreeDirBlock++;
369     } else {
370       *id = this->freeDirBlocks.front();
371       iter_swap(this->freeDirBlocks.begin(), this->freeDirBlocks.end());
372       this->freeDirBlocks.pop_back();
373     }
374     lk.unlock();
375
376     string filename = this->mountpoint;
377     if ('/' != filename.back())
378       filename += '/';
379
380     filename = filename + DIR_BLOCKS_DIR + "/" + to_string(*id);
381
382     return createFile(filename);
383   }
384
385   int BlockDevice::delDirBlock(const uint64_t &id) {
386     unique_lock<mutex> lk(this->dirBlockMutex);
387     if (id == this->nextFreeDirBlock - 1)
388       this->nextFreeDirBlock--;
389     else
390       this->freeDirBlocks.push_back(id);
391     lk.unlock();
392
393     string filename = this->mountpoint;
394     if ('/' != filename.back())
395       filename += '/';
396
397     filename = filename + DIR_BLOCKS_DIR + "/" + to_string(id);
398
399     return deleteFile(filename);
400   }
401
402   int BlockDevice::getDirBlock(const uint64_t &id, dirBlock_t &block) {
403     string filename = this->mountpoint;
404     if ('/' != filename.back())
405       filename += '/';
```

```
406
407     filename = filename + DIR_BLOCKS_DIR + "/" + to_string(id);
408
409     ifstream file(filename);
410     if (!file.is_open())
411       return errno != 0 ? errno : ENOENT;
412
413
414     IStreamWrapper wrapper(file);
415
416     Document d;
417     d.ParseStream(wrapper);
418
419     assert(d.IsObject());
420
421     for (auto &&item: d.GetObject()) {
422       assert(item.value.IsArray());
423
424       vector<ident_t> ids;
425
426       for (auto &&ident: item.value.GetArray()) {
427         ident_t i;
428         i.fromJson(ident);
429         ids.push_back(i);
430       }
431       block.entries.insert(make_pair(item.name.GetString(), ids));
432     }
433     return this->SUCCESS;
434   }
435
436   int BlockDevice::putDirBlock(const uint64_t &id, const dirBlock_t &block) {
437     Document d;
438     d.SetObject();
439
440     Document::AllocatorType &allocator = d.GetAllocator();
441
442     for (auto &&item: block.entries) {
443       Value r(kArrayType);
444       for (auto &&ident: item.second) {
445         Value v(kObjectType);
446         ident.toJson(v, allocator);
447         r.PushBack(v, allocator);
448       }
449       d.AddMember(StringRef(item.first.c_str()), r, allocator);
450     }
451
452     StringBuffer sb;
453     PrettyWriter<StringBuffer> pw(sb);
454     d.Accept(pw);
455
456     string filename = this->mountpoint;
457     if ('/' != filename.back())
458       filename += '/';
459
460     filename = filename + BlockDevice::DIR_BLOCKS_DIR + "/" + to_string(id);
461     ofstream file(filename);
462     if (!file.is_open())
463       return errno != 0 ? errno : ENOENT;
464     file << sb.GetString() << endl;
```

```
465     file.close();
466
467     return this->SUCCESS;
468   }
469
470   int BlockDevice::getDirBlockMetas(const uint64_t &id, mtfs::blockInfo_t &
      metas) {
471     string filename = this->mountpoint;
472     if ('/' != filename.back())
473       filename += '/';
474
475     filename = filename + DIR_BLOCK_METAS_DIR + "/" + to_string(id) + ".json";
476     return getMetas(filename, metas);
477   }
478
479   int BlockDevice::putDirBlockMetas(const uint64_t &id, const mtfs::blockInfo_t
      &metas) {
480     string filename = this->mountpoint;
481     if ('/' != filename.back())
482       filename += '/';
483
484     filename = filename + DIR_BLOCK_METAS_DIR + "/" + to_string(id) + ".json";
485     return putMetas(filename, metas);
486   }
487
488   int BlockDevice::addBlock(uint64_t *blockId) {
489     unique_lock<mutex> lk(this->blockMutex);
490     if (this->freeBlocks.empty()) {
491       *blockId = this->nextFreeBlock;
492       this->nextFreeBlock++;
493     } else {
494       *blockId = this->freeBlocks[this->freeBlocks.size() - 1];
495       this->freeBlocks.pop_back();
496     }
497     lk.unlock();
498
499     string filename = this->mountpoint;
500     if ('/' != filename.back())
501       filename += '/';
502
503     filename = filename + BLOCKS_DIR + "/" + to_string(*blockId);
504
505     return createFile(filename);
506   }
507
508   int BlockDevice::delBlock(const uint64_t &blockId) {
509     unique_lock<mutex> lk(this->blockMutex);
510     if (this->nextFreeBlock - 1 == blockId)
511       nextFreeBlock--;
512     else
513       this->freeBlocks.push_back(blockId);
514     lk.unlock();
515
516     string filename = this->mountpoint;
517     if ('/' != filename.back())
518       filename += '/';
519
520     filename = filename + BLOCKS_DIR + "/" + to_string(blockId);
521
```

```
522     return deleteFile(filename);
523   }
524
525   int BlockDevice::getBlock(const uint64_t &blockId, std::uint8_t *buffer) {
526     string filename = this->mountpoint;
527     if ('/' != filename.back())
528       filename += '/';
529
530     filename = filename + BLOCKS_DIR + "/" + to_string(blockId);
531
532     ifstream file(filename);
533     if (!file.is_open())
534       return errno != 0 ? errno : ENOENT;
535
536     file.read((char *) buffer, this->blockSize);
537     file.close();
538     return this->SUCCESS;
539   }
540
541   int BlockDevice::putBlock(const uint64_t &blockId, const uint8_t *buffer) {
542     string filename = this->mountpoint;
543     if ('/' != filename.back())
544       filename += '/';
545
546     filename = filename + BLOCKS_DIR + "/" + to_string(blockId);
547     ofstream file(filename);
548     if (!file.is_open())
549       return errno != 0 ? errno : ENOENT;
550
551     file.write((const char *) buffer, this->blockSize);
552     file.close();
553     return this->SUCCESS;
554   }
555
556   int BlockDevice::getBlockMetas(const uint64_t &blockId, mtfs::blockInfo_t &
      metas) {
557     string filename = this->mountpoint;
558     if ('/' != filename.back())
559       filename += '/';
560
561     filename = filename + BLOCK_METAS_DIR + "/" + to_string(blockId) + ".json";
562
563     return getMetas(filename, metas);
564   }
565
566   int BlockDevice::putBlockMetas(const uint64_t &blockId, const blockInfo_t &
      metas) {
567     string filename = this->mountpoint;
568     if ('/' != filename.back())
569       filename += '/';
570
571     filename = filename + BLOCK_METAS_DIR + "/" + to_string(blockId) + ".json";
572
573     return putMetas(filename, metas);
574   }
575
576   bool BlockDevice::getSuperblock(mtfs::superblock_t &superblock) {
577     return false;
578   }
```

```
579
580   bool BlockDevice::putSuperblock(const superblock_t &superblock) {
581     string filename = this->mountpoint;
582     if ('/' != filename.back())
583       filename += '/';
584
585     filename = filename + METAS_DIR + "/superblock";
586     ofstream sbFile(filename, ios::binary);
587     sbFile.write((const char *) &superblock, sizeof(superblock));
588     sbFile.close();
589
590     return true;
591   }
592
593   //////////////Private method///////////////
594
595   void BlockDevice::initDirHierarchie() {
596     if (!dirExists(this->mountpoint + BlockDevice::INODES_DIR))
597       mkdir((this->mountpoint + BlockDevice::INODES_DIR).c_str(), 0700);
598     if (!dirExists(this->mountpoint + BlockDevice::DIR_BLOCKS_DIR))
599       mkdir((this->mountpoint + BlockDevice::DIR_BLOCKS_DIR).c_str(), 0700);
600     if (!dirExists(this->mountpoint + BlockDevice::BLOCKS_DIR))
601       mkdir((this->mountpoint + BlockDevice::BLOCKS_DIR).c_str(), 0700);
602     if (!dirExists(this->mountpoint + BlockDevice::METAS_DIR))
603       mkdir((this->mountpoint + BlockDevice::METAS_DIR).c_str(), 0700);
604     if (!dirExists(this->mountpoint + BlockDevice::INODE_METAS_DIR))
605       mkdir((this->mountpoint + BlockDevice::INODE_METAS_DIR).c_str(), 0700);
606     if (!dirExists(this->mountpoint + BlockDevice::DIR_BLOCK_METAS_DIR))
607       mkdir((this->mountpoint + BlockDevice::DIR_BLOCK_METAS_DIR).c_str(),
    0700);
608     if (!dirExists(this->mountpoint + BlockDevice::BLOCK_METAS_DIR))
609       mkdir((this->mountpoint + BlockDevice::BLOCK_METAS_DIR).c_str(), 0700);
610   }
611
612   void BlockDevice::initInodes() {
613     string filename = this->mountpoint;
614     if ('/' != filename.back())
615       filename += '/';
616
617     filename = filename + METAS_DIR + "/inodes.json";
618
619     ifstream inodeFile(filename);
620     if (!inodeFile.is_open())
621       return;
622
623     IStreamWrapper isw(inodeFile);
624
625     Document d;
626     d.ParseStream(isw);
627
628     assert(d.IsObject());
629     assert(d.HasMember("nextFreeInode"));
630     assert(d.HasMember("freeInodes"));
631     this->nextFreeInode = d["nextFreeInode"].GetUint64();
632     const Value &inodeArray = d["freeInodes"];
633
634     this->freeInodes.clear();
635     assert(inodeArray.IsArray());
636     for (SizeType i = 0; i < inodeArray.Size(); i++) {
```

```
637       this->freeInodes.push_back(inodeArray[i].GetUint64());
638     }
639   }
640
641   void BlockDevice::initDirBlocks() {
642     string filename = this->mountpoint;
643     if ('/' != filename.back())
644       filename += '/';
645
646     filename = filename + METAS_DIR + "/dirBlocks.json";
647
648     ifstream inodeFile(filename);
649     if (!inodeFile.is_open())
650       return;
651
652     IStreamWrapper isw(inodeFile);
653
654     Document d;
655     d.ParseStream(isw);
656
657     assert(d.IsObject());
658     assert(d.HasMember("nextFreeDirBlock"));
659     assert(d.HasMember("freeDirBlocks"));
660     this->nextFreeDirBlock = d["nextFreeDirBlock"].GetUint64();
661     const Value &array = d["freeDirBlocks"];
662
663     this->freeDirBlocks.clear();
664     assert(array.IsArray());
665     for (SizeType i = 0; i < array.Size(); i++) {
666       this->freeDirBlocks.push_back(array[i].GetUint64());
667     }
668   }
669
670   void BlockDevice::initBlocks() {
671     string filename = this->mountpoint;
672     if ('/' != filename.back())
673       filename += '/';
674
675     filename = filename + METAS_DIR + "/blocks.json";
676
677     ifstream inodeFile(filename);
678     if (!inodeFile.is_open())
679       return;
680
681     IStreamWrapper isw(inodeFile);
682
683     Document d;
684     d.ParseStream(isw);
685
686     assert(d.IsObject());
687     assert(d.HasMember("nextFreeBlock"));
688     assert(d.HasMember("freeBlocks"));
689     this->nextFreeBlock = d["nextFreeBlock"].GetUint64();
690     const Value &inodeArray = d["freeBlocks"];
691
692     this->freeBlocks.clear();
693     assert(inodeArray.IsArray());
694     for (SizeType i = 0; i < inodeArray.Size(); i++) {
695       this->freeBlocks.push_back(inodeArray[i].GetUint64());
```

```
696     }
697   }
698
699   void BlockDevice::writeMetas() {
700     {
701 //    writeInodeMeta
702       Document d;
703       d.SetObject();
704
705       Document::AllocatorType &allocator = d.GetAllocator();
706
707       Value value(kObjectType);
708       value.SetUint64(this->nextFreeInode);
709       d.AddMember(StringRef("nextFreeInode"), value, allocator);
710
711       Value inodeList(kArrayType);
712       Value inode(kObjectType);
713
714       for (unsigned long &freeInode : this->freeInodes) {
715         inode.SetUint64(freeInode);
716         inodeList.PushBack(Value(freeInode), allocator);
717       }
718
719       d.AddMember(StringRef("freeInodes"), inodeList, allocator);
720
721       StringBuffer strBuff;
722       PrettyWriter<StringBuffer> writer(strBuff);
723       d.Accept(writer);
724
725       string filename = this->mountpoint;
726       if ('/' != filename.back())
727         filename += '/';
728
729       filename = filename + METAS_DIR + "/inodes.json";
730
731       ofstream inodeFile;
732       inodeFile.open(filename);
733       inodeFile << strBuff.GetString() << endl;
734       inodeFile.close();
735     }
736
737     {
738 //    writeDirBlocksMeta
739       Document d;
740       d.SetObject();
741
742       Document::AllocatorType &allocator = d.GetAllocator();
743
744       Value freeInode(kObjectType);
745       freeInode.SetUint64(this->nextFreeDirBlock);
746       d.AddMember(StringRef("nextFreeDirBlock"), freeInode, allocator);
747
748       Value inodeList(kArrayType);
749       Value inode(kObjectType);
750
751       for (unsigned long &freeDirBlock : this->freeDirBlocks) {
752         inode.SetUint64(freeDirBlock);
753         inodeList.PushBack(Value(freeDirBlock), allocator);
754       }
```

```
755
756       d.AddMember(StringRef("freeDirBlocks"), inodeList, allocator);
757
758       StringBuffer strBuff;
759       PrettyWriter<StringBuffer> writer(strBuff);
760       d.Accept(writer);
761
762       string filename = this->mountpoint;
763       if ('/' != filename.back())
764         filename += '/';
765
766       filename = filename + METAS_DIR + "/dirBlocks.json";
767
768       ofstream inodeFile;
769       inodeFile.open(filename);
770       inodeFile << strBuff.GetString() << endl;
771       inodeFile.close();
772     }
773
774     {
775 //    Write block metas
776       Document db;
777       db.SetObject();
778
779       Document::AllocatorType &blAllocator = db.GetAllocator();
780
781       Value freeBlock(kObjectType);
782       freeBlock.SetUint64(this->nextFreeBlock);
783       db.AddMember(StringRef("nextFreeBlock"), freeBlock, blAllocator);
784
785       Value blockList(kArrayType);
786
787       for (auto b :this->freeBlocks) {
788         blockList.PushBack(Value(b), blAllocator);
789       }
790
791       db.AddMember(StringRef("freeBlocks"), blockList, blAllocator);
792
793       StringBuffer bStrBuff;
794       PrettyWriter<StringBuffer> bWriter(bStrBuff);
795       db.Accept(bWriter);
796
797       string filename = this->mountpoint;
798       if ('/' != filename.back())
799         filename += '/';
800
801       filename = filename + METAS_DIR + "/blocks.json";
802
803       ofstream blockFile;
804       blockFile.open(filename);
805       blockFile << bStrBuff.GetString() << endl;
806       blockFile.close();
807     }
808   }
809
810   void BlockDevice::logError(string message) {
811     cerr << message << endl;
812   }
813
```

```
814  bool BlockDevice::dirExists(string path) {
815    struct stat info{};
816
817    if (stat(path.c_str(), &info) != 0)
818      return false;
819    return (info.st_mode & S_IFDIR) != 0;
820  }
821
822  int BlockDevice::createFile(string path) {
823    if (creat(path.c_str(), 0600) < 0) {
824      string message = "create " + path + " error " + string(strerror(errno)) +
     " [" + to_string(errno) + "]";
825      logError(message);
826      return errno;
827    }
828    return this->SUCCESS;
829  }
830
831  int BlockDevice::deleteFile(std::string path) {
832    if (remove(path.c_str()) != 0) {
833      string message = "ERROR: deleting file " + path;
834      logError(message);
835      return errno;
836    }
837    return SUCCESS;
838  }
839
840  int BlockDevice::getMetas(const std::string &filename, mtfs::blockInfo_t &
     infos) {
841    ifstream file(filename);
842    if (!file.is_open())
843      return 0 != errno ? errno : EAGAIN;
844
845    IStreamWrapper wrapper(file);
846
847    Document d;
848    d.ParseStream(wrapper);
849
850    assert(d.HasMember(BI_REFF));
851    assert(d[BI_REFF].IsArray());
852    assert(d.HasMember(BI_ACCESS));
853
854    for (auto &&id :d[BI_REFF].GetArray()) {
855      assert(id.IsObject());
856      assert(id.HasMember(ID_POOL));
857      assert(id.HasMember(ID_VOLUME));
858      assert(id.HasMember(ID_ID));
859
860      uint32_t poolId = id[ID_POOL].GetUint();
861      uint32_t volumeId = id[ID_VOLUME].GetUint();
862      uint64_t i = id[ID_ID].GetUint64();
863
864      infos.referenceId.emplace_back(i, volumeId, poolId);
865    }
866
867    infos.lastAccess = d[BI_ACCESS].GetUint64();
868
869    return 0;
870  }
```

```
871
872   int BlockDevice::putMetas(const std::string &filename, const mtfs::
        blockInfo_t &infos) {
873     Document d;
874     d.SetObject();
875     Document::AllocatorType &allocator = d.GetAllocator();
876
877     Value v;
878
879     Value a(kArrayType);
880     for (auto &&id : infos.referenceId) {
881       v.SetObject();
882
883       v.AddMember(StringRef(ID_POOL), Value(id.poolId), allocator);
884       v.AddMember(StringRef(ID_VOLUME), Value(id.volumeId), allocator);
885       v.AddMember(StringRef(ID_ID), Value(id.id), allocator);
886
887       a.PushBack(v, allocator);
888     }
889     d.AddMember(StringRef(BI_REFF), a, allocator);
890
891     v.SetUint64(infos.lastAccess);
892     d.AddMember(StringRef(BI_ACCESS), v, allocator);
893
894     StringBuffer bStrBuff;
895     PrettyWriter<StringBuffer> bWriter(bStrBuff);
896     d.Accept(bWriter);
897
898     ofstream blockFile;
899     blockFile.open(filename);
900     if (!blockFile.is_open())
901       return -1;
902
903     blockFile << bStrBuff.GetString() << endl;
904     blockFile.close();
905
906     return 0;
907   }
908
909
910 }  // namespace Plugin
911
912 extern "C" pluginSystem::Plugin *createObj() {
913   return new pluginSystem::BlockDevice();
914 }
915
916 extern "C" void destroyObj(pluginSystem::Plugin *plugin) {
917   delete plugin;
918 }
919
920 extern "C" pluginSystem::pluginInfo_t getInfo() {
921   vector<string> params;
922   params.emplace_back("devicePath");
923   params.emplace_back("fsType");
924
925   pluginSystem::pluginInfo_t info = {
926       .name = pluginSystem::BlockDevice::NAME,
927       .params = params,
928   };
```

```
929
930   return info;
931 }
```

Listing 3.7 – "pluginSystem/BlockDevice.cpp

3.2.4 S3

S3.h

```
1  /**
2   * \file S3.h
3   * \brief
4   * \author David Wittwer
5   * \version 0.0.1
6   * \copyright GNU Publis License V3
7   *
8   * This file is part of MTFS.
9   *
10     MTFS is free software: you can redistribute it and/or modify
11     it under the terms of the GNU General Public License as published by
12     the Free Software Foundation, either version 3 of the License, or
13     (at your option) any later version.
14
15     Foobar is distributed in the hope that it will be useful,
16     but WITHOUT ANY WARRANTY; without even the implied warranty of
17     MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
18     GNU General Public License for more details.
19
20     You should have received a copy of the GNU General Public License
21     along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
22   */
23
24 #ifndef MTFS_S3_H
25 #define MTFS_S3_H
26
27 #include <pluginSystem/Plugin.h>
28 #include <aws/core/Aws.h>
29 #include <aws/s3/S3Client.h>
30
31 namespace pluginSystem {
32   class S3 : public Plugin {
33   public:
34
35     static constexpr const char *NAME = "s3";
36
37     S3();
38
39     std::string getName() override;
40
41     bool attach(std::map<std::string, std::string> params) override;
42
43     bool detach() override;
44
45     int add(uint64_t *id, const mtfs::blockType &type) override;
46
47     int del(const uint64_t &id, const mtfs::blockType &type) override;
48
```

```
49      int get(const uint64_t &id, void *data, const mtfs::blockType &type, bool
        metas) override;
50
51      int put(const uint64_t &id, const void *data, const mtfs::blockType &type,
        bool metas) override;
52
53      bool getSuperblock(mtfs::superblock_t &superblock) override;
54
55      bool putSuperblock(const mtfs::superblock_t &superblock) override;
56
57    private:
58      static constexpr const char *INODE_PREFIX = "inodes/";
59      static constexpr const char *DIRECTORY_PREFIX = "directories/";
60      static constexpr const char *DATA_PREFIX = "datas/";
61
62      Aws::S3::S3Client *s3Client;
63      Aws::SDKOptions *options;
64      std::string home;
65      size_t blocksize;
66      Aws::String bucket;
67
68      std::mutex inodeMutex;
69      std::vector<uint64_t> freeInodes;
70      uint64_t nextFreeInode;
71
72      std::mutex dirBlockMutex;
73      std::vector<uint64_t> freeDirectory;
74      uint64_t nextFreeDirectory;
75
76      std::mutex blockMutex;
77      std::vector<uint64_t> freeDatas;
78      uint64_t nextFreeData;
79
80      int writeTmpFile(const std::string &filename, const void *data, const mtfs
        ::blockType &type);
81
82      int writeInode(const std::string &filename, const mtfs::inode_t *inode);
83
84      int writeDirBlock(const std::string &filename, const mtfs::dirBlock_t *
        dirBlock);
85
86      int writeDataBlock(const std::string &filename, const uint8_t *datas);
87
88      int writeSuperblock(const std::string &filename, const mtfs::superblock_t *
        superblock);
89
90      int dlObj(const std::string &filename, const std::string &key);
91
92      int upObj(const std::string &filename, const std::string &key);
93
94      bool dirExists(std::string path);
95
96      void initIds();
97
98      void writeMetas();
99
100     void delObj(const std::string &key);
101   };
102 }
```

```
103
104 #endif //MTFS_S3_H
```

Listing 3.8 – "pluginSystem/S3.h"

S3.cpp

```
1  /**
2   * \file S3.cpp
3   * \brief
4   * \author David Wittwer
5   * \version 0.0.1
6   * \copyright GNU Publis License V3
7   *
8   * This file is part of MTFS.
9
10     MTFS is free software: you can redistribute it and/or modify
11     it under the terms of the GNU General Public License as published by
12     the Free Software Foundation, either version 3 of the License, or
13     (at your option) any later version.
14
15     Foobar is distributed in the hope that it will be useful,
16     but WITHOUT ANY WARRANTY; without even the implied warranty of
17     MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
18     GNU General Public License for more details.
19
20     You should have received a copy of the GNU General Public License
21     along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
22  */
23
24 #include <aws/s3/model/PutObjectRequest.h>
25 #include <aws/s3/model/GetObjectRequest.h>
26 #include <aws/s3/model/DeleteObjectRequest.h>
27 #include <iostream>
28 #include <fstream>
29 #include <rapidjson/stringbuffer.h>
30 #include <rapidjson/prettywriter.h>
31 #include <sys/stat.h>
32 #include <utils/Logger.h>
33 #include <zconf.h>
34 #include <rapidjson/istreamwrapper.h>
35 #include <mtfs/structs.h>
36
37 #include "S3.h"
38
39 using namespace std;
40 using namespace Aws::S3;
41 using namespace rapidjson;
42
43 namespace pluginSystem {
44
45   S3::S3() : nextFreeInode(1), nextFreeDirectory(0), nextFreeData(0) {
46     this->freeDatas.clear();
47     this->freeDirectory.clear();
48     this->freeInodes.clear();
49   }
50
51   std::string S3::getName() {
52     return S3::NAME;
```

```
53  }
54
55  bool S3::attach(std::map<std::string, std::string> params) {
56    if (params.end() == params.find("home") || params.end() == params.find("
    blockSize") ||
57      params.end() == params.find("region") || params.end() == params.find("
    bucket"))
58      return false;
59
60    this->blocksize = static_cast<size_t>(stoi(params["blockSize"]));
61    this->bucket = params["bucket"].c_str();
62    this->home = params["home"] + this->bucket.c_str() + "/";
63
64    this->options = new Aws::SDKOptions();
65    Aws::InitAPI(*this->options);
66
67    Aws::Client::ClientConfiguration configuration;
68    configuration.region = params["region"].c_str();
69    this->s3Client = new S3Client(configuration);
70
71    if (!dirExists(this->home)) {
72      if (mkdir(this->home.c_str(), 0700) != 0) {
73        Logger::getInstance()->log("S3", "mkdir error " + this->home + " " +
    strerror(errno), Logger::L_ERROR);
74        return false;
75      }
76    }
77
78    this->initIds();
79
80    return true;
81  }
82
83  bool S3::detach() {
84    this->writeMetas();
85
86    Aws::ShutdownAPI(*this->options);
87
88    return true;
89  }
90
91  int S3::add(uint64_t *id, const mtfs::blockType &type) {
92
93    mutex *mu = nullptr;
94    vector<uint64_t> *ve = nullptr;
95    uint64_t *nextId;
96
97    switch (type) {
98      case mtfs::INODE:
99        mu = &this->inodeMutex;
100       ve = &this->freeInodes;
101       nextId = &this->nextFreeInode;
102       break;
103     case mtfs::DIR_BLOCK:
104       mu = &this->dirBlockMutex;
105       ve = &this->freeDirectory;
106       nextId = &this->nextFreeDirectory;
107       break;
108     case mtfs::DATA_BLOCK:
```

```
109         mu = &this->blockMutex;
110         ve = &this->freeDatas;
111         nextId = &this->nextFreeData;
112         break;
113       default:
114         return ENOSYS;
115     }
116
117     unique_lock<mutex> lk(*mu);
118     if (ve->empty()) {
119       *id = *nextId;
120       (*nextId)++;
121     } else {
122       *id = (*ve)[0];
123       ve->erase(ve->begin());
124     }
125     lk.unlock();
126
127     return 0;
128   }
129
130   int S3::del(const uint64_t &id, const mtfs::blockType &type) {
131     mutex *mu = nullptr;
132     vector<uint64_t> *ve = nullptr;
133     uint64_t *nextId;
134
135     string key;
136
137     switch (type) {
138       case mtfs::INODE:
139         mu = &this->inodeMutex;
140         ve = &this->freeInodes;
141         nextId = &this->nextFreeInode;
142         key = INODE_PREFIX;
143         break;
144       case mtfs::DIR_BLOCK:
145         mu = &this->dirBlockMutex;
146         ve = &this->freeDirectory;
147         nextId = &this->nextFreeDirectory;
148         key = DIRECTORY_PREFIX;
149         break;
150       case mtfs::DATA_BLOCK:
151         mu = &this->blockMutex;
152         ve = &this->freeDatas;
153         nextId = &this->nextFreeData;
154         key = DATA_PREFIX;
155         break;
156       default:
157         return ENOSYS;
158     }
159
160     unique_lock<mutex> lk(*mu);
161     if (id == *nextId - 1) {
162       (*nextId)--;
163     } else {
164       ve->push_back(id);
165     }
166     lk.unlock();
167
```

```
168     key += to_string(id);
169     this->delObj(key);
170 
171     return 0;
172   }
173 
174   int S3::get(const uint64_t &id, void *data, const mtfs::blockType &type, bool
      metas) {
175     string filename = this->home, key;
176     switch (type) {
177       case mtfs::INODE:
178         filename += "in";
179         key += INODE_PREFIX;
180         break;
181       case mtfs::DIR_BLOCK:
182         filename += "di";
183         key += DIRECTORY_PREFIX;
184         break;
185       case mtfs::DATA_BLOCK:
186         filename += "da";
187         key += DATA_PREFIX;
188         break;
189       default:
190         return ENOSYS;
191     }
192 
193     if (metas) {
194       filename += "me";
195       key = "metas/" + key;
196     }
197 
198     key += to_string(id);
199 
200     if (0 != this->dlObj(filename, key))
201       return 1;
202 
203     if (mtfs::DATA_BLOCK == type) {
204       if (metas) {
205         ifstream file(filename);
206         if (!file.is_open())
207           return errno != 0 ? errno : ENOENT;
208 
209         IStreamWrapper wrapper(file);
210 
211         Document d;
212         d.ParseStream(wrapper);
213 
214         ((mtfs::blockInfo_t *) data)->fromJson(d);
215       } else {
216         ifstream file(filename);
217         if (!file.is_open())
218           return errno != 0 ? errno : ENOENT;
219 
220         file.read((char *) data, this->blocksize);
221         file.close();
222       }
223     } else {
224       ifstream file(filename);
225       if (!file.is_open())
```

```
226         return errno != 0 ? errno : ENOENT;
227
228       IStreamWrapper wrapper(file);
229
230       Document d;
231       d.ParseStream(wrapper);
232
233       switch (type) {
234         case mtfs::INODE:
235           if (metas)
236             ((mtfs::blockInfo_t *) data)->fromJson(d);
237           else
238             ((mtfs::inode_t *) data)->fromJson(d);
239           break;
240         case mtfs::DIR_BLOCK:
241           if (metas)
242             ((mtfs::blockInfo_t *) data)->fromJson(d);
243           else
244             ((mtfs::dirBlock_t *) data)->fromJson(d);
245           break;
246         case mtfs::SUPERBLOCK:
247           break;
248         default:
249           return ENOSYS;
250       }
251
252       file.close();
253     }
254
255     unlink(filename.c_str());
256     return 0;
257   }
258
259   int S3::put(const uint64_t &id, const void *data, const mtfs::blockType &type
      , bool metas) {
260     string filename = this->home, key;
261     switch (type) {
262       case mtfs::INODE:
263         filename += "in";
264         key += INODE_PREFIX;
265         break;
266       case mtfs::DIR_BLOCK:
267         filename += "di";
268         key += DIRECTORY_PREFIX;
269         break;
270       case mtfs::DATA_BLOCK:
271         filename += "da";
272         key += DATA_PREFIX;
273         break;
274       default:
275         return ENOSYS;
276     }
277
278     if (metas) {
279       filename += "me";
280       key = "metas/" + key;
281     }
282
283     key += to_string(id);
```

```
284
285     if (mtfs::DATA_BLOCK == type) {
286       if (metas) {
287         Document d;
288
289         ((mtfs::blockInfo_t *) data)->toJson(d);
290
291         StringBuffer sb;
292         PrettyWriter<StringBuffer> pw(sb);
293         d.Accept(pw);
294
295         ofstream file(filename);
296         if (!file.is_open())
297           return errno != 0 ? errno : ENOENT;
298         file << sb.GetString() << endl;
299         file.close();
300       } else {
301         ofstream file(filename);
302         if (!file.is_open())
303           return errno != 0 ? errno : ENOENT;
304
305         file.write((char *) data, this->blocksize);
306         file.close();
307       }
308     } else {
309       Document d;
310
311       switch (type) {
312         case mtfs::INODE:
313           if (metas)
314             ((mtfs::blockInfo_t *) data)->toJson(d);
315           else
316             ((mtfs::inode_t *) data)->toJson(d);
317           break;
318         case mtfs::DIR_BLOCK:
319           if (metas)
320             ((mtfs::blockInfo_t *) data)->toJson(d);
321           else
322             ((mtfs::dirBlock_t *) data)->toJson(d);
323           break;
324         case mtfs::SUPERBLOCK:
325           break;
326         default:
327           return ENOSYS;
328       }
329
330       StringBuffer sb;
331       PrettyWriter<StringBuffer> pw(sb);
332       d.Accept(pw);
333
334       ofstream file(filename);
335       if (!file.is_open())
336         return errno != 0 ? errno : ENOENT;
337       file << sb.GetString() << endl;
338       file.close();
339     }
340
341     if (0 != this->upObj(filename, key))
342       return 1;
```

```
343
344     unlink(filename.c_str());
345     return 0;
346   }
347
348   bool S3::getSuperblock(mtfs::superblock_t &superblock) {
349     return false;
350   }
351
352   bool S3::putSuperblock(const mtfs::superblock_t &superblock) {
353     return false;
354   }
355
356   int S3::writeTmpFile(const string &filename, const void *data, const mtfs::
      blockType &type) {
357     switch (type) {
358       case mtfs::INODE:
359         return this->writeInode(filename, (mtfs::inode_t *) data);
360         break;
361       case mtfs::DIR_BLOCK:
362         return this->writeDirBlock(filename, (mtfs::dirBlock_t *) data);
363         break;
364       case mtfs::DATA_BLOCK:
365         return this->writeDataBlock(filename, (uint8_t *) data);
366         break;
367       case mtfs::SUPERBLOCK:
368         return this->writeSuperblock(filename, (mtfs::superblock_t *) data);
369         break;
370       default:
371         return ENOSYS;
372     }
373   }
374
375   int S3::writeInode(const std::string &filename, const mtfs::inode_t *inode) {
376     Document d;
377     d.SetObject();
378     Document::AllocatorType &alloc = d.GetAllocator();
379
380     inode->toJson(d);
381
382     StringBuffer sb;
383     PrettyWriter<StringBuffer> pw(sb);
384     d.Accept(pw);
385
386     ofstream inodeFile(filename);
387     inodeFile << sb.GetString() << endl;
388     inodeFile.close();
389
390     return this->SUCCESS;
391   }
392
393   int S3::writeDirBlock(const std::string &filename, const mtfs::dirBlock_t *
      dirBlock) {
394     Document d;
395     d.SetObject();
396
397     Document::AllocatorType &allocator = d.GetAllocator();
398
399     for (auto &&item: dirBlock->entries) {
```

```
400         Value r(kArrayType);
401         for (auto &&ident: item.second) {
402           Value v(kObjectType);
403           ident.toJson(v, allocator);
404           r.PushBack(v, allocator);
405         }
406         d.AddMember(StringRef(item.first.c_str()), r, allocator);
407       }
408
409       StringBuffer sb;
410       PrettyWriter<StringBuffer> pw(sb);
411       d.Accept(pw);
412
413       ofstream file(filename);
414       if (!file.is_open())
415         return errno != 0 ? errno : ENOENT;
416       file << sb.GetString() << endl;
417       file.close();
418
419       return this->SUCCESS;
420     }
421
422     int S3::writeDataBlock(const std::string &filename, const uint8_t *datas) {
423       ofstream file(filename);
424       if (!file.is_open())
425         return errno != 0 ? errno : ENOENT;
426
427       file.write((const char *) datas, this->blocksize);
428       file.close();
429       return this->SUCCESS;
430     }
431
432     int S3::writeSuperblock(const std::string &filename, const mtfs::superblock_t
       *superblock) {
433       ofstream sbFile(filename, ios::binary);
434       sbFile.write((const char *) superblock, sizeof(*superblock));
435       sbFile.close();
436     }
437
438     int S3::dlObj(const std::string &filename, const std::string &key) {
439       Model::GetObjectRequest objectRequest;
440       objectRequest.WithBucket(this->bucket).WithKey(key.c_str());
441
442       auto getObjectOutcome = this->s3Client->GetObject(objectRequest);
443
444       if (getObjectOutcome.IsSuccess()) {
445         Aws::OFStream localFile;
446         localFile.open(filename, ios_base::out | ios_base::binary);
447         localFile << getObjectOutcome.GetResult().GetBody().rdbuf();
448         return 0;
449       }
450
451       return 1;
452     }
453
454     int S3::upObj(const std::string &filename, const std::string &key) {
455       Model::PutObjectRequest objectRequest;
456       objectRequest.WithBucket(this->bucket).WithKey(key.c_str());
457
```

```
458     auto inputData = Aws::MakeShared<Aws::FStream>("PutObjectInputStream",
459                                 filename.c_str(), std::ios_base::in);
460
461     objectRequest.SetBody(inputData);
462
463     auto putObjectOutcome = this->s3Client->PutObject(objectRequest);
464
465     if (putObjectOutcome.IsSuccess()) {
466 //    std::cout << "Done!" << std::endl;
467       return 0;
468     }
469     string message = string("PutObject error: ") + putObjectOutcome.GetError().
    GetExceptionName().c_str() + " " +
470               putObjectOutcome.GetError().GetMessage().c_str();
471     Logger::getInstance()->log("S3", message, Logger::L_ERROR);
472
473     return 1;
474   }
475
476   void S3::delObj(const string &key) {
477     Aws::S3::Model::DeleteObjectRequest objectRequest;
478     objectRequest.WithBucket(this->bucket).WithKey(key.c_str());
479
480     auto deleteObjectOutcome = this->s3Client->DeleteObject(objectRequest);
481
482     if (deleteObjectOutcome.IsSuccess()) {
483       Logger::getInstance()->log("S3", "Delete Success", Logger::L_INFO);
484     } else {
485       string message =
486           string("PutObject error: ") + deleteObjectOutcome.GetError().
    GetExceptionName().c_str() + " " +
487           deleteObjectOutcome.GetError().GetMessage().c_str();
488       Logger::getInstance()->log("S3", message, Logger::L_ERROR);
489     }
490   }
491
492   bool S3::dirExists(string path) {
493     struct stat info{};
494
495     if (stat(path.c_str(), &info) != 0)
496       return false;
497     return (info.st_mode & S_IFDIR) != 0;
498   }
499
500   void S3::initIds() {
501     string keyName = "ids.json";
502     string filename = this->home + keyName;
503
504     if (0 != dlObj(filename, keyName)) {
505       return;
506     }
507
508     ifstream inodeFile(filename);
509     if (!inodeFile.is_open())
510       return;
511
512     IStreamWrapper isw(inodeFile);
513
514     Document d;
```

```
515     d.ParseStream(isw);
516
517     assert(d.IsObject());
518
519 //  Init inode ids
520     assert(d.HasMember("inode"));
521     Value o = d["inode"].GetObject();
522     assert(o.HasMember("next"));
523     this->nextFreeInode = o["next"].GetUint64();
524     assert(o.HasMember("frees"));
525     for (auto &&id : o["frees"].GetArray()) {
526       this->freeInodes.push_back(id.GetUint64());
527     }
528
529 //  Init Dir block ids
530     assert(d.HasMember("directory"));
531     o = d["directory"].GetObject();
532     assert(o.HasMember("next"));
533     this->nextFreeDirectory = o["next"].GetUint64();
534     assert(o.HasMember("frees"));
535     for (auto &&id : o["frees"].GetArray()) {
536       this->freeDirectory.push_back(id.GetUint64());
537     }
538
539 //  Init data Block Ids
540     assert(d.HasMember("data"));
541     o = d["data"].GetObject();
542     assert(o.HasMember("next"));
543     this->nextFreeData = o["next"].GetUint64();
544     assert(o.HasMember("frees"));
545     for (auto &&id : o["frees"].GetArray()) {
546       this->freeDatas.push_back(id.GetUint64());
547     }
548
549
550     unlink(filename.c_str());
551
552     Logger::getInstance()->log("S3", "INIT SUCCESS", Logger::L_INFO);
553   }
554
555   void S3::writeMetas() {
556     Document d;
557     d.SetObject();
558
559     Document::AllocatorType &allocator = d.GetAllocator();
560
561     Value o(kObjectType);
562     Value a(kArrayType);
563     Value v;
564     v.SetUint64(this->nextFreeInode);
565     o.AddMember(StringRef("next"), v, allocator);
566     for (auto &&id :this->freeInodes) {
567       v.SetUint64(id);
568       a.PushBack(v, allocator);
569     }
570     o.AddMember(StringRef("frees"), a, allocator);
571     d.AddMember(StringRef("inode"), o, allocator);
572
573     o.SetObject();
```

```
574     a.SetArray();
575     v.SetUint64(this->nextFreeDirectory);
576     o.AddMember(StringRef("next"), v, allocator);
577     for (auto &&id :this->freeDirectory) {
578       v.SetUint64(id);
579       a.PushBack(v, allocator);
580     }
581     o.AddMember(StringRef("frees"), a, allocator);
582     d.AddMember(StringRef("directory"), o, allocator);
583 
584     o.SetObject();
585     a.SetArray();
586     v.SetUint64(this->nextFreeData);
587     o.AddMember(StringRef("next"), v, allocator);
588     for (auto &&id :this->freeDatas) {
589       v.SetUint64(id);
590       a.PushBack(v, allocator);
591     }
592     o.AddMember(StringRef("frees"), a, allocator);
593     d.AddMember(StringRef("data"), o, allocator);
594 
595     StringBuffer strBuff;
596     PrettyWriter<StringBuffer> writer(strBuff);
597     d.Accept(writer);
598 
599     string key = "ids.json";
600     string filename = this->home + key;
601     ofstream file;
602     file.open(filename);
603     file << strBuff.GetString() << endl;
604     file.close();
605 
606     this->upObj(filename, key);
607 
608     unlink(filename.c_str());
609   }
610 }
611 
612 extern "C" pluginSystem::Plugin *createObj() {
613   return new pluginSystem::S3();
614 }
615 
616 extern "C" void destroyObj(pluginSystem::Plugin *plugin) {
617   delete plugin;
618 }
619 
620 extern "C" pluginSystem::pluginInfo_t getInfo() {
621   vector<string> params;
622   params.emplace_back("bucket");
623   params.emplace_back("region");
624 
625   pluginSystem::pluginInfo_t info = {
626       .name = pluginSystem::S3::NAME,
627       .params = params,
628   };
629 
630   return info;
631 }
```

Listing 3.9 – "pluginSystem/S3.cpp

3.3 *Wrapper*

3.3.1 FuseBase

FuseBase.h

```
/**
 * \file FuseBase.h
 * \brief
 * \author David Wittwer
 * \version 0.0.1
 * \copyright GNU Publis License V3
 *
 * This file is part of MTFS.

    MTFS is free software: you can redistribute it and/or modify
    it under the terms of the GNU General Public License as published by
    the Free Software Foundation, either version 3 of the License, or
    (at your option) any later version.

    Foobar is distributed in the hope that it will be useful,
    but WITHOUT ANY WARRANTY; without even the implied warranty of
    MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
    GNU General Public License for more details.

    You should have received a copy of the GNU General Public License
    along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
 */

#ifndef MTFSFUSE_FUSE_BASE_H
#define MTFSFUSE_FUSE_BASE_H

#include <fuse3/fuse_lowlevel.h>
#include <string>
#include <vector>
#include <list>
#include <iostream>
#include <assert.h>

#include "wrapper/FuseCallback.h"


namespace wrapper {
  class FuseCallback;

  class FuseBase {

  public:
    FuseBase();

    virtual ~FuseBase() = 0;

    int run(int argc, char **argv);

```

```
49
50  protected:
51    friend class FuseCallback;
52
53    virtual bool runPrepare(int argc, char **argv)=0;
54
55    virtual void init(void *userdata, fuse_conn_info *conn);
56
57    virtual void destroy(void *userdata);
58
59    virtual void lookup(fuse_req_t req, fuse_ino_t parent, const char *name);
60
61    virtual void forget(fuse_req_t req, fuse_ino_t ino, uint64_t nlookup);
62
63    virtual void getAttr(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi);
64
65    virtual void setattr(fuse_req_t req, fuse_ino_t ino, struct stat *attr, int
      to_set, fuse_file_info *fi);
66
67    virtual void readlink(fuse_req_t req, fuse_ino_t ino);
68
69    virtual void mknod(fuse_req_t req, fuse_ino_t parent, const char *name,
    mode_t mode, dev_t rdev);
70
71    virtual void mkdir(fuse_req_t req, fuse_ino_t parent, const char *name,
    mode_t mode);
72
73    virtual void unlink(fuse_req_t req, fuse_ino_t parent, const char *name);
74
75    virtual void rmdir(fuse_req_t req, fuse_ino_t parent, const char *name);
76
77    virtual void symlink(fuse_req_t req, const char *link, fuse_ino_t parent,
    const char *name);
78
79    virtual void
80    rename(fuse_req_t req, fuse_ino_t parent, const char *name, fuse_ino_t
    newparent, const char *newname,
81          unsigned int flags);
82
83    virtual void link(fuse_req_t req, fuse_ino_t ino, fuse_ino_t newparent,
    const char *newname);
84
85    virtual void open(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi);
86
87    virtual void read(fuse_req_t req, fuse_ino_t ino, size_t size, off_t off,
    fuse_file_info *fi);
88
89    virtual void write(fuse_req_t req, fuse_ino_t ino, const char *buf, size_t
    size, off_t off, fuse_file_info *fi);
90
91    virtual void flush(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi);
92
93    virtual void release(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi);
94
95    virtual void fsync(fuse_req_t req, fuse_ino_t ino, int datasync,
    fuse_file_info *fi);
96
97    virtual void opendir(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi);
98
```

```
99      virtual void readdir(fuse_req_t req, fuse_ino_t ino, size_t size, off_t off
        , fuse_file_info *fi);
100
101     virtual void releasedir(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi)
        ;
102
103     virtual void fsyncdir(fuse_req_t req, fuse_ino_t ino, int datasync,
        fuse_file_info *fi);
104
105     virtual void statfs(fuse_req_t req, fuse_ino_t ino);
106
107     virtual void
108     setxattr(fuse_req_t req, fuse_ino_t ino, const char *name, const char *
        value, size_t size, int flags);
109
110     virtual void getxattr(fuse_req_t req, fuse_ino_t ino, const char *name,
        size_t size);
111
112     virtual void listxattr(fuse_req_t req, fuse_ino_t ino, size_t size);
113
114     virtual void removexattr(fuse_req_t req, fuse_ino_t ino, const char *name);
115
116     virtual void access(fuse_req_t req, fuse_ino_t ino, int mask);
117
118     virtual void create(fuse_req_t req, fuse_ino_t parent, const char *name,
        mode_t mode, fuse_file_info *fi);
119
120     virtual void getlk(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi,
        struct flock *lock);
121
122     virtual void setlk(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi,
        struct flock *lock, int sleep);
123
124     virtual void bmap(fuse_req_t req, fuse_ino_t ino, size_t blocksize,
        uint64_t idx);
125
126     virtual void ioctl(fuse_req_t req, fuse_ino_t ino, int cmd, void *arg,
        fuse_file_info *fi, unsigned int flags,
127                const void *in_buf, size_t in_bufsz, size_t out_bufsz);
128
129     virtual void poll(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi,
        fuse_pollhandle *ph);
130
131     virtual void write_buf(fuse_req_t req, fuse_ino_t ino, fuse_bufvec *bufv,
        off_t off, fuse_file_info *fi);
132
133     virtual void retrive_reply(fuse_req_t req, void *cookie, fuse_ino_t ino,
        off_t offset, fuse_bufvec *bufv);
134
135     virtual void forget_multi(fuse_req_t req, size_t count, fuse_forget_data *
        forgets);
136
137     virtual void flock(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi, int
        op);
138
139     virtual void
140     fallocate(fuse_req_t req, fuse_ino_t ino, int mode, off_t offset, off_t
        length, fuse_file_info *fi);
141
```

```
142     virtual void readdirplus(fuse_req_t req, fuse_ino_t ino, size_t size, off_t
        off, fuse_file_info *fi);
143
144   private:
145     FuseCallback *callbacks;
146
147   };
148
149 }  // namespace wrapper
150 #endif
```

Listing 3.10 – "wrapper/FuseBase.h"

FuseBase.cpp

```
1  /**
2   * \file FuseBase.cpp
3   * \brief
4   * \author David Wittwer
5   * \version 0.0.1
6   * \copyright GNU Publis License V3
7   *
8   * This file is part of MTFS.
9
10    MTFS is free software: you can redistribute it and/or modify
11    it under the terms of the GNU General Public License as published by
12    the Free Software Foundation, either version 3 of the License, or
13    (at your option) any later version.
14
15    Foobar is distributed in the hope that it will be useful,
16    but WITHOUT ANY WARRANTY; without even the implied warranty of
17    MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
18    GNU General Public License for more details.
19
20    You should have received a copy of the GNU General Public License
21    along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
22  */
23
24 #include <utils/Logger.h>
25 #include <fstream>
26 #include "wrapper/FuseBase.h"
27
28 namespace wrapper {
29
30   FuseBase::FuseBase() {
31     callbacks = FuseCallback::getInstance();
32   }
33
34   FuseBase::~FuseBase() = default;
35
36   int FuseBase::run(int argc, char **argv) {
37
38     struct fuse_args args = FUSE_ARGS_INIT(argc, argv);
39     struct fuse_session *se;
40     struct fuse_cmdline_opts opts{};
41     int ret = -1;
42
43     if (!runPrepare(argc, argv))
44       return -1;
```

```
45 //    std::cout << "run" << std::endl;
46
47     callbacks->setBase(this);
48
49     if (fuse_parse_cmdline(&args, &opts) != 0)
50       return 1;
51     if (0 != opts.show_help) {
52       std::cerr << "usage: " << argv[0] << " [options] <mountpoint> <configName
       >" << std::endl << std::endl;
53       fuse_cmdline_help();
54       fuse_lowlevel_help();
55       ret = 0;
56       goto err_out1;
57     } else if (0 != opts.show_version) {
58       std::cerr << "FUSE library version " << fuse_pkgversion() << std::endl;
59       fuse_lowlevel_version();
60       ret = 0;
61       goto err_out1;
62     }
63
64     if (0 != opts.debug) {
65       std::ofstream log("/tmp/mtfs.log");
66       Logger::init(std::cerr, Logger::L_DEBUG);
67     } else {
68       std::ofstream log;
69       log.open("/var/log/mtfs.log");
70       Logger::init(log, Logger::L_ERROR);
71     }
72
73     se = fuse_session_new(&args, &FuseCallback::ops, sizeof(FuseCallback::ops),
       nullptr);
74
75     if (se == nullptr)
76       goto err_out1;
77
78     if (fuse_set_signal_handlers(se) != 0)
79       goto err_out2;
80
81     if (fuse_session_mount(se, opts.mountpoint) != 0)
82       goto err_out3;
83
84     fuse_daemonize(opts.foreground);
85
86     /* Block until ctrl+c or fusermount -u */
87     if (0 != opts.singlethread)
88       ret = fuse_session_loop(se);
89     else
90       ret = fuse_session_loop_mt(se, opts.clone_fd);
91
92     fuse_session_unmount(se);
93     err_out3:
94     fuse_remove_signal_handlers(se);
95     err_out2:
96     fuse_session_destroy(se);
97     err_out1:
98     free(opts.mountpoint);
99     fuse_opt_free_args(&args);
100
101    return 0 != ret ? 1 : 0;
```

```
102   }
103
104   void FuseBase::init(void *userdata, fuse_conn_info *conn) {
105     (void) userdata, conn;
106   }
107
108   void FuseBase::destroy(void *userdata) {
109     (void) userdata;
110   }
111
112   void FuseBase::lookup(fuse_req_t req, fuse_ino_t parent, const char *name) {
113     (void) parent, name;
114     fuse_reply_err(req, ENOSYS);
115   }
116
117   void FuseBase::forget(fuse_req_t req, fuse_ino_t ino, uint64_t nlookup) {
118     (void) ino, nlookup;
119     fuse_reply_err(req, ENOSYS);
120   }
121
122   void FuseBase::getAttr(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi) {
123     (void) ino, fi;
124     fuse_reply_err(req, ENOSYS);
125   }
126
127   void FuseBase::setattr(fuse_req_t req, fuse_ino_t ino, struct stat *attr, int
        to_set, fuse_file_info *fi) {
128     (void) ino, attr, to_set, fi;
129     fuse_reply_err(req, ENOSYS);
130   }
131
132   void FuseBase::readlink(fuse_req_t req, fuse_ino_t ino) {
133     (void) ino;
134     fuse_reply_err(req, ENOSYS);
135   }
136
137   void FuseBase::mknod(fuse_req_t req, fuse_ino_t parent, const char *name,
       mode_t mode, dev_t rdev) {
138     (void) parent, name, mode, rdev;
139     fuse_reply_err(req, ENOSYS);
140   }
141
142   void FuseBase::mkdir(fuse_req_t req, fuse_ino_t parent, const char *name,
       mode_t mode) {
143     (void) parent, name, mode;
144     fuse_reply_err(req, ENOSYS);
145   }
146
147   void FuseBase::unlink(fuse_req_t req, fuse_ino_t parent, const char *name) {
148     (void) parent, name;
149     fuse_reply_err(req, ENOSYS);
150   }
151
152   void FuseBase::rmdir(fuse_req_t req, fuse_ino_t parent, const char *name) {
153     (void) parent, name;
154     fuse_reply_err(req, ENOSYS);
155   }
156
```

```
157  void FuseBase::symlink(fuse_req_t req, const char *link, fuse_ino_t parent,
      const char *name) {
158    (void) link, parent, name;
159    fuse_reply_err(req, ENOSYS);
160  }
161
162  void
163  FuseBase::rename(fuse_req_t req, fuse_ino_t parent, const char *name,
      fuse_ino_t newparent, const char *newname,
164            unsigned int flags) {
165    (void) parent, name, newparent, newname, flags;
166    fuse_reply_err(req, ENOSYS);
167  }
168
169  void FuseBase::link(fuse_req_t req, fuse_ino_t ino, fuse_ino_t newparent,
      const char *newname) {
170    (void) ino, newparent, newname;
171    fuse_reply_err(req, ENOSYS);
172  }
173
174  void FuseBase::open(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi) {
175    (void) ino, fi;
176    fuse_reply_err(req, ENOSYS);
177  }
178
179  void FuseBase::read(fuse_req_t req, fuse_ino_t ino, size_t size, off_t off,
      fuse_file_info *fi) {
180    (void) ino, size, off, fi;
181    fuse_reply_err(req, ENOSYS);
182  }
183
184  void FuseBase::write(fuse_req_t req, fuse_ino_t ino, const char *buf, size_t
      size, off_t off, fuse_file_info *fi) {
185    (void) ino, buf, size, off, fi;
186    fuse_reply_err(req, ENOSYS);
187  }
188
189  void FuseBase::flush(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi) {
190    (void) ino, fi;
191    fuse_reply_err(req, ENOSYS);
192  }
193
194  void FuseBase::release(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi) {
195    (void) ino, fi;
196    fuse_reply_err(req, ENOSYS);
197  }
198
199  void FuseBase::fsync(fuse_req_t req, fuse_ino_t ino, int datasync,
      fuse_file_info *fi) {
200    (void) ino, datasync, fi;
201    fuse_reply_err(req, ENOSYS);
202  }
203
204  void FuseBase::opendir(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi) {
205    (void) ino, fi;
206    fuse_reply_err(req, ENOSYS);
207  }
208
```

```
209  void FuseBase::readdir(fuse_req_t req, fuse_ino_t ino, size_t size, off_t off
       , fuse_file_info *fi) {
210    (void) ino, size, off, fi;
211    fuse_reply_err(req, ENOSYS);
212  }
213
214  void FuseBase::releasedir(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi)
       {
215    (void) ino, fi;
216    fuse_reply_err(req, ENOSYS);
217  }
218
219  void FuseBase::fsyncdir(fuse_req_t req, fuse_ino_t ino, int datasync,
       fuse_file_info *fi) {
220    (void) ino, datasync, fi;
221    fuse_reply_err(req, ENOSYS);
222  }
223
224  void FuseBase::statfs(fuse_req_t req, fuse_ino_t ino) {
225    (void) ino;
226    fuse_reply_err(req, ENOSYS);
227  }
228
229  void
230  FuseBase::setxattr(fuse_req_t req, fuse_ino_t ino, const char *name, const
       char *value, size_t size, int flags) {
231    (void) ino, name, value, size, flags;
232    fuse_reply_err(req, ENOSYS);
233  }
234
235  void FuseBase::getxattr(fuse_req_t req, fuse_ino_t ino, const char *name,
       size_t size) {
236    (void) ino, name, size;
237    fuse_reply_err(req, ENOSYS);
238  }
239
240  void FuseBase::listxattr(fuse_req_t req, fuse_ino_t ino, size_t size) {
241    (void) ino, size;
242    fuse_reply_err(req, ENOSYS);
243  }
244
245  void FuseBase::removexattr(fuse_req_t req, fuse_ino_t ino, const char *name)
       {
246    (void) ino, name;
247    fuse_reply_err(req, ENOSYS);
248  }
249
250  void FuseBase::access(fuse_req_t req, fuse_ino_t ino, int mask) {
251    (void) ino, mask;
252    fuse_reply_err(req, ENOSYS);
253  }
254
255  void FuseBase::create(fuse_req_t req, fuse_ino_t parent, const char *name,
       mode_t mode, fuse_file_info *fi) {
256    (void) parent, name, mode, fi;
257    fuse_reply_err(req, ENOSYS);
258  }
259
```

```
260 void FuseBase::getlk(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi,
    struct flock *lock) {
261   (void) ino, fi, lock;
262   fuse_reply_err(req, ENOSYS);
263 }
264
265 void FuseBase::setlk(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi,
    struct flock *lock, int sleep) {
266   (void) ino, fi, lock, sleep;
267   fuse_reply_err(req, ENOSYS);
268 }
269
270 void FuseBase::bmap(fuse_req_t req, fuse_ino_t ino, size_t blocksize,
    uint64_t idx) {
271   (void) ino, blocksize, idx;
272   fuse_reply_err(req, ENOSYS);
273 }
274
275 void FuseBase::ioctl(fuse_req_t req, fuse_ino_t ino, int cmd, void *arg,
    fuse_file_info *fi, unsigned int flags,
276             const void *in_buf, size_t in_bufsz, size_t out_bufsz) {
277   (void) ino, cmd, arg, fi, flags, in_buf, in_bufsz, out_bufsz;
278   fuse_reply_err(req, ENOSYS);
279 }
280
281 void FuseBase::poll(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi,
    fuse_pollhandle *ph) {
282   (void) ino, fi, ph;
283   fuse_reply_err(req, ENOSYS);
284 }
285
286 void FuseBase::write_buf(fuse_req_t req, fuse_ino_t ino, fuse_bufvec *bufv,
    off_t off, fuse_file_info *fi) {
287   (void) ino, bufv, off, fi;
288   fuse_reply_err(req, ENOSYS);
289 }
290
291 void FuseBase::retrive_reply(fuse_req_t req, void *cookie, fuse_ino_t ino,
    off_t offset, fuse_bufvec *bufv) {
292   (void) cookie, ino, offset, bufv;
293   fuse_reply_err(req, ENOSYS);
294 }
295
296 void FuseBase::forget_multi(fuse_req_t req, size_t count, fuse_forget_data *
    forgets) {
297   (void) count, forgets;
298   fuse_reply_err(req, ENOSYS);
299 }
300
301 void FuseBase::flock(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi, int
    op) {
302   (void) ino, fi, op;
303   fuse_reply_err(req, ENOSYS);
304 }
305
306 void FuseBase::fallocate(fuse_req_t req, fuse_ino_t ino, int mode, off_t
    offset, off_t length, fuse_file_info *fi) {
307   (void) ino, mode, offset, length, fi;
308   fuse_reply_err(req, ENOSYS);
```

```
309   }
310
311   void FuseBase::readdirplus(fuse_req_t req, fuse_ino_t ino, size_t size, off_t
        off, fuse_file_info *fi) {
312     (void) ino, size, off, fi;
313     fuse_reply_err(req, ENOSYS);
314   }
315
316
317 }  // namespace wrapper
```

Listing 3.11 – "wrapper/FuseBase.cpp"

3.3.2 FuseCallback

FuseCallback.h

```
1  /**
2   * \file FuseCallback.h
3   * \brief
4   * \author David Wittwer
5   * \version 0.0.1
6   * \copyright GNU Publis License V3
7   *
8   * This file is part of MTFS.
9
10    MTFS is free software: you can redistribute it and/or modify
11    it under the terms of the GNU General Public License as published by
12    the Free Software Foundation, either version 3 of the License, or
13    (at your option) any later version.
14
15    Foobar is distributed in the hope that it will be useful,
16    but WITHOUT ANY WARRANTY; without even the implied warranty of
17    MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
18    GNU General Public License for more details.
19
20    You should have received a copy of the GNU General Public License
21    along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
22  */
23
24 #ifndef MTFSFUSE_FUSE_CALLBACK_H
25 #define MTFSFUSE_FUSE_CALLBACK_H
26
27 #include <fuse3/fuse_lowlevel.h>
28 #include <string>
29 #include <vector>
30 #include <list>
31 #include <iostream>
32
33 #include "wrapper/FuseBase.h"
34
35
36 namespace wrapper {
37   class FuseBase;
38
39   class FuseCallback {
40   public:
41     static FuseCallback *getInstance();
```

```
42
43      void setBase(FuseBase *base);
44
45      static struct fuse_lowlevel_ops ops;
46
47
48    private:
49      FuseCallback();
50
51      static void init(void *userdata, struct fuse_conn_info *conn);
52
53      static void destroy(void *userdata);
54
55      static void lookup(fuse_req_t req, fuse_ino_t parent, const char *name);
56
57      static void forget(fuse_req_t req, fuse_ino_t ino, std::uint64_t nlookup);
58
59      static void getAttr(fuse_req_t req, fuse_ino_t ino, struct fuse_file_info *
        fi);
60
61      static void setattr(fuse_req_t req, fuse_ino_t ino, struct stat *attr, int
        to_set, struct fuse_file_info *fi);
62
63      static void readlink(fuse_req_t req, fuse_ino_t ino);
64
65      static void mknod(fuse_req_t req, fuse_ino_t parent, const char *name,
        mode_t mode, dev_t rdev);
66
67      static void mkdir(fuse_req_t req, fuse_ino_t parent, const char *name,
        mode_t mode);
68
69      static void unlink(fuse_req_t req, fuse_ino_t parent, const char *name);
70
71      static void rmdir(fuse_req_t req, fuse_ino_t parent, const char *name);
72
73      static void symlink(fuse_req_t req, const char *link, fuse_ino_t parent,
        const char *name);
74
75      static void
76      rename(fuse_req_t req, fuse_ino_t parent, const char *name, fuse_ino_t
        newparent, const char *newname,
77             unsigned int flags);
78
79      static void link(fuse_req_t req, fuse_ino_t ino, fuse_ino_t newparent,
        const char *newname);
80
81      static void open(fuse_req_t req, fuse_ino_t ino, struct fuse_file_info *fi)
        ;
82
83      static void read(fuse_req_t req, fuse_ino_t ino, std::size_t size, off_t
        off, struct fuse_file_info *fi);
84
85      static void
86      write(fuse_req_t req, fuse_ino_t ino, const char *buf, std::size_t size,
        off_t off, struct fuse_file_info *fi);
87
88      static void flush(fuse_req_t req, fuse_ino_t ino, struct fuse_file_info *fi
        );
89
```

```
90      static void release(fuse_req_t req, fuse_ino_t ino, struct fuse_file_info *
        fi);
91
92      static void fsync(fuse_req_t req, fuse_ino_t ino, int datasync, struct
        fuse_file_info *fi);
93
94      static void opendir(fuse_req_t req, fuse_ino_t ino, struct fuse_file_info *
        fi);
95
96      static void readdir(fuse_req_t req, fuse_ino_t ino, std::size_t size, off_t
         off, struct fuse_file_info *fi);
97
98      static void releasedir(fuse_req_t req, fuse_ino_t ino, struct
        fuse_file_info *fi);
99
100     static void fsyncdir(fuse_req_t req, fuse_ino_t ino, int datasync, struct
        fuse_file_info *fi);
101
102     static void statfs(fuse_req_t req, fuse_ino_t ino);
103
104     static void
105     setxattr(fuse_req_t req, fuse_ino_t ino, const char *name, const char *
        value, std::size_t size, int flags);
106
107     static void getxattr(fuse_req_t req, fuse_ino_t ino, const char *name, std
        ::size_t size);
108
109     static void listxattr(fuse_req_t req, fuse_ino_t ino, std::size_t size);
110
111     static void removexattr(fuse_req_t req, fuse_ino_t ino, const char *name);
112
113     static void access(fuse_req_t req, fuse_ino_t ino, int mask);
114
115     static void create(fuse_req_t req, fuse_ino_t parent, const char *name,
        mode_t mode, struct fuse_file_info *fi);
116
117     static void getlk(fuse_req_t req, fuse_ino_t ino, struct fuse_file_info *fi
        , struct flock *lock);
118
119     static void setlk(fuse_req_t req, fuse_ino_t ino, struct fuse_file_info *fi
        , struct flock *lock, int sleep);
120
121     static void bmap(fuse_req_t req, fuse_ino_t ino, std::size_t blocksize, std
        ::uint64_t idx);
122
123     static void
124     ioctl(fuse_req_t req, fuse_ino_t ino, int cmd, void *arg, struct
        fuse_file_info *fi, unsigned int flags,
125         const void *in_buf, std::size_t in_bufsz, std::size_t out_bufsz);
126
127     static void poll(fuse_req_t req, fuse_ino_t ino, struct fuse_file_info *fi,
         struct fuse_pollhandle *ph);
128
129     static void
130     write_buf(fuse_req_t req, fuse_ino_t ino, struct fuse_bufvec *bufv, off_t
        off, struct fuse_file_info *fi);
131
132     static void retrive_reply(fuse_req_t req, void *cookie, fuse_ino_t ino,
        off_t offset, struct fuse_bufvec *bufv);
```

```
133
134     static void forget_multi(fuse_req_t req, std::size_t count, struct
        fuse_forget_data *forgets);
135
136     static void flock(fuse_req_t req, fuse_ino_t ino, struct fuse_file_info *fi
        , int op);
137
138     static void
139     fallocate(fuse_req_t req, fuse_ino_t ino, int mode, off_t offset, off_t
        length, struct fuse_file_info *fi);
140
141     static void readdirplus(fuse_req_t req, fuse_ino_t ino, std::size_t size,
        off_t off, struct fuse_file_info *fi);
142
143
144     static FuseCallback *self;
145
146     static FuseBase *base;
147
148   };
149
150 }  // namespace wrapper
151 #endif
```

Listing 3.12 – "wrapper/FuseCallback.h"

FuseCallback.cpp

```
1  #include <string>
2  #include <vector>
3  #include <list>
4  /**
5   * \file FuseCallback.cpp
6   * \brief
7   * \author David Wittwer
8   * \version 0.0.1
9   * \copyright GNU Publis License V3
10  *
11  * This file is part of MTFS.
12
13     MTFS is free software: you can redistribute it and/or modify
14     it under the terms of the GNU General Public License as published by
15     the Free Software Foundation, either version 3 of the License, or
16     (at your option) any later version.
17
18     Foobar is distributed in the hope that it will be useful,
19     but WITHOUT ANY WARRANTY; without even the implied warranty of
20     MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
21     GNU General Public License for more details.
22
23     You should have received a copy of the GNU General Public License
24     along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
25  */
26
27 #include <iostream>
28 #include <assert.h>
29
30 #include <wrapper/FuseCallback.h>
31
```

```
32 namespace wrapper {
33   FuseCallback *FuseCallback::self = 0;
34   FuseBase *FuseCallback::base = 0;
35
36   struct fuse_lowlevel_ops FuseCallback::ops =
37       {
38           .init = FuseCallback::init,
39           .destroy=FuseCallback::destroy,
40           .lookup=FuseCallback::lookup,
41           .forget=FuseCallback::forget,
42           .getattr=FuseCallback::getAttr,
43           .setattr=FuseCallback::setattr,
44           .readlink=FuseCallback::readlink,
45           .mknod=FuseCallback::mknod,
46           .mkdir=FuseCallback::mkdir,
47           .unlink=FuseCallback::unlink,
48           .rmdir=FuseCallback::rmdir,
49           .symlink=FuseCallback::symlink,
50           .rename=FuseCallback::rename,
51           .link=FuseCallback::link,
52           .open=FuseCallback::open,
53           .read=FuseCallback::read,
54           .write=FuseCallback::write,
55           .flush=FuseCallback::flush,
56           .release=FuseCallback::release,
57           .fsync=FuseCallback::fsync,
58           .opendir=FuseCallback::opendir,
59           .readdir=FuseCallback::readdir,
60           .releasedir=FuseCallback::releasedir,
61           .fsyncdir=FuseCallback::fsyncdir,
62           .statfs=FuseCallback::statfs,
63           .setxattr=FuseCallback::setxattr,
64           .getxattr=FuseCallback::getxattr,
65           .listxattr=FuseCallback::listxattr,
66           .removexattr=FuseCallback::removexattr,
67           .access=FuseCallback::access,
68           .create=FuseCallback::create,
69           .getlk=FuseCallback::getlk,
70           .setlk=FuseCallback::setlk,
71           .bmap=FuseCallback::bmap,
72           .ioctl=FuseCallback::ioctl,
73           .poll=FuseCallback::poll,
74           .write_buf=FuseCallback::write_buf,
75           .retrieve_reply=FuseCallback::retrive_reply,
76           .forget_multi=FuseCallback::forget_multi,
77           .flock=FuseCallback::flock,
78           .fallocate=FuseCallback::fallocate,
79           .readdirplus=FuseCallback::readdirplus,
80       };
81
82   FuseCallback::FuseCallback() {
83     this->base = 0;
84   }
85
86   FuseCallback *FuseCallback::getInstance() {
87     if (!self)
88       self = new FuseCallback();
89
90     return self;
```

```
91  }
92
93  void FuseCallback::setBase(FuseBase *base) {
94    this->base = base;
95  }
96
97  void FuseCallback::init(void *userdata, struct fuse_conn_info *conn) {
98    if (base)
99      base->init(userdata, conn);
100 }
101
102 void FuseCallback::destroy(void *userdata) {
103   if (base)
104     base->destroy(userdata);
105 }
106
107 void FuseCallback::lookup(fuse_req_t req, fuse_ino_t parent, const char *name
      ) {
108   if (base)
109     base->lookup(req, parent, name);
110   else
111     fuse_reply_err(req, ENOSYS);
112 }
113
114 void FuseCallback::forget(fuse_req_t req, fuse_ino_t ino, uint64_t nlookup) {
115   if (base)
116     base->forget(req, ino, nlookup);
117   else
118     fuse_reply_err(req, ENOSYS);
119 }
120
121 void FuseCallback::getAttr(fuse_req_t req, fuse_ino_t ino, struct
      fuse_file_info *fi) {
122   if (base)
123     base->getAttr(req, ino, fi);
124   else
125     fuse_reply_err(req, ENOSYS);
126 }
127
128 void
129 FuseCallback::setattr(fuse_req_t req, fuse_ino_t ino, struct stat *attr, int
      to_set, struct fuse_file_info *fi) {
130   if (base)
131     base->setattr(req, ino, attr, to_set, fi);
132   else
133     fuse_reply_err(req, ENOSYS);
134 }
135
136 void FuseCallback::readlink(fuse_req_t req, fuse_ino_t ino) {
137   if (base)
138     base->readlink(req, ino);
139   else
140     fuse_reply_err(req, ENOSYS);
141 }
142
143 void FuseCallback::mknod(fuse_req_t req, fuse_ino_t parent, const char *name,
      mode_t mode, dev_t rdev) {
144   if (base)
145     base->mknod(req, parent, name, mode, rdev);
```

```
146       else
147         fuse_reply_err(req, ENOSYS);
148     }
149
150     void FuseCallback::mkdir(fuse_req_t req, fuse_ino_t parent, const char *name,
          mode_t mode) {
151       if (base)
152         base->mkdir(req, parent, name, mode);
153       else
154         fuse_reply_err(req, ENOSYS);
155     }
156
157     void FuseCallback::unlink(fuse_req_t req, fuse_ino_t parent, const char *name
          ) {
158       if (base)
159         base->unlink(req, parent, name);
160       else
161         fuse_reply_err(req, ENOSYS);
162     }
163
164     void FuseCallback::rmdir(fuse_req_t req, fuse_ino_t parent, const char *name)
          {
165       if (base)
166         base->rmdir(req, parent, name);
167       else
168         fuse_reply_err(req, ENOSYS);
169     }
170
171     void FuseCallback::symlink(fuse_req_t req, const char *link, fuse_ino_t
          parent, const char *name) {
172       if (base)
173         base->symlink(req, link, parent, name);
174       else
175         fuse_reply_err(req, ENOSYS);
176     }
177
178     void
179     FuseCallback::rename(fuse_req_t req, fuse_ino_t parent, const char *name,
          fuse_ino_t newparent, const char *newname,
180               unsigned int flags) {
181       if (base)
182         base->rename(req, parent, name, newparent, newname, flags);
183       else
184         fuse_reply_err(req, ENOSYS);
185     }
186
187     void FuseCallback::link(fuse_req_t req, fuse_ino_t ino, fuse_ino_t newparent,
          const char *newname) {
188       if (base)
189         base->link(req, ino, newparent, newname);
190       else
191         fuse_reply_err(req, ENOSYS);
192     }
193
194     void FuseCallback::open(fuse_req_t req, fuse_ino_t ino, struct fuse_file_info
          *fi) {
195       if (base)
196         base->open(req, ino, fi);
197       else
```

```
198       fuse_reply_err(req, ENOSYS);
199   }
200
201   void FuseCallback::read(fuse_req_t req, fuse_ino_t ino, size_t size, off_t
      off, struct fuse_file_info *fi) {
202     if (base)
203       base->read(req, ino, size, off, fi);
204     else
205       fuse_reply_err(req, ENOSYS);
206   }
207
208   void FuseCallback::write(fuse_req_t req, fuse_ino_t ino, const char *buf,
      size_t size, off_t off,
209                struct fuse_file_info *fi) {
210     if (base)
211       base->write(req, ino, buf, size, off, fi);
212     else
213       fuse_reply_err(req, ENOSYS);
214   }
215
216   void FuseCallback::flush(fuse_req_t req, fuse_ino_t ino, struct
      fuse_file_info *fi) {
217     if (base)
218       base->flush(req, ino, fi);
219     else
220       fuse_reply_err(req, ENOSYS);
221   }
222
223   void FuseCallback::release(fuse_req_t req, fuse_ino_t ino, struct
      fuse_file_info *fi) {
224     if (base)
225       base->release(req, ino, fi);
226     else
227       fuse_reply_err(req, ENOSYS);
228   }
229
230   void FuseCallback::fsync(fuse_req_t req, fuse_ino_t ino, int datasync, struct
       fuse_file_info *fi) {
231     if (base)
232       base->fsync(req, ino, datasync, fi);
233     else
234       fuse_reply_err(req, ENOSYS);
235   }
236
237   void FuseCallback::opendir(fuse_req_t req, fuse_ino_t ino, struct
      fuse_file_info *fi) {
238     if (base)
239       base->opendir(req, ino, fi);
240     else
241       fuse_reply_err(req, ENOSYS);
242   }
243
244   void FuseCallback::readdir(fuse_req_t req, fuse_ino_t ino, size_t size, off_t
       off, struct fuse_file_info *fi) {
245     if (base)
246       base->readdir(req, ino, size, off, fi);
247     else
248       fuse_reply_err(req, ENOSYS);
249   }
```

```
250
251   void FuseCallback::releasedir(fuse_req_t req, fuse_ino_t ino, struct
       fuse_file_info *fi) {
252     if (base)
253       base->releasedir(req, ino, fi);
254     else
255       fuse_reply_err(req, ENOSYS);
256   }
257
258   void FuseCallback::fsyncdir(fuse_req_t req, fuse_ino_t ino, int datasync,
       struct fuse_file_info *fi) {
259     if (base)
260       base->fsyncdir(req, ino, datasync, fi);
261     else
262       fuse_reply_err(req, ENOSYS);
263   }
264
265   void FuseCallback::statfs(fuse_req_t req, fuse_ino_t ino) {
266     if (base)
267       base->statfs(req, ino);
268     else
269       fuse_reply_err(req, ENOSYS);
270   }
271
272   void FuseCallback::setxattr(fuse_req_t req, fuse_ino_t ino, const char *name,
       const char *value, size_t size,
273                 int flags) {
274     if (base)
275       base->setxattr(req, ino, name, value, size, flags);
276     else
277       fuse_reply_err(req, ENOSYS);
278   }
279
280   void FuseCallback::getxattr(fuse_req_t req, fuse_ino_t ino, const char *name,
       size_t size) {
281     if (base)
282       base->getxattr(req, ino, name, size);
283     else
284       fuse_reply_err(req, ENOSYS);
285   }
286
287   void FuseCallback::listxattr(fuse_req_t req, fuse_ino_t ino, size_t size) {
288     if (base)
289       base->listxattr(req, ino, size);
290     else
291       fuse_reply_err(req, ENOSYS);
292   }
293
294   void FuseCallback::removexattr(fuse_req_t req, fuse_ino_t ino, const char *
       name) {
295     if (base)
296       base->removexattr(req, ino, name);
297     else
298       fuse_reply_err(req, ENOSYS);
299   }
300
301   void FuseCallback::access(fuse_req_t req, fuse_ino_t ino, int mask) {
302     if (base)
303       base->access(req, ino, mask);
```

```
304       else
305         fuse_reply_err(req, ENOSYS);
306     }
307
308     void
309     FuseCallback::create(fuse_req_t req, fuse_ino_t parent, const char *name,
        mode_t mode, struct fuse_file_info *fi) {
310       if (base)
311         base->create(req, parent, name, mode, fi);
312       else
313         fuse_reply_err(req, ENOSYS);
314     }
315
316     void FuseCallback::getlk(fuse_req_t req, fuse_ino_t ino, struct
        fuse_file_info *fi, struct flock *lock) {
317       if (base)
318         base->getlk(req, ino, fi, lock);
319       else
320         fuse_reply_err(req, ENOSYS);
321     }
322
323     void FuseCallback::setlk(fuse_req_t req, fuse_ino_t ino, struct
        fuse_file_info *fi, struct flock *lock, int sleep) {
324       if (base)
325         base->setlk(req, ino, fi, lock, sleep);
326       else
327         fuse_reply_err(req, ENOSYS);
328     }
329
330     void FuseCallback::bmap(fuse_req_t req, fuse_ino_t ino, size_t blocksize,
        uint64_t idx) {
331       if (base)
332         base->bmap(req, ino, blocksize, idx);
333       else
334         fuse_reply_err(req, ENOSYS);
335     }
336
337     void FuseCallback::ioctl(fuse_req_t req, fuse_ino_t ino, int cmd, void *arg,
        struct fuse_file_info *fi,
338                 unsigned int flags,
339                 const void *in_buf, size_t in_bufsz, size_t out_bufsz) {
340       if (base)
341         base->ioctl(req, ino, cmd, arg, fi, flags, in_buf, in_bufsz, out_bufsz);
342       else
343         fuse_reply_err(req, ENOSYS);
344     }
345
346     void FuseCallback::poll(fuse_req_t req, fuse_ino_t ino, struct fuse_file_info
        *fi, struct fuse_pollhandle *ph) {
347       if (base)
348         base->poll(req, ino, fi, ph);
349       else
350         fuse_reply_err(req, ENOSYS);
351     }
352
353     void FuseCallback::write_buf(fuse_req_t req, fuse_ino_t ino, struct
        fuse_bufvec *bufv, off_t off,
354                  struct fuse_file_info *fi) {
355       if (base)
```

```
356       base->write_buf(req, ino, bufv, off, fi);
357     else
358       fuse_reply_err(req, ENOSYS);
359   }
360
361   void
362   FuseCallback::retrive_reply(fuse_req_t req, void *cookie, fuse_ino_t ino,
      off_t offset, struct fuse_bufvec *bufv) {
363     if (base)
364       base->retrive_reply(req, cookie, ino, offset, bufv);
365     else
366       fuse_reply_err(req, ENOSYS);
367   }
368
369   void FuseCallback::forget_multi(fuse_req_t req, size_t count, struct
      fuse_forget_data *forgets) {
370     if (base)
371       base->forget_multi(req, count, forgets);
372     else
373       fuse_reply_err(req, ENOSYS);
374   }
375
376   void FuseCallback::flock(fuse_req_t req, fuse_ino_t ino, struct
      fuse_file_info *fi, int op) {
377     if (base)
378       base->flock(req, ino, fi, op);
379     else
380       fuse_reply_err(req, ENOSYS);
381   }
382
383   void
384   FuseCallback::fallocate(fuse_req_t req, fuse_ino_t ino, int mode, off_t
      offset, off_t length,
385               struct fuse_file_info *fi) {
386     if (base)
387       base->fallocate(req, ino, mode, offset, length, fi);
388     else
389       fuse_reply_err(req, ENOSYS);
390   }
391
392   void
393   FuseCallback::readdirplus(fuse_req_t req, fuse_ino_t ino, size_t size, off_t
      off, struct fuse_file_info *fi) {
394     if (base)
395       base->readdirplus(req, ino, size, off, fi);
396     else
397       fuse_reply_err(req, ENOSYS);
398   }
399
400
401 }  // namespace wrapper
```

Listing 3.13 – "wrapper/FuseCallback.cpp"

3.3.3 MtfsFuse

MtfsFuse.h

```
/**
 * \file MtfsFuse.h
 * \brief
 * \author David Wittwer
 * \version 0.0.1
 * \copyright GNU Publis License V3
 *
 * This file is part of MTFS.

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    it under the terms of the GNU General Public License as published by
    the Free Software Foundation, either version 3 of the License, or
    (at your option) any later version.

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    but WITHOUT ANY WARRANTY; without even the implied warranty of
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    along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
 */

#ifndef MTFSFUSE_MTFS_FUSE_H
#define MTFSFUSE_MTFS_FUSE_H

#include <string>
#include <vector>
#include <list>
#include <iostream>
#include <cassert>

#include "wrapper/FuseBase.h"

namespace wrapper {
  class MtfsFuse : public FuseBase {

  public:

    ~MtfsFuse() override;

  protected:
    bool runPrepare(int argc, char **argv) override;


    void init(void *userdata, fuse_conn_info *conn) override;

    void destroy(void *userdata) override;

    void lookup(fuse_req_t req, fuse_ino_t parent, const char *name) override;

    void getAttr(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi) override;

    void setattr(fuse_req_t req, fuse_ino_t ino, struct stat *attr, int to_set,
     fuse_file_info *fi) override;

    void mknod(fuse_req_t req, fuse_ino_t parent, const char *name, mode_t mode
    , dev_t rdev) override;

```

```
58      void open(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi) override;
59
60      void release(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi) override;
61
62      void opendir(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi) override;
63
64      void access(fuse_req_t req, fuse_ino_t ino, int mask) override;
65
66      void readdirplus(fuse_req_t req, fuse_ino_t ino, size_t size, off_t off,
        fuse_file_info *fi) override;
67
68      void releasedir(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi)
        override;
69
70      void readdir(fuse_req_t req, fuse_ino_t ino, size_t size, off_t off,
        fuse_file_info *fi) override;
71
72      void mkdir(fuse_req_t req, fuse_ino_t parent, const char *name, mode_t mode
        ) override;
73
74      void
75      write(fuse_req_t req, fuse_ino_t ino, const char *buf, size_t size, off_t
        off, fuse_file_info *fi) override;
76
77      void write_buf(fuse_req_t req, fuse_ino_t ino, fuse_bufvec *bufv, off_t off
        , fuse_file_info *fi) override;
78
79      void read(fuse_req_t req, fuse_ino_t ino, size_t size, off_t off,
        fuse_file_info *fi) override;
80
81      void unlink(fuse_req_t req, fuse_ino_t parent, const char *name) override;
82
83      void rmdir(fuse_req_t req, fuse_ino_t parent, const char *name) override;
84    };
85
86  }  // namespace wrapper
87  #endif
```

Listing 3.14 – "wrapper/MtfsFuse.h"

MtfsFuse.cpp

```
1   /**
2    * \file MtfsFuse.cpp
3    * \brief
4    * \author David Wittwer
5    * \version 0.0.1
6    * \copyright GNU Publis License V3
7    *
8    * This file is part of MTFS.
9
10      MTFS is free software: you can redistribute it and/or modify
11      it under the terms of the GNU General Public License as published by
12      the Free Software Foundation, either version 3 of the License, or
13      (at your option) any later version.
14
15      Foobar is distributed in the hope that it will be useful,
16      but WITHOUT ANY WARRANTY; without even the implied warranty of
17      MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
```

```
18      GNU General Public License for more details.
19
20      You should have received a copy of the GNU General Public License
21      along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
22   */
23
24  #include <string>
25  #include <mtfs/Mtfs.h>
26
27  #include "wrapper/MtfsFuse.h"
28
29
30  namespace wrapper {
31
32
33    MtfsFuse::~MtfsFuse() {
34
35    }
36
37    bool MtfsFuse::runPrepare(int argc, char **argv) {
38      (void) argc, argv;
39      return true;
40    }
41
42    void MtfsFuse::init(void *userdata, fuse_conn_info *conn) {
43      mtfs::Mtfs::getInstance()->init(userdata, conn);
44    }
45
46    void MtfsFuse::destroy(void *userdata) {
47      mtfs::Mtfs::getInstance()->destroy(userdata);
48    }
49
50    void MtfsFuse::lookup(fuse_req_t req, fuse_ino_t parent, const char *name) {
51      mtfs::Mtfs::getInstance()->lookup(req, parent, name);
52    }
53
54    void MtfsFuse::getAttr(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi) {
55      mtfs::Mtfs::getInstance()->getAttr(req, ino, fi);
56    }
57
58    void MtfsFuse::setattr(fuse_req_t req, fuse_ino_t ino, struct stat *attr, int
       to_set, fuse_file_info *fi) {
59      mtfs::Mtfs::getInstance()->setAttr(req, ino, attr, to_set, fi);
60    }
61
62    void MtfsFuse::mknod(fuse_req_t req, fuse_ino_t parent, const char *name,
       mode_t mode, dev_t rdev) {
63      mtfs::Mtfs::getInstance()->mknod(req, parent, name, mode, rdev);
64    }
65
66    void MtfsFuse::mkdir(fuse_req_t req, fuse_ino_t parent, const char *name,
       mode_t mode) {
67      mtfs::Mtfs::getInstance()->mkdir(req, parent, name, mode);
68    }
69
70    void MtfsFuse::unlink(fuse_req_t req, fuse_ino_t parent, const char *name) {
71      mtfs::Mtfs::getInstance()->unlink(req, parent, name);
72    }
73
```

```
74  void MtfsFuse::rmdir(fuse_req_t req, fuse_ino_t parent, const char *name) {
75    mtfs::Mtfs::getInstance()->rmdir(req, parent, name);
76  }
77
78  void MtfsFuse::open(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi) {
79    mtfs::Mtfs::getInstance()->open(req, ino, fi);
80  }
81
82  void MtfsFuse::release(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi) {
83    mtfs::Mtfs::getInstance()->release(req, ino, fi);
84  }
85
86  void MtfsFuse::opendir(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi) {
87    mtfs::Mtfs::getInstance()->opendir(req, ino, fi);
88  }
89
90  void MtfsFuse::access(fuse_req_t req, fuse_ino_t ino, int mask) {
91    mtfs::Mtfs::getInstance()->access(req, ino, mask);
92  }
93
94  void MtfsFuse::readdir(fuse_req_t req, fuse_ino_t ino, size_t size, off_t off
      , fuse_file_info *fi) {
95    mtfs::Mtfs::getInstance()->readdir(req, ino, size, off, fi);
96  }
97
98  void MtfsFuse::readdirplus(fuse_req_t req, fuse_ino_t ino, size_t size, off_t
       off, fuse_file_info *fi) {
99    mtfs::Mtfs::getInstance()->readdirplus(req, ino, size, off, fi);
100 }
101
102 void MtfsFuse::releasedir(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi)
       {
103   mtfs::Mtfs::getInstance()->releasedir(req, ino, fi);
104 }
105
106 void MtfsFuse::write(fuse_req_t req, fuse_ino_t ino, const char *buf, size_t
      size, off_t off, fuse_file_info *fi) {
107   mtfs::Mtfs::getInstance()->write(req, ino, buf, size, off, fi);
108 }
109
110 void MtfsFuse::write_buf(fuse_req_t req, fuse_ino_t ino, fuse_bufvec *bufv,
      off_t off, fuse_file_info *fi) {
111   mtfs::Mtfs::getInstance()->write_buf(req, ino, bufv, off, fi);
112 }
113
114 void MtfsFuse::read(fuse_req_t req, fuse_ino_t ino, size_t size, off_t off,
      fuse_file_info *fi) {
115   mtfs::Mtfs::getInstance()->read(req, ino, size, off, fi);
116 }
117
118 }  // namespace wrapper
```

Listing 3.15 – "wrapper/MtfsFuse.cpp"

3.4 *Core*

3.4.1 structs.h

```
/**
 * \file structs.h
 * \brief
 * \author David Wittwer
 * \version 0.0.1
 * \copyright GNU Publis License V3
 *
 * This file is part of MTFS.

    MTFS is free software: you can redistribute it and/or modify
    it under the terms of the GNU General Public License as published by
    the Free Software Foundation, either version 3 of the License, or
    (at your option) any later version.

    Foobar is distributed in the hope that it will be useful,
    but WITHOUT ANY WARRANTY; without even the implied warranty of
    MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
    GNU General Public License for more details.

    You should have received a copy of the GNU General Public License
    along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
 */

#ifndef TRAVAIL_BACHELOR_STRUCTS_H
#define TRAVAIL_BACHELOR_STRUCTS_H

#include <map>
#include <rapidjson/document.h>

#define IN_MODE "mode"
#define IN_UID "uid"
#define IN_GID "gid"
#define IN_SIZE "size"
#define IN_LINKS "linkCount"
#define IN_ACCESS "atime"
#define IN_BLOCKS "dataBlocks"

#define ID_POOL "poolId"
#define ID_VOLUME "volumeId"
#define ID_ID "id"

#define RU_MIGRATION "migration"

#define PO_POOLS "pools"

#define SB_INODE_CACHE "inodeCacheSize"
#define SB_DIR_CACHE "directoryCacheSize"
#define SB_BLOCK_CACHE "blockCacheSize"
#define SB_BLOCK_SIZE_ST "blockSize"
#define SB_REDUNDANCY "redundancy"

#define BI_REFF "referenceId"
#define BI_ACCESS "lastAccess"

namespace mtfs {
  class Rule;

  enum blockType {
    INODE,
```

```
60      DIR_BLOCK,
61      DATA_BLOCK,
62      SUPERBLOCK
63    };
64
65    typedef struct ruleInfo_st {
66      uid_t uid;
67      gid_t gid;
68      uint64_t lastAccess;
69
70      ruleInfo_st() : ruleInfo_st(0, 0, 0) {}
71
72      ruleInfo_st(uid_t uid, gid_t gid, uint64_t atime) : uid(uid), gid(gid),
      lastAccess(atime) {}
73    } ruleInfo_t;
74
75    typedef struct ident_st {
76      std::uint32_t poolId;
77      std::uint32_t volumeId;
78      std::uint64_t id;
79
80      explicit ident_st(std::uint64_t id = 0, std::uint32_t vid = 0, std::
      uint32_t pid = 0) : id(id),
81                                                volumeId(vid),
82                                                poolId(pid) {}
83
84      ~ident_st() = default;
85
86      ident_st &operator=(const ident_st &id) {
87        this->poolId = id.poolId;
88        this->volumeId = id.volumeId;
89        this->id = id.id;
90
91        return *this;
92      }
93
94      bool operator==(const ident_st &i) const {
95        return (poolId == i.poolId && volumeId == i.volumeId && id == i.id);
96      }
97
98      bool operator!=(const ident_st &i) const {
99        return (poolId != i.poolId || volumeId != i.volumeId || id != i.id);
100     }
101
102     bool operator<(const ident_st &i) const {
103       if (poolId < i.poolId)
104         return true;
105
106       if (volumeId < i.volumeId)
107         return true;
108
109       return id < i.id;
110     }
111
112     void toJson(rapidjson::Value &dest, rapidjson::Document::AllocatorType &
      alloc) const {
113       rapidjson::Value v;
114
115       v.SetUint(this->poolId);
```

```
116       dest.AddMember(rapidjson::StringRef(ID_POOL), v, alloc);
117
118       v.SetUint(this->volumeId);
119       dest.AddMember(rapidjson::StringRef(ID_VOLUME), v, alloc);
120
121       v.SetUint64(this->id);
122       dest.AddMember(rapidjson::StringRef(ID_ID), v, alloc);
123     }
124
125     void fromJson(rapidjson::Value &src) {
126       assert(src.IsObject());
127       assert(src.HasMember(ID_POOL));
128       assert(src.HasMember(ID_VOLUME));
129       assert(src.HasMember(ID_ID));
130
131       this->poolId = src[ID_POOL].GetUint();
132       this->volumeId = src[ID_VOLUME].GetUint();
133       this->id = src[ID_ID].GetUint64();
134     }
135
136     std::string toString() {
137       return "p:" + std::to_string(this->poolId) + " v:" + std::to_string(this
    ->volumeId) + " i:" +
138              std::to_string(this->id);
139     }
140
141   } ident_t;
142
143   typedef struct inode_st {
144     mode_t accesRight{0};
145     uid_t uid{0};
146     gid_t gid{0};
147     uint64_t size{0};
148     uint32_t linkCount{1};
149     std::uint64_t atime;
150     std::vector<std::vector<ident_t>> dataBlocks;
151
152     inode_st() : atime((uint64_t) time(nullptr)) {
153       this->dataBlocks.clear();
154     }
155
156     bool operator==(const inode_st &rhs) const {
157       if (accesRight != rhs.accesRight)
158         return false;
159       if (uid != rhs.uid)
160         return false;
161       if (gid != rhs.gid)
162         return false;
163       if (size != rhs.size)
164         return false;
165       if (linkCount != rhs.linkCount)
166         return false;
167       if (atime != rhs.atime)
168         return false;
169
170       if (dataBlocks.size() != rhs.dataBlocks.size()) {
171 //        std::cout << "size differ " << dataBlocks.size() << " " << rhs.
    dataBlocks.size() << std::endl;
172         return false;
```

```
173       }
174       for (auto lIter = dataBlocks.begin(), rIter = rhs.dataBlocks.begin();
175          lIter != dataBlocks.end(); lIter++, rIter++) {
176         std::vector<ident_t> red = *lIter, rhsRed = *rIter;
177
178         if (red.size() != rhsRed.size())
179           return false;
180         for (auto lb = red.begin(), rb = rhsRed.begin();
181            lb != red.end(); lb++, rb++) {
182           ident_t li = *lb, ri = *rb;
183
184           if (li != ri)
185             return false;
186         }
187       }
188
189       return true;
190     }
191
192     void toJson(rapidjson::Document &dest) const {
193       dest.SetObject();
194
195       rapidjson::Value v;
196       rapidjson::Document::AllocatorType &alloc = dest.GetAllocator();
197
198       v.SetInt(this->accesRight);
199       dest.AddMember(rapidjson::StringRef(IN_MODE), v, alloc);
200
201       v.SetInt(this->uid);
202       dest.AddMember(rapidjson::StringRef(IN_UID), v, alloc);
203
204       v.SetInt(this->gid);
205       dest.AddMember(rapidjson::StringRef(IN_GID), v, alloc);
206
207       v.SetUint64(this->size);
208       dest.AddMember(rapidjson::StringRef(IN_SIZE), v, alloc);
209
210       v.SetUint(this->linkCount);
211       dest.AddMember(rapidjson::StringRef(IN_LINKS), v, alloc);
212
213       v.SetUint64(this->atime);
214       dest.AddMember(rapidjson::StringRef(IN_ACCESS), v, alloc);
215
216       rapidjson::Value a(rapidjson::kArrayType);
217       for (auto &&blocks : dataBlocks) {
218         rapidjson::Value red(rapidjson::kArrayType);
219
220         for (auto &&block : blocks) {
221           rapidjson::Value ident(rapidjson::kObjectType);
222
223           block.toJson(ident, alloc);
224
225           red.PushBack(ident, alloc);
226         }
227
228         a.PushBack(red, alloc);
229       }
230       dest.AddMember(rapidjson::StringRef(IN_BLOCKS), a, alloc);
231     }
```

```
232
233     void fromJson(rapidjson::Document &d) {
234       assert(d.IsObject());
235       assert(d.HasMember(IN_MODE));
236       assert(d.HasMember(IN_UID));
237       assert(d.HasMember(IN_GID));
238       assert(d.HasMember(IN_SIZE));
239       assert(d.HasMember(IN_LINKS));
240       assert(d.HasMember(IN_ACCESS));
241       assert(d.HasMember(IN_BLOCKS));
242
243       this->accesRight = (uint16_t) d[IN_MODE].GetUint();
244       this->uid = (uint16_t) d[IN_UID].GetUint();
245       this->gid = (uint16_t) d[IN_GID].GetUint();
246       this->size = d[IN_SIZE].GetUint64();
247       this->linkCount = (uint8_t) d[IN_LINKS].GetUint();
248       this->atime = d[IN_ACCESS].GetUint64();
249
250       const rapidjson::Value &dataArray = d[IN_BLOCKS];
251       assert(dataArray.IsArray());
252       this->dataBlocks.clear();
253       for (auto &a : dataArray.GetArray()) {
254         std::vector<ident_t> redundancy;
255
256         assert(a.IsArray());
257         for (auto &v : a.GetArray()) {
258           ident_t ident;
259
260           assert(v.IsObject());
261           assert(v.HasMember(ID_POOL));
262           assert(v.HasMember(ID_VOLUME));
263           assert(v.HasMember(ID_ID));
264
265           ident.poolId = (uint16_t) v[ID_POOL].GetUint();
266           ident.volumeId = (uint16_t) v[ID_VOLUME].GetUint();
267           ident.id = v[ID_ID].GetUint64();
268
269           redundancy.push_back(ident);
270         }
271
272         this->dataBlocks.push_back(redundancy);
273       }
274     }
275   } inode_t;
276
277   typedef struct dirBlock_st {
278     std::map<std::string, std::vector<mtfs::ident_t>> entries;
279
280     void fromJson(rapidjson::Document &d) {
281       assert(d.IsObject());
282
283       for (auto &&item: d.GetObject()) {
284         assert(item.value.IsArray());
285
286         std::vector<ident_t> ids;
287
288         for (auto &&ident: item.value.GetArray()) {
289           ident_t i;
290           i.fromJson(ident);
```

```
291             ids.push_back(i);
292           }
293           this->entries.emplace(item.name.GetString(), ids);
294         }
295       }
296
297       void toJson(rapidjson::Document &d) {
298         d.SetObject();
299
300         rapidjson::Document::AllocatorType &allocator = d.GetAllocator();
301
302         for (auto &&item: this->entries) {
303           rapidjson::Value r(rapidjson::kArrayType);
304           for (auto &&ident: item.second) {
305             rapidjson::Value v(rapidjson::kObjectType);
306             ident.toJson(v, allocator);
307             r.PushBack(v, allocator);
308           }
309           d.AddMember(rapidjson::StringRef(item.first.c_str()), r, allocator);
310         }
311       }
312
313     } dirBlock_t;
314
315     typedef struct volume_st {
316       std::string pluginName;
317       Rule *rule;
318       std::map<std::string, std::string> params;
319     } volume_t;
320
321     typedef struct pool_st {
322       int migration;
323       Rule *rule;
324       std::map<uint32_t, volume_t> volumes;
325     } pool_t;
326
327     typedef struct superblock_st {
328       size_t iCacheSz;
329       size_t dCacheSz;
330       size_t bCacheSz;
331       size_t blockSz;
332       size_t redundancy;
333       int migration;
334       std::map<uint32_t, pool_t> pools;
335       std::vector<ident_t> rootInodes;
336     } superblock_t;
337
338     typedef struct blockInfo_st {
339       ident_t id;
340       std::vector<ident_t> referenceId;
341       uint64_t lastAccess{0};
342
343       bool operator==(const blockInfo_st &other) const {
344         if (other.id != this->id)
345           return false;
346
347         if (!(other.referenceId == this->referenceId))
348           return false;
349
```

```
350
351       return (other.lastAccess == this->lastAccess);
352     }
353
354     blockInfo_st() : id(ident_t()) {};
355
356     void toJson(rapidjson::Document &d) {
357       d.SetObject();
358       rapidjson::Document::AllocatorType &allocator = d.GetAllocator();
359
360       rapidjson::Value v;
361
362       rapidjson::Value a(rapidjson::kArrayType);
363       for (auto &&id : this->referenceId) {
364         v.SetObject();
365
366         v.AddMember(rapidjson::StringRef(ID_POOL), rapidjson::Value(id.poolId),
      allocator);
367         v.AddMember(rapidjson::StringRef(ID_VOLUME), rapidjson::Value(id.
     volumeId), allocator);
368         v.AddMember(rapidjson::StringRef(ID_ID), rapidjson::Value(id.id),
     allocator);
369
370         a.PushBack(v, allocator);
371       }
372       d.AddMember(rapidjson::StringRef(BI_REFF), a, allocator);
373
374       v.SetUint64(this->lastAccess);
375       d.AddMember(rapidjson::StringRef(BI_ACCESS), v, allocator);
376     }
377
378     void fromJson(rapidjson::Document &d) {
379       assert(d.IsObject());
380       assert(d.HasMember(BI_REFF));
381       assert(d[BI_REFF].IsArray());
382       assert(d.HasMember(BI_ACCESS));
383
384       for (auto &&id :d[BI_REFF].GetArray()) {
385         assert(id.IsObject());
386         assert(id.HasMember(ID_POOL));
387         assert(id.HasMember(ID_VOLUME));
388         assert(id.HasMember(ID_ID));
389
390         uint32_t poolId = id[ID_POOL].GetUint();
391         uint32_t volumeId = id[ID_VOLUME].GetUint();
392         uint64_t i = id[ID_ID].GetUint64();
393
394         this->referenceId.push_back(ident_st(i, volumeId, poolId));
395       }
396
397       this->lastAccess = d[BI_ACCESS].GetUint64();
398     }
399
400   } blockInfo_t;
401
402
403 }  // namespace mtFS
404
405 #endif //TRAVAIL_BACHELOR_STRUCTS_H
```

Listing 3.16 – "core/structs.h"

3.4.2 Acces.h

```
/**
 * \file Access.h
 * \brief
 * \author David Wittwer
 * \version 0.0.1
 * \copyright GNU Publis License V3
 *
 * This file is part of MTFS.

    MTFS is free software: you can redistribute it and/or modify
    it under the terms of the GNU General Public License as published by
    the Free Software Foundation, either version 3 of the License, or
    (at your option) any later version.

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    but WITHOUT ANY WARRANTY; without even the implied warranty of
    MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
    GNU General Public License for more details.

    You should have received a copy of the GNU General Public License
    along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
 */

#ifndef FILESTORAGE_INODE_ACCES_H
#define FILESTORAGE_INODE_ACCES_H

#include <string>
#include <vector>
#include <list>
#include <iostream>
#include <assert.h>
#include <mtfs/structs.h>

namespace mtfs {
  typedef struct ruleInfo_st ruleInfo_t;

  class Acces {
  public:

    virtual ~Acces() {};

    /**
     * Add a block in a volume
     *
     * @param [in] info ruleInfo_t To choose a pool or volume in which add the
    block
     * @param [out] ids Id for new blocks
     * @param [in] type Type of block (see enum blockType)
     * @param [in] nb Numbre of block to add.
     *
     * @return 0 if success else std linus error code.
     */
```

```
52      virtual int add(const ruleInfo_t &info, std::vector<ident_t> &ids,
        blockType type, size_t nb)=0;
53
54      /**
55       * Dele a block in a volume
56       *
57       * @param [in] id Id of block to delete
58       * @param [in] type Type of block to delete
59       *
60       * @return 0 if success else std linus error code.
61       */
62      virtual int del(const ident_t &id, blockType type)=0;
63
64      /**
65       * Get a block in a volume
66       *
67       * @param [in] id Id of block
68       * @param [out] data Pointer on memory already allocate
69       * @param [in] type Type of block
70       *
71       * @return 0 if success else std linus error code.
72       */
73      virtual int get(const ident_t &id, void *data, blockType type)=0;
74
75      /**
76       * Put a block in a volume
77       *
78       * @param [in] id Id of block
79       * @param [in] data Pointer on memory who contains the data.
80       * @param [in] type Type of block
81       *
82       * @return 0 if success else std linus error code.
83       */
84      virtual int put(const ident_t &id, const void *data, blockType type)=0;
85
86      /**
87       * Get metas block info
88       *
89       * @param [in] id Id of block
90       * @param [out] metas Datas
91       * @param [in] type Type of block
92       *
93       * @return 0 if success else std linus error code.
94       */
95      virtual int getMetas(const ident_t &id, blockInfo_t &metas, blockType type)
        =0;
96
97      /**
98       * Put metas block info
99       *
100      * @param id Id of block
101      * @param metas Datas
102      * @param type Type of block
103      *
104      * @return 0 if success else std linus error code.
105      */
106     virtual int putMetas(const ident_t &id, const blockInfo_t &metas, blockType
        type)=0;
107 };
```

```
108
109 }  // namespace mtfs
110 #endif
```

Listing 3.17 – "core/Acces.h"

3.4.3 Mtfs

Mtfs.h

```
1  /**
2   * \file Mtfs.h
3   * \brief
4   * \author David Wittwer
5   * \version 0.0.1
6   * \copyright GNU Publis License V3
7   *
8   * This file is part of MTFS.
9
10     MTFS is free software: you can redistribute it and/or modify
11     it under the terms of the GNU General Public License as published by
12     the Free Software Foundation, either version 3 of the License, or
13     (at your option) any later version.
14
15     Foobar is distributed in the hope that it will be useful,
16     but WITHOUT ANY WARRANTY; without even the implied warranty of
17     MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
18     GNU General Public License for more details.
19
20     You should have received a copy of the GNU General Public License
21     along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
22  */
23
24 #ifndef FILESTORAGE_MTFS_H
25 #define FILESTORAGE_MTFS_H
26
27 #include <thread>
28
29 #include <mtfs/Rule.h>
30 #include <mtfs/Acces.h>
31 #include <rapidjson/document.h>
32 #include <boost/threadpool.hpp>
33 #include <fuse3/fuse_lowlevel.h>
34 #include "structs.h"
35 #include "Migrator.h"
36 #include <mutex>
37 #include <condition_variable>
38 #include <utils/Semaphore.h>
39
40 namespace mtfs {
41   struct internalInode_st;
42   struct dl_st;
43
44   class Mtfs {
45   public:
46 //     static constexpr const char *SYSTEMS_DIR = "Systems";
47     static constexpr const char *CONFIG_DIR = "Configs";
48
```

```
49      static constexpr const char *INODE_CACHE = "inodeCacheSize";
50      static constexpr const char *DIR_CACHE = "directoryCacheSize";
51      static constexpr const char *BLOCK_CACHE = "blockCacheSize";
52      static constexpr const char *BLOCK_SIZE_ST = "blockSize";
53      static constexpr const char *REDUNDANCY = "redundancy";
54      static constexpr const char *ROOT_INODES = "rootInodes";
55
56
57    private:
58  //    CONFIG
59      static const size_t SIMULT_DL = 2;
60      static const size_t SIMULT_UP = 2;
61      static const int INIT_DL = 2;
62      static constexpr const double ATTR_TIMEOUT = 1.0;
63
64  //    REQUEST STATUS CODES
65      static const int SUCCESS = 0;
66      static const int PENDING = 9999;
67
68      static Mtfs *instance;
69      static boost::threadpool::pool *threadPool;
70      static std::string systemName;
71
72      size_t redundancy;
73      size_t blockSize;
74      int maxEntryPerBlock;
75      internalInode_st *rootIn;
76
77      Acces *inodes;
78      Acces *dirBlocks;
79      Acces *blocks;
80
81      std::thread migratorThr;
82      Migrator::info_st migratorInfo;
83
84    public:
85      static Mtfs *getInstance();
86
87      /**
88       * Validate system config
89       *
90       * @param system JSON config of system
91       *
92       * @return true if validelse false
93       */
94      static bool validate(const rapidjson::Value &system);
95
96      /**
97       * Create the root inode
98       *
99       * @param [out] inode The root inode
100      *
101      * @return true if success
102      */
103     static bool createRootInode(inode_t &inode);
104
105     /**
106      * Start MTFS
107      *
```

```
108      * @param system System config
109      * @param homeDir MTFS home dir
110      * @param sysName System name
111      *
112      * @return true if success
113      */
114     static bool start(rapidjson::Document &system, std::string homeDir, std::
        string sysName);
115
116     /**
117      * Stop MTFS
118      */
119     static void stop();
120
121     /**
122      * Convert struct superblock to JSON document
123      *
124      * @param [in] sb Superblock struct
125      * @param [out] d JSON document
126      */
127     static void structToJson(const superblock_t &sb, rapidjson::Document &d);
128
129     /**
130      * Convert JSON document to struct superblock
131      *
132      * @param [in] d JSON document
133      * @param [out] sb Struct superblock
134      */
135     static void jsonToStruct(rapidjson::Document &d, superblock_t &sb);
136
137     /*            Fuse handlers           */
138
139     /**
140      * Init handler
141      *
142      * @param userdata
143      * @param conn
144      */
145     void init(void *userdata, fuse_conn_info *conn);
146
147     /**
148      * Destroy handler
149      *
150      * @param userdata
151      */
152     void destroy(void *userdata);
153
154     /**
155      * Lookup handler
156      *
157      * @param req
158      * @param parent
159      * @param name
160      */
161     void lookup(fuse_req_t req, fuse_ino_t parent, const std::string &name);
162
163     /**
164      * Getattr handler
165      *
```

```
166         * @param req
167         * @param ino
168         * @param fi
169         */
170        void getAttr(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi);
171
172        /**
173         * Setattr handler
174         *
175         * @param req
176         * @param ino
177         * @param attr
178         * @param toSet
179         * @param fi
180         */
181        void setAttr(fuse_req_t req, fuse_ino_t ino, struct stat *attr, int toSet,
           fuse_file_info *fi);
182
183        /**
184         * Mknod handler
185         *
186         * @param req
187         * @param parent
188         * @param name
189         * @param mode
190         * @param rdev
191         */
192        void mknod(fuse_req_t req, fuse_ino_t parent, const std::string &name,
           mode_t mode, dev_t rdev);
193
194        /**
195         * Mkdir handler
196         *
197         * @param req
198         * @param ino
199         * @param name
200         * @param mode
201         */
202        void mkdir(fuse_req_t req, fuse_ino_t ino, const std::string &name, mode_t
           mode);
203
204        /**
205         * Unlink handler
206         *
207         * @param req
208         * @param parent
209         * @param name
210         */
211        void unlink(fuse_req_t req, fuse_ino_t parent, const std::string &name);
212
213        /**
214         * Rmdir handler
215         *
216         * @param req
217         * @param parent
218         * @param name
219         */
220        void rmdir(fuse_req_t req, fuse_ino_t parent, const std::string &name);
221
```

```
222     /**
223      * Open handler
224      *
225      * @param req
226      * @param ino
227      * @param fi
228      */
229     void open(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi);
230 
231     /**
232      * Read handler
233      *
234      * @param req
235      * @param ino
236      * @param size
237      * @param off
238      * @param fi
239      */
240     void read(fuse_req_t req, fuse_ino_t ino, size_t size, off_t off,
    fuse_file_info *fi);
241 
242     /**
243      * Write handler
244      *
245      * @param req
246      * @param ino
247      * @param buf
248      * @param size
249      * @param off
250      * @param fi
251      */
252     void write(fuse_req_t req, fuse_ino_t ino, const char *buf, size_t size,
    off_t off, fuse_file_info *fi);
253 
254     /**
255      * Release handler
256      *
257      * @param req
258      * @param ino
259      * @param fi
260      */
261     void release(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi);
262 
263     /**
264      * Opendir handler
265      *
266      * @param req
267      * @param ino
268      * @param fi
269      */
270     void opendir(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi);
271 
272     /**
273      * Readdir handler
274      *
275      * @param req
276      * @param ino
277      * @param size
278      * @param off
```

```
279         * @param fi
280         */
281        void readdir(fuse_req_t req, fuse_ino_t ino, size_t size, off_t off,
       fuse_file_info *fi);
282
283        /**
284         * Releasedir handler
285         *
286         * @param req
287         * @param ino
288         * @param fi
289         */
290        void releasedir(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi);
291
292        /**
293         * Access handler
294         *
295         * @param req
296         * @param ino
297         * @param mask
298         */
299        void access(fuse_req_t req, fuse_ino_t ino, int mask);
300
301        /**
302         * Write_buf handler
303         *
304         * @param req
305         * @param ino
306         * @param bufv
307         * @param off
308         * @param fi
309         */
310        void write_buf(fuse_req_t req, fuse_ino_t ino, fuse_bufvec *bufv, off_t off
       , fuse_file_info *fi);
311
312        /**
313         * Readdirplus handler
314         *
315         * @param req
316         * @param ino
317         * @param size
318         * @param off
319         * @param fi
320         */
321        void readdirplus(fuse_req_t req, fuse_ino_t ino, size_t size, off_t off,
       fuse_file_info *fi);
322
323
324      private:
325
326        Mtfs();
327
328
329        inode_t getRootInode();
330
331        bool build(const superblock_t &superblock);
332
333        void readRootInode();
334
```

```
335     void writeRootInode();
336
337     int addEntry(internalInode_st *parentInode, std::string name, std::vector<
    ident_t> &inodeIds);
338
339     int insertInode(const inode_t &inode, std::vector<ident_t> &idents);
340
341     void dlBlocks(const inode_t &inode, dl_st *dlSt, const blockType type,
    const int firstBlockIdx);
342
343     void dlDirBlocks(std::vector<ident_t> &ids, std::queue<dirBlock_t> *q, std
    ::mutex *queueMutex, Semaphore *sem);
344
345     void dlInodes(dl_st *src, dl_st *dst);
346
347     void initMetas(const internalInode_st &parentInode, const std::vector<
    ident_t> &ids, const blockType &type,
348             boost::threadpool::pool *thPool = nullptr);
349
350     void
351     dlInode(std::vector<ident_t> &ids, std::queue<std::pair<std::string,
    inode_t>> *queue, std::mutex *queueMutex,
352         Semaphore *sem,
353         std::string &key);
354
355
356     ////              UTILS             ////
357
358     internalInode_st *getIntInode(fuse_ino_t ino);
359
360     void
361     doReaddir(fuse_req_t req, fuse_ino_t ino, size_t size, off_t off,
    fuse_file_info *fi, const bool &plus = false);
362
363     size_t dirBufAdd(fuse_req_t &req, char *buf, size_t &currentSize, std::
    string name, internalInode_st &inode,
364             const bool &plus);
365
366     void buildParam(const internalInode_st &inode, fuse_entry_param &param);
367
368     void buildStat(const internalInode_st &inode, struct stat &st);
369
370     ruleInfo_t getRuleInfo(const inode_t &inode);
371
372     static internalInode_st *newInode(const mode_t &mode, const fuse_ctx *ctx);
373
374     static uint64_t now();
375
376     int doUnlink(internalInode_st *parent, const std::string name);
377
378     int delEntry(std::vector<ident_t> &ids, dirBlock_t &blk, const std::string
    &name);
379   };
380
381 }  // namespace mtfs
382 #endif
```

Listing 3.18 – "core/Mtfs.h"

Mtfs.cpp

```
/**
 * \file Mtfs.cpp
 * \brief
 * \author David Wittwer
 * \version 0.0.1
 * \copyright GNU Publis License V3
 *
 * This file is part of MTFS.

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 */

#include <mtfs/Mtfs.h>
#include <mtfs/Cache.h>
#include <pluginSystem/PluginManager.h>
#include <fstream>
#include <rapidjson/istreamwrapper.h>
#include <rapidjson/stringbuffer.h>
#include <rapidjson/prettywriter.h>
#include <boost/filesystem.hpp>
#include <utility>
#include <grp.h>
#include <pwd.h>
#include <utils/Logger.h>

#define GROUPS_TO_SEARCH 30
//TODO compute this value in function of entry size
#define ENTRY_PER_BLOCK 20

namespace mtfs {
  using namespace std;
  using namespace rapidjson;
  using namespace boost::threadpool;

  struct internalInode_st {
    inode_t inode;
    vector<ident_t> idents;
  };

  struct dl_st {
    mutex *fifoMu{nullptr};
    Semaphore *sem{nullptr};
    union {
      queue<pair<string, inode_t>> *inodeQueue;
      queue<dirBlock_t> *dirQueue;
      queue<uint8_t *> *blkQueue;
```

```
58      } fifo;
59      bool end{false};
60      mutex *endMu{nullptr};
61      pool *dlThPool{nullptr};
62
63      dl_st() {
64      }
65    };
66
67    struct fd_st {
68      enum bt {
69        DATA,
70        DIR,
71      };
72
73      bool firstCall{true};
74      bt blockT;
75      dl_st blkDl;
76      dl_st inoDl;
77      boost::thread *blkThr{nullptr};
78      boost::thread *inoThr{nullptr};
79
80      fd_st() : blkDl(dl_st()), inoDl(dl_st()) {}
81
82      ~fd_st() {
83        switch (this->blockT) {
84          case DATA:
85            delete blkDl.fifo.blkQueue;
86            break;
87          case DIR:
88            delete blkDl.fifo.dirQueue;
89            break;
90        }
91      }
92    };
93
94
95    Mtfs *Mtfs::instance = nullptr;
96    pool *Mtfs::threadPool = nullptr;
97    string Mtfs::systemName;
98
99    //
      ////////////////////////////////////////////////////////////////////////////////
100   ////                          STATICS                                       ////
101   //
      ////////////////////////////////////////////////////////////////////////////////
102
103   Mtfs *Mtfs::getInstance() {
104     if (instance == nullptr)
105       instance = new Mtfs();
106
107     return instance;
108   }
109
110   bool Mtfs::validate(const Value &system) {
111     if (!system.IsObject())
112       throw invalid_argument("Not a object!");
```

```
113
114     if (!system.HasMember(INODE_CACHE))
115       throw invalid_argument("Inode cache missing!");
116
117     if (!system.HasMember(DIR_CACHE))
118       throw invalid_argument("Directory cache missing!");
119
120     if (!system.HasMember(BLOCK_CACHE))
121       throw invalid_argument("Block cache missing!");
122
123     if (!system.HasMember(BLOCK_SIZE_ST))
124       throw invalid_argument("Block size missing!");
125
126     if (!system.HasMember(REDUNDANCY))
127       throw invalid_argument("Redundancy missing!");
128
129     if (!system.HasMember(Pool::POOLS))
130       throw invalid_argument("Pools missing!");
131     if (!system[Pool::POOLS].IsObject())
132       throw invalid_argument("Pool is not a object!");
133
134     int migration = -1;
135     if (system[Pool::POOLS].MemberCount() <= 0)
136       throw invalid_argument("Number of pool invalid!");
137     else if (system[Pool::POOLS].MemberCount() != 1) {
138       if (!system.HasMember(Rule::MIGRATION))
139         throw invalid_argument("Migration missing!");
140
141       migration = system[Rule::MIGRATION].GetInt();
142     }
143
144     for (auto &m: system[Pool::POOLS].GetObject()) {
145       if (Rule::rulesAreValid(migration, m.value) != Rule::VALID_RULES)
146         throw invalid_argument(string("Rules invalid for pool '") + m.name.
    GetString() + "'");
147
148       if (!Pool::validate(m.value))
149         throw invalid_argument(string("Pool '") + m.name.GetString() + "'
    invalid!");
150     }
151
152     return true;
153   }
154
155   bool Mtfs::createRootInode(inode_t &inode) {
156     inode.accesRight = S_IFDIR | 0775;
157     inode.uid = 0;
158     inode.gid = 1001;
159     inode.size = 0;
160     inode.linkCount = 2;
161     inode.atime = (uint64_t) time(nullptr);
162     inode.dataBlocks.clear();
163
164     return true;
165   }
166
167   bool Mtfs::start(Document &system, std::string homeDir, string sysName) {
168     (void) homeDir;
169     systemName = std::move(sysName);
```

```
170
171     superblock_t superblock;
172     jsonToStruct(system, superblock);
173
174     if (!getInstance()->build(superblock))
175       return false;
176
177     auto nbThread = (unsigned int) (thread::hardware_concurrency() * 1.25);
178     threadPool = new pool(nbThread);
179
180     return true;
181   }
182
183   void Mtfs::stop() {
184     delete threadPool;
185
186     delete instance;
187   }
188
189   void Mtfs::structToJson(const superblock_t &sb, rapidjson::Document &d) {
190     rapidjson::Document::AllocatorType &allocator = d.GetAllocator();
191
192     d.SetObject();
193
194     rapidjson::Value v;
195
196     v.SetUint((unsigned int) sb.iCacheSz);
197     d.AddMember(rapidjson::StringRef(Mtfs::INODE_CACHE), v, allocator);
198
199     v.SetUint((unsigned int) sb.dCacheSz);
200     d.AddMember(rapidjson::StringRef(Mtfs::DIR_CACHE), v, allocator);
201
202     v.SetUint((unsigned int) sb.bCacheSz);
203     d.AddMember(rapidjson::StringRef(Mtfs::BLOCK_CACHE), v, allocator);
204
205     v.SetUint((unsigned int) sb.blockSz);
206     d.AddMember(rapidjson::StringRef(Mtfs::BLOCK_SIZE_ST), v, allocator);
207
208     v.SetUint((unsigned int) sb.redundancy);
209     d.AddMember(rapidjson::StringRef(Mtfs::REDUNDANCY), v, allocator);
210
211     v.SetInt(sb.migration);
212     d.AddMember(rapidjson::StringRef(Rule::MIGRATION), v, allocator);
213
214     rapidjson::Value pools(rapidjson::kObjectType);
215     for (auto &&item: sb.pools) {
216       rapidjson::Value pool(rapidjson::kObjectType);
217
218       Pool::structToJson(item.second, pool, allocator);
219
220       string id = to_string(item.first);
221       Value index(id.c_str(), (SizeType) id.size(), allocator);
222       pools.AddMember(index, pool, allocator);
223     }
224     d.AddMember(rapidjson::StringRef(Pool::POOLS), pools, allocator);
225
226     v.SetArray();
227     for (auto &&id: sb.rootInodes) {
228       Value ident(kObjectType);
```

```
229       id.toJson(ident, allocator);
230       v.PushBack(ident, allocator);
231     }
232     d.AddMember(StringRef(ROOT_INODES), v, allocator);
233   }
234
235   void Mtfs::jsonToStruct(rapidjson::Document &d, superblock_t &sb) {
236     assert(d.HasMember(INODE_CACHE));
237     sb.iCacheSz = d[INODE_CACHE].GetUint();
238
239     assert(d.HasMember(DIR_CACHE));
240     sb.dCacheSz = d[DIR_CACHE].GetUint();
241
242     assert(d.HasMember(BLOCK_CACHE));
243     sb.bCacheSz = d[BLOCK_CACHE].GetUint();
244
245     assert(d.HasMember(BLOCK_SIZE_ST));
246     sb.blockSz = d[BLOCK_SIZE_ST].GetUint();
247
248     assert(d.HasMember(REDUNDANCY));
249     sb.redundancy = d[REDUNDANCY].GetUint();
250
251     assert(d.HasMember(Rule::MIGRATION));
252     sb.migration = d[Rule::MIGRATION].GetInt();
253
254     assert(d.HasMember(Pool::POOLS));
255     for (auto &&item :d[Pool::POOLS].GetObject()) {
256       string sId = item.name.GetString();
257       auto id = (uint32_t) stoul(sId);
258       pool_t pool;
259       memset(&pool, 0, sizeof(pool_t));
260       pool.volumes.clear();
261
262       pool.rule = Rule::buildRule(sb.migration, item.value);
263
264       Pool::jsonToStruct(item.value, pool);
265
266       sb.pools.insert(make_pair(id, pool));
267     }
268
269     assert(d.HasMember(ROOT_INODES) && d[ROOT_INODES].IsArray());
270     for (auto &&ident: d[ROOT_INODES].GetArray()) {
271       ident_t id = ident_t();
272       id.fromJson(ident);
273       sb.rootInodes.push_back(id);
274     }
275   }
276
277   //
     ////////////////////////////////////////////////////////////////////////////////
278   ////                          MEMBERS                                       ////
279   //
     ////////////////////////////////////////////////////////////////////////////////
280
281   //
     ////////////////////////////////////////////////////////////////////////////////
```

```
282   ////                          FUSE fcts                                ////
283   //
       ////////////////////////////////////////////////////////////////////////////////////////
284
285   void Mtfs::init(void *userdata, fuse_conn_info *conn) {
286     (void) userdata, conn;
287
288     getInstance()->readRootInode();
289
290     this->migratorInfo.poolManager = (PoolManager *) this->blocks;
291
292     this->migratorThr = std::thread(Migrator::main, &this->migratorInfo);
293
294 #ifdef DEBUG
295     cerr << "[MTFS]: End init" << endl;
296 #endif
297   }
298
299   void Mtfs::destroy(void *userdata) {
300     (void) userdata;
301
302     unique_lock<mutex> lk(*this->migratorInfo.endMutex);
303     this->migratorInfo.end = true;
304     lk.unlock();
305     this->migratorInfo.condV.notify_all();
306
307     this->migratorThr.join();
308
309     Acces *iptr = this->inodes;
310     Acces *dptr = this->dirBlocks;
311     Acces *bptr = this->blocks;
312
313     if (iptr != dptr && iptr != bptr)
314       delete this->inodes;
315
316     if (dptr != bptr)
317       delete this->dirBlocks;
318     delete this->blocks;
319   }
320
321   void Mtfs::getAttr(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi) {
322     (void) fi;
323
324     internalInode_st *inode = this->getIntInode(ino);
325
326     if (nullptr == inode)
327       return (void) fuse_reply_err(req, ENOENT);
328
329     struct stat st{};
330     this->buildStat(*inode, st);
331
332     fuse_reply_attr(req, &st, this->ATTR_TIMEOUT);
333   }
334
335   void Mtfs::setAttr(fuse_req_t req, fuse_ino_t ino, struct stat *attr, int
       toSet, fuse_file_info *fi) {
336     (void) fi;
337
```

```
338     internalInode_st *inInode = this->getIntInode(ino);
339
340     if (0 != (FUSE_SET_ATTR_MODE & toSet))
341       inInode->inode.accesRight = attr->st_mode;
342
343     if (0 != (FUSE_SET_ATTR_UID & toSet))
344       inInode->inode.uid = attr->st_uid;
345
346     if (0 != (FUSE_SET_ATTR_GID & toSet))
347       inInode->inode.gid = attr->st_gid;
348
349     if (0 != (FUSE_SET_ATTR_SIZE & toSet))
350       inInode->inode.size = (uint64_t) attr->st_size;
351
352     if (0 != (FUSE_SET_ATTR_ATIME & toSet))
353       inInode->inode.atime = (uint64_t) attr->st_atim.tv_sec;
354
355     buildStat(*inInode, *attr);
356     fuse_reply_attr(req, attr, 1.0);
357
358     pool upThPool(this->SIMULT_UP);
359     for (auto &&id: inInode->idents) {
360       upThPool.schedule(bind(&Acces::put, this->inodes, id, &inInode->inode,
    INODE));
361     }
362   }
363
364   void Mtfs::lookup(fuse_req_t req, fuse_ino_t parent, const string &name) {
365     Logger::getInstance()->log("LOOKUP", name, Logger::L_DEBUG);
366
367     internalInode_st *parentInode = this->getIntInode(parent);
368
369 //     dl All blocks
370     dl_st blkDl = dl_st();
371     blkDl.dlThPool = new pool(this->SIMULT_DL);
372     blkDl.sem = new Semaphore();
373     blkDl.fifoMu = new mutex;
374     blkDl.fifo.dirQueue = new queue<dirBlock_t>();
375     blkDl.endMu = new mutex;
376
377     this->dlBlocks(parentInode->inode, &blkDl, blockType::DIR_BLOCK, 0);
378
379     vector<ident_t> inodeIds;
380
381     unique_lock<mutex> endLk(*blkDl.endMu, defer_lock);
382     unique_lock<mutex> fifoLk(*blkDl.fifoMu, defer_lock);
383     lock(endLk, fifoLk);
384     while (!(blkDl.end && blkDl.fifo.dirQueue->empty())) {
385       endLk.unlock();
386       fifoLk.unlock();
387
388       blkDl.sem->wait();
389
390       lock(endLk, fifoLk);
391       if (blkDl.end && blkDl.fifo.dirQueue->empty())
392         break;
393       endLk.unlock();
394
395       dirBlock_t block = blkDl.fifo.dirQueue->front();
```

```
396       blkDl.fifo.dirQueue->pop();
397       fifoLk.unlock();
398
399 //      if entry is find
400       if (block.entries.end() != block.entries.find(name)) {
401         blkDl.dlThPool->clear();
402         inodeIds = block.entries[name];
403
404         lock(endLk, fifoLk);
405         break;
406       }
407
408       lock(endLk, fifoLk);
409     }
410     endLk.unlock();
411     fifoLk.unlock();
412
413
414 //    TODO Doit etre un pointeur car lookup avant open donc inode doit etre en
    memoire.
415     auto *inode = new internalInode_st();
416     inode->idents = inodeIds;
417     int ret;
418
419     if (inodeIds.empty()) {
420       fuse_reply_err(req, ENOENT);
421       return;
422     }
423
424     do {
425       ret = this->inodes->get(inodeIds.back(), &inode->inode, blockType::INODE)
    ;
426       inodeIds.pop_back();
427       if (inodeIds.empty())
428         break;
429     } while (0 != ret);
430
431 //    Send reply to fuse
432     if (0 != ret)
433       fuse_reply_err(req, ret);
434     else {
435       fuse_entry_param param = fuse_entry_param();
436       this->buildParam(*inode, param);
437       fuse_reply_entry(req, &param);
438     }
439
440 //    free all datas;
441     blkDl.dlThPool->wait();
442
443     delete (blkDl.dlThPool);
444     delete (blkDl.sem);
445     delete (blkDl.fifoMu);
446     delete (blkDl.endMu);
447
448     while (!blkDl.fifo.dirQueue->empty())
449       blkDl.fifo.dirQueue->pop();
450
451     delete (blkDl.fifo.dirQueue);
452   }
```

```
453
454   void Mtfs::mknod(fuse_req_t req, fuse_ino_t parent, const string &name,
       mode_t mode, dev_t rdev) {
455     (void) rdev;
456
457     int ret;
458
459     internalInode_st *parentInode = this->getIntInode(parent);
460
461 //    Create and write new inode
462     internalInode_st *inode = this->newInode(mode, fuse_req_ctx(req));
463     vector<ident_t> inodeIdents;
464     if (0 != (ret = this->insertInode(inode->inode, inodeIdents))) {
465       delete inode;
466       fuse_reply_err(req, ret);
467       return;
468     }
469
470     pool mPool(SIMULT_UP);
471     this->initMetas(*parentInode, inodeIdents, blockType::INODE, &mPool);
472
473 //      Add entry in dir
474     if (0 != (ret = this->addEntry(parentInode, name, inodeIdents))) {
475       delete inode;
476       fuse_reply_err(req, ret);
477       return;
478     }
479
480 //      reply to fuse
481     fuse_entry_param param{};
482     memset(&param, 0, sizeof(fuse_entry_param));
483
484     this->buildParam(*inode, param);
485
486     fuse_reply_entry(req, &param);
487   }
488
489   void Mtfs::mkdir(fuse_req_t req, fuse_ino_t ino, const string &name, mode_t
       mode) {
490     int ret;
491     internalInode_st *parentInode = this->getIntInode(ino);
492
493 //    Create and write new inode
494     internalInode_st *inode = this->newInode(mode, fuse_req_ctx(req));
495     inode->inode.accesRight |= S_IFDIR;
496     vector<ident_t> inodeIdents;
497     if (0 != (ret = this->insertInode(inode->inode, inodeIdents))) {
498       delete inode;
499       fuse_reply_err(req, ret);
500       return;
501     }
502
503     pool mPool(SIMULT_UP);
504     this->initMetas(*parentInode, inodeIdents, blockType::INODE, &mPool);
505
506 //      Add entry in dir
507     if (0 != (ret = this->addEntry(parentInode, name, inodeIdents))) {
508       delete inode;
509       fuse_reply_err(req, ret);
```

```
510       return;
511     }
512
513 //      reply to fuse
514     fuse_entry_param param{};
515     memset(&param, 0, sizeof(fuse_entry_param));
516
517     this->buildParam(*inode, param);
518
519     fuse_reply_entry(req, &param);
520   }
521
522   void Mtfs::unlink(fuse_req_t req, fuse_ino_t parent, const string &name) {
523     internalInode_st *parentInode = this->getIntInode(parent);
524
525     int ret;
526     if (SUCCESS != (ret = this->doUnlink(parentInode, name)))
527       fuse_reply_err(req, ret);
528     else
529       fuse_reply_err(req, SUCCESS);
530   }
531
532   void Mtfs::rmdir(fuse_req_t req, fuse_ino_t parent, const string &name) {
533     (void) parent, name;
534
535     fuse_reply_err(req, ENOSYS);
536   }
537
538   void Mtfs::access(fuse_req_t req, fuse_ino_t ino, int mask) {
539
540     const struct fuse_ctx *context = fuse_req_ctx(req);
541
542     if (FUSE_ROOT_ID == ino) {
543       int ret = EACCES;
544       inode_t inode = instance->getRootInode();
545       if (context->uid == inode.uid) {
546         if ((mask << 6 & inode.accesRight) != 0)
547           ret = 0;
548         else {
549           cerr << "[MTFS]: bad user right: " << (inode.accesRight & (mask << 6)
    ) << endl;
550         }
551       } else {
552
553 //        get all user groups;
554         auto bufsize = (size_t) sysconf(_SC_GETPW_R_SIZE_MAX);
555         if (bufsize == -1)
556           bufsize = 16384;
557
558         auto *buf = (char *) malloc(bufsize * sizeof(char));
559         if (nullptr == buf) {
560           fuse_reply_err(req, ENOMEM);
561           free(buf);
562           return;
563         }
564
565         struct passwd pwd{}, *result;
566         int s = getpwuid_r(context->uid, &pwd, buf, bufsize, &result);
567         if (nullptr == result) {
```

```
568             int err;
569             if (0 == s)
570               err = EAGAIN;
571             else
572               err = s;
573             fuse_reply_err(req, err);
574             free(buf);
575             return;
576           }
577 
578           int ngroups = GROUPS_TO_SEARCH;
579           auto *groups = (gid_t *) malloc(ngroups * sizeof(gid_t));
580           if (getgrouplist(pwd.pw_name, pwd.pw_gid, groups, &ngroups) == -1) {
581             cerr << "get group list error. ngoups " << ngroups << endl;
582             free(buf);
583             free(groups);
584           }
585 
586           if (find(groups, groups + ngroups, inode.gid) != groups + ngroups) {
587             if ((mask << 3 & inode.accesRight) != 0)
588               ret = 0;
589           } else {
590             if ((mask & inode.accesRight) != 0)
591               ret = 0;
592           }
593 
594           free(buf);
595           free(groups);
596         }
597 
598         fuse_reply_err(req, ret);
599 
600 
601       } else {
602         fuse_reply_err(req, SUCCESS);
603       }
604     }
605 
606     void Mtfs::open(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi) {
607       (void) ino;
608 //      internalInode_st *inode = getIntInode(ino);
609 
610 //      if (!inode->inode.dataBlocks.empty()) {
611 //        uint8_t *firstBlock = (uint8_t *) malloc(this->blockSize * sizeof(
    uint8_t));
612 //
613 //        this->blocks->get(inode->inode.dataBlocks.front().front(), &firstBlock,
     blockType::DATA_BLOCK);
614 //        fi->fh = (uint64_t) firstBlock;
615 //      } else
616 //        fi->fh = 0;A
617 
618       auto *fd = new fd_st();
619       fd->blockT = fd->DATA;
620       fd->blkDl.dlThPool = new pool(this->SIMULT_DL);
621       fd->blkDl.sem = new Semaphore();
622       fd->blkDl.fifoMu = new mutex();
623       fd->blkDl.endMu = new mutex();
624       fd->blkDl.fifo.blkQueue = new queue<uint8_t *>();
```

```
625     fd->inoDl.dlThPool = new pool(this->SIMULT_UP);
626
627     fi->fh = (uint64_t) fd;
628
629     fuse_reply_open(req, fi);
630   }
631
632   void Mtfs::release(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi) {
633     (void) ino;
634 //    internalInode_st *intIno = this->getIntInode(ino);
635
636     delete (uint8_t *) fi->fh;
637     fi->fh = 0;
638
639     fuse_reply_err(req, SUCCESS);
640   }
641
642   void Mtfs::opendir(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi) {
643
644     internalInode_st *intInode = this->getIntInode(ino);
645
646     auto *fd = new fd_st();
647     fd->blockT = fd->DIR;
648     fd->blkDl.dlThPool = new pool(this->SIMULT_DL);
649     fd->blkDl.sem = new Semaphore();
650     fd->blkDl.fifoMu = new mutex();
651     fd->blkDl.endMu = new mutex();
652     fd->blkDl.fifo.dirQueue = new queue<dirBlock_t>();
653
654     int i = 0;
655     for (auto &&blks: intInode->inode.dataBlocks) {
656
657 //      bind(&Mtfs::dlDirBlocks, this, blks, &blkQueue, &queueMutex, &semaphore
    ));
658       fd->blkDl.dlThPool->schedule(
659           bind(&Mtfs::dlDirBlocks, this, blks, fd->blkDl.fifo.dirQueue, fd->
    blkDl.fifoMu, fd->blkDl.sem));
660
661       if (this->INIT_DL <= i)
662         break;
663     }
664
665     fi->fh = (uint64_t) fd;
666
667     fuse_reply_open(req, fi);
668 //    fuse_reply_err(req, ENOSYS);
669   }
670
671   void Mtfs::readdir(fuse_req_t req, fuse_ino_t ino, size_t size, off_t off,
     fuse_file_info *fi) {
672     this->doReaddir(req, ino, size, off, fi, false);
673   }
674
675   void Mtfs::readdirplus(fuse_req_t req, fuse_ino_t ino, size_t size, off_t off
    , fuse_file_info *fi) {
676     this->doReaddir(req, ino, size, off, fi, true);
677   }
678
679   void Mtfs::releasedir(fuse_req_t req, fuse_ino_t ino, fuse_file_info *fi) {
```

```
680     (void) ino;
681
682     auto *fd = (fd_st *) fi->fh;
683     delete fd;
684     fi->fh = 0;
685
686     fuse_reply_err(req, SUCCESS);
687   }
688
689   void Mtfs::write(fuse_req_t req, fuse_ino_t ino, const char *buf, size_t size
      , off_t off, fuse_file_info *fi) {
690     (void) ino, buf, size, off, fi;
691 //    internalInode_st *inode = this->getIntInode(ino);
692 //
693 //    int startBlock = (int) (off / this->blockSize);
694 //
695 //    fuse_reply_write(req, size);
696     fuse_reply_err(req, ENOSYS);
697   }
698
699   void Mtfs::write_buf(fuse_req_t req, fuse_ino_t ino, fuse_bufvec *bufv, off_t
      off, fuse_file_info *fi) {
700     int ret = 0;
701
702     auto *fd = (fd_st *) fi->fh;
703
704     internalInode_st *inode = this->getIntInode(ino);
705
706     size_t size = bufv->buf[0].size;
707     auto firstBlock = (int) (off / this->blockSize);
708     auto lastBlock = (int) ((off + size - 1) / this->blockSize);
709
710     ruleInfo_t newBlockInfo = ruleInfo_st();
711     newBlockInfo.gid = inode->inode.gid;
712     newBlockInfo.uid = inode->inode.uid;
713     newBlockInfo.lastAccess = this->now();
714
715     size_t rem = size;
716     size_t write = 0;
717
718     pool metasTp(SIMULT_UP);
719
720     vector<uint64_t> toFree;
721
722     for (int blockToWrite = firstBlock; blockToWrite <= lastBlock; ++
      blockToWrite) {
723       auto *block = (uint8_t *) calloc(sizeof(uint8_t), this->blockSize);
724       memset(block, 0, this->blockSize);
725
726       vector<ident_t> blockIdents;
727       if (inode->inode.dataBlocks.empty() || inode->inode.dataBlocks.size() <=
      blockToWrite) {
728         if (SUCCESS !=
729           (ret = this->blocks->add(newBlockInfo, blockIdents, blockType::
      DATA_BLOCK,
730                                    (const int) this->redundancy))) {
731           fuse_reply_err(req, ret);
732           return;
733         }
```

```
734
735         this->initMetas(*inode, blockIdents, blockType::DATA_BLOCK, &metasTp);
736
737         inode->inode.dataBlocks.push_back(blockIdents);
738       } else {
739         blockIdents = inode->inode.dataBlocks[blockToWrite];
740
741         for (auto &&id: blockIdents) {
742           ret = this->blocks->get(id, block, blockType::DATA_BLOCK);
743           if (SUCCESS == ret)
744             break;
745         }
746         if (SUCCESS != ret)
747           return (void) fuse_reply_err(req, ret);
748       }
749
750       size_t startPos = blockToWrite == firstBlock ? off % this->blockSize : 0;
751       size_t endPos = (blockToWrite == lastBlock ? rem % (this->blockSize + 1)
    : this->blockSize) - startPos;
752
753       memcpy(block + startPos, bufv->buf->mem, endPos);
754       write += endPos;
755       rem -= endPos;
756
757       for (auto &&id: blockIdents) {
758         fd->blkDl.dlThPool->schedule(bind(&Acces::put, this->blocks, id, block,
     blockType::DATA_BLOCK));
759       }
760
761       toFree.push_back((uint64_t) block);
762     }
763
764     auto *data = (uint8_t *) malloc(size * sizeof(uint8_t));
765     memcpy(data, bufv->buf[0].mem, bufv->buf[0].size);
766
767     inode->inode.size = off + size;
768
769 //    TODO supprimer les block en trop.
770     vector<ident_t> toDel;
771     if (inode->inode.dataBlocks.size() > lastBlock + 1) {
772       for (auto &dataBlock : inode->inode.dataBlocks) {
773         for (auto &&id: dataBlock) {
774           toDel.push_back(id);
775         }
776       }
777
778       inode->inode.dataBlocks.erase(inode->inode.dataBlocks.begin() + lastBlock
     + 1,
779                     inode->inode.dataBlocks.end());
780     }
781
782     for (auto &&id: inode->idents) {
783       fd->inoDl.dlThPool->schedule(bind(&Acces::put, this->inodes, id, &inode->
    inode, blockType::INODE));
784     }
785
786     fd->blkDl.dlThPool->wait();
787     fd->inoDl.dlThPool->wait();
788
```

```
789     fuse_reply_write(req, write);
790
791     pool delPool(this->redundancy);
792     for (auto &&id: toDel) {
793       delPool.schedule(bind(&Acces::del, this->blocks, id, blockType::
    DATA_BLOCK));
794     }
795
796     for (auto &&ptr: toFree) {
797       free((uint8_t *) ptr);
798     }
799   }
800
801   void Mtfs::read(fuse_req_t req, fuse_ino_t ino, size_t size, off_t off,
     fuse_file_info *fi) {
802     (void) fi;
803     internalInode_st *inode = this->getIntInode(ino);
804
805
806     size = min(size, inode->inode.size);
807     int firstBlock, lastBlock;
808     firstBlock = (int) (off / this->blockSize);
809     lastBlock = (int) ((off + size - 1) / this->blockSize);
810
811     size_t rem = size;
812     size_t read = 0;
813
814     char *buf;
815     buf = new char[size];
816     char *p = buf;
817
818     for (int blockToRead = firstBlock; blockToRead <= lastBlock; blockToRead++)
      {
819       uint8_t block[this->blockSize];
820       if (SUCCESS != this->blocks->get(inode->inode.dataBlocks[blockToRead][0],
     block, blockType::DATA_BLOCK)) {
821         delete[] buf;
822         fuse_reply_err(req, EAGAIN);
823
824         return;
825       }
826
827       size_t startPos = blockToRead == firstBlock ? off % this->blockSize : 0;
828       size_t endPos = blockToRead == lastBlock ? rem % (this->blockSize + 1) :
     this->blockSize;
829
830       size_t toCopy = endPos - startPos;
831       memcpy(p, block + startPos, toCopy);
832
833       rem -= toCopy;
834       read += toCopy;
835       p += toCopy;
836     }
837
838     fuse_reply_buf(req, buf, read);
839     delete[] buf;
840   }
841
```

```
842 //
    ////////////////////////////////////////////////////////////////////////////////
843 ////                          PRIVATE                                       ////
844 //
    ////////////////////////////////////////////////////////////////////////////////
845
846   Mtfs::Mtfs() : redundancy(1), maxEntryPerBlock(ENTRY_PER_BLOCK) {
847     this->inodes = nullptr;
848     this->dirBlocks = nullptr;
849     this->blocks = nullptr;
850     this->rootIn = new internalInode_st();
851   }
852
853   /**
854    * Get the root inode
855    *
856    * @return the inode
857    */
858   inode_t Mtfs::getRootInode() {
859     return this->rootIn->inode;
860 //    return this->rootInode;
861   }
862
863   /**
864    * Build MTFS system
865    *
866    * @param superblock
867    * @return
868    */
869   bool Mtfs::build(const superblock_t &superblock) {
870
871     this->redundancy = superblock.redundancy;
872     this->blockSize = superblock.blockSz;
873     this->rootIn->idents = superblock.rootInodes;
874
875     pluginSystem::PluginManager *manager = pluginSystem::PluginManager::
      getInstance();
876
877     PoolManager *poolManager;
878     poolManager = new PoolManager();
879     for (auto &&poolSt: superblock.pools) {
880       Pool *pool;
881       pool = new Pool(this->blockSize);
882
883       for (auto volSt: poolSt.second.volumes) {
884         volSt.second.params.insert(make_pair("home", MTFS_PLUGIN_HOME));
885         volSt.second.params.insert(make_pair("blockSize", to_string(this->
      blockSize)));
886
887         pluginSystem::Plugin *plugin = manager->getPlugin(volSt.second.
      pluginName);
888
889         if (!plugin->attach(volSt.second.params)) {
890           cerr << "Failed attach plugin " << volSt.second.pluginName << endl;
891         }
892
893         pool->addVolume(volSt.first, new Volume(plugin), volSt.second.rule);
```

```
894         }
895
896         poolManager->addPool(poolSt.first, pool, poolSt.second.rule);
897       }
898
899       this->inodes = poolManager;
900       this->dirBlocks = poolManager;
901       this->blocks = poolManager;
902
903       return true;
904     }
905
906     /**
907      * Read the root inode
908      */
909     void Mtfs::readRootInode() {
910       string filename = string(MTFS_INSTALL_DIR) + "/" + systemName + "/root.json
          ";
911       ifstream file(filename);
912       if (!file.is_open())
913         return;
914
915       IStreamWrapper wrapper(file);
916
917       Document d(kObjectType);
918       d.ParseStream(wrapper);
919
920       assert(d.HasMember(IN_MODE));
921       this->rootIn->inode.accesRight = d[IN_MODE].GetUint();
922
923       assert(d.HasMember(IN_LINKS));
924       this->rootIn->inode.linkCount = (uint8_t) d[IN_LINKS].GetUint();
925
926       assert(d.HasMember(IN_UID));
927       this->rootIn->inode.uid = d[IN_UID].GetUint();
928
929       assert(d.HasMember(IN_GID));
930       this->rootIn->inode.gid = d[IN_GID].GetUint();
931
932       assert(d.HasMember(IN_SIZE));
933       this->rootIn->inode.size = d[IN_SIZE].GetUint64();
934
935       assert(d.HasMember(IN_ACCESS));
936       this->rootIn->inode.atime = d[IN_ACCESS].GetUint64();
937
938       assert(d.HasMember(IN_BLOCKS));
939       for (auto &&item: d[IN_BLOCKS].GetArray()) {
940         vector<ident_t> blocksRedundancy;
941         for (auto &&block: item.GetArray()) {
942           ident_t ident = ident_t();
943
944           assert(block.HasMember(ID_POOL));
945           ident.poolId = block[ID_POOL].GetUint();
946
947           assert(block.HasMember(ID_VOLUME));
948           ident.volumeId = block[ID_VOLUME].GetUint();
949
950           assert(block.HasMember(ID_ID));
951           ident.id = block[ID_ID].GetUint64();
```

```
952
953         blocksRedundancy.push_back(ident);
954       }
955       this->rootIn->inode.dataBlocks.push_back(blocksRedundancy);
956     }
957   }
958
959   /**
960    * Write the root inode
961    */
962   void Mtfs::writeRootInode() {
963     Document d;
964
965     this->rootIn->inode.toJson(d);
966
967     StringBuffer sb;
968     PrettyWriter<StringBuffer> pw(sb);
969     d.Accept(pw);
970
971     string filename = string(MTFS_INSTALL_DIR) + "/" + systemName + "/root.json
      ";
972     ofstream rootFile(filename);
973     rootFile << sb.GetString() << endl;
974     rootFile.close();
975   }
976
977   /**
978    * @brief Add entry in directory.
979    *
980    * This function add a new entry in directory and update parent inode if
      necessary.
981    *
982    * @param parentInode   Directory to add entry
983    * @param name      Name of entry
984    * @param inodeIds    Inodes od entry
985    *
986    * @return          0 if success else errno.
987    */
988   int Mtfs::addEntry(internalInode_st *parentInode, std::string name, vector<
      ident_t> &inodeIds) {
989     int ret = 0;
990
991     dirBlock_t dirBlock = dirBlock_t();
992
993     vector<ident_t> blockIdents;
994
995     pool iPool(parentInode->idents.size());
996     pool mPool(SIMULT_UP);
997
998 //    if directory is empty add one block
999     if (parentInode->inode.dataBlocks.empty()) {
1000       if (0 !=
1001         (ret = this->dirBlocks->add(getRuleInfo(parentInode->inode),
      blockIdents, blockType::DIR_BLOCK,
1002                       this->redundancy))) {
1003         return ret;
1004       }
1005
1006       dirBlock.entries.clear();
```

```
1007
1008        this->initMetas(*parentInode, blockIdents, blockType::DIR_BLOCK, &mPool);
1009
1010        parentInode->inode.atime = this->now();
1011        parentInode->inode.dataBlocks.push_back(blockIdents);
1012        for (auto &&ident: parentInode->idents) {
1013          iPool.schedule(bind(&Acces::put, this->inodes, ident, &parentInode->
    inode, blockType::INODE));
1014        }
1015        if (parentInode == this->rootIn)
1016          this->writeRootInode();
1017
1018      } else {
1019//        else get the first block.
1020        blockIdents = parentInode->inode.dataBlocks.back();
1021
1022        for (const auto &blockIdent : blockIdents) {
1023          if (0 == (ret = this->dirBlocks->get(blockIdent, &dirBlock, blockType::
    DIR_BLOCK)))
1024            break;
1025        }
1026
1027        if (ret != SUCCESS)
1028          return ret;
1029      }
1030
1031
1032//      if block is full, allocate new block.
1033      if (this->maxEntryPerBlock == dirBlock.entries.size()) {
1034        ruleInfo_t info = getRuleInfo(parentInode->inode);
1035        info.lastAccess = this->now();
1036        if (0 != (ret = this->dirBlocks->add(info, blockIdents, blockType::
    DIR_BLOCK, this->redundancy))) {
1037          return ret;
1038        }
1039
1040        this->initMetas(*parentInode, blockIdents, blockType::DIR_BLOCK, &mPool);
1041
1042        dirBlock.entries.clear();
1043
1044        parentInode->inode.atime = this->now();
1045        parentInode->inode.dataBlocks.push_back(blockIdents);
1046        for (auto &&ident: parentInode->idents) {
1047          iPool.schedule(bind(&Acces::put, this->inodes, ident, &parentInode->
    inode, blockType::INODE));
1048        }
1049        if (parentInode == this->rootIn)
1050          this->writeRootInode();
1051      }
1052
1053
1054//      write block
1055      dirBlock.entries.insert(make_pair(name, inodeIds));
1056      pool wpool(blockIdents.size());
1057      for (auto &&ident: blockIdents) {
1058//        TODO try again if block not write.
1059        wpool.schedule(bind(&Acces::put, this->dirBlocks, ident, &dirBlock,
    blockType::DIR_BLOCK));
1060      }
```

```
1061
1062      return 0;
1063    }
1064
1065    /**
1066     * @brief Insert inode in system.
1067     *
1068     * This function get free inode Id and put inode in volumes
1069     *
1070     * @param[in] inode Inode to put
1071     * @param[out] idents Ids to new inode
1072     *
1073     * @return 0 if SUCCESS else @see satic const vars.
1074     */
1075    int Mtfs::insertInode(const inode_t &inode, vector<ident_t> &idents) {
1076      int ret;
1077
1078  //    get new inode idents
1079      if (0 != (ret = this->inodes->add(this->getRuleInfo(inode), idents,
     blockType::INODE, this->redundancy))) {
1080        return ret;
1081      }
1082
1083  //    write inode in volumes
1084      {
1085        pool thPool(idents.size());
1086        for (auto &&ident: idents) {
1087          thPool.schedule(bind(&Acces::put, this->inodes, ident, &inode,
     blockType::INODE));
1088        }
1089      }
1090
1091      return ret;
1092    }
1093
1094    /**
1095     * Download all blocks in inode
1096     *
1097     * @param inode Inode who containe the blocks
1098     * @param dlSt Download struct
1099     * @param type Type of block to dowload DIR_BLOCK | DATA_BLOCK
1100     * @param firstBlockIdx Index of first block to download
1101     */
1102    void Mtfs::dlBlocks(const inode_t &inode, dl_st *dlSt, const blockType type,
     const int firstBlockIdx) {
1103  //    TODO implements
1104
1105      if (firstBlockIdx < inode.dataBlocks.size()) {
1106        for (auto idents = inode.dataBlocks.begin() + firstBlockIdx; idents !=
     inode.dataBlocks.end(); idents++) {
1107          switch (type) {
1108            case DIR_BLOCK:
1109              dlSt->dlThPool->schedule(
1110                  bind(&Mtfs::dlDirBlocks, this, *idents, dlSt->fifo.dirQueue,
     dlSt->fifoMu, dlSt->sem));
1111              break;
1112            case DATA_BLOCK:
1113              break;
1114            default:
```

```
1115 //           TODO Log error
1116              break;
1117            }
1118          }
1119        }
1120
1121        dlSt->dlThPool->wait();
1122
1123        unique_lock<mutex> endLk(*dlSt->endMu);
1124        dlSt->end = true;
1125        endLk.unlock();
1126        dlSt->sem->notify();
1127      }
1128
1129      /**
1130       * @brief download or get a directory block.
1131       *
1132       * This function is create for work in a other thread than worker.
1133       *
1134       * @param[in] ids   Block ids
1135       * @param[out] q  Queue
1136       * @param[in] queueMutex
1137       * @param[in] sem
1138       */
1139      void Mtfs::dlDirBlocks(vector<ident_t> &ids, queue<dirBlock_t> *q, mutex *
          queueMutex, Semaphore *sem) {
1140 //   TODO gerer le cas ou aucun bloc n'a pu etre dl.
1141        int ret = 1;
1142        dirBlock_t db = dirBlock_t();
1143
1144        for (auto &&id: ids) {
1145          ret = this->dirBlocks->get(id, &db, blockType::DIR_BLOCK);
1146          if (SUCCESS == ret)
1147            break;
1148        }
1149
1150        if (SUCCESS == ret) {
1151          unique_lock<mutex> lk(*queueMutex);
1152          q->push(db);
1153          sem->notify();
1154        }
1155      }
1156
1157      /**
1158       * Download all inodes from dir entries.
1159       *
1160       * @param src dl dir entries struct
1161       * @param dst dl inode struct
1162       */
1163      void Mtfs::dlInodes(dl_st *src, dl_st *dst) {
1164        pool inodesPool(this->SIMULT_DL);
1165        unique_lock<mutex> srcEndLk(*src->endMu, defer_lock);
1166        unique_lock<mutex> srcFifoLk(*src->fifoMu, defer_lock);
1167        std::lock(srcEndLk, srcFifoLk);
1168        while (!(src->end && src->fifo.dirQueue->empty())) {
1169          srcEndLk.unlock();
1170          srcFifoLk.unlock();
1171
1172          src->sem->wait();
```

```
1173
1174        std::lock(srcEndLk, srcFifoLk);
1175        if (src->end && src->fifo.dirQueue->empty())
1176          break;
1177        srcEndLk.unlock();
1178
1179        dirBlock_t dirBlock = src->fifo.dirQueue->front();
1180        src->fifo.dirQueue->pop();
1181        srcFifoLk.unlock();
1182
1183        for (auto &&entry: dirBlock.entries) {
1184          inodesPool.schedule(
1185              bind(&Mtfs::dlInode, this, entry.second, dst->fifo.inodeQueue, dst
    ->fifoMu, dst->sem,
1186                   entry.first));
1187        }
1188
1189        std::lock(srcEndLk, srcFifoLk);
1190      }
1191      srcEndLk.unlock();
1192      srcFifoLk.unlock();
1193
1194      inodesPool.wait();
1195
1196      unique_lock<mutex> dstEndLock(*dst->endMu);
1197      dst->end = true;
1198      dstEndLock.unlock();
1199
1200      dst->sem->notify();
1201    }
1202
1203    /**
1204     * Download inodes
1205     *
1206     * @param ids
1207     * @param queue
1208     * @param queueMutex
1209     * @param sem
1210     * @param key
1211     */
1212    void
1213    Mtfs::dlInode(vector<ident_t> &ids, queue<pair<string, inode_t>> *queue,
     mutex *queueMutex, Semaphore *sem,
1214            string &key) {
1215      int ret = 1;
1216      inode_t in = inode_t();
1217
1218      for (auto &&id: ids) {
1219        ret = this->inodes->get(id, &in, blockType::INODE);
1220        if (SUCCESS == ret)
1221          break;
1222      }
1223
1224      if (SUCCESS == ret) {
1225        unique_lock<mutex> lk(*queueMutex);
1226        queue->push(make_pair(key, in));
1227        sem->notify();
1228      }
1229    }
```

```
1230
1231  internalInode_st *Mtfs::getIntInode(fuse_ino_t ino) {
1232    if (FUSE_ROOT_ID == ino)
1233      return this->rootIn;
1234
1235    return (internalInode_st *) ino;
1236  }
1237
1238  void Mtfs::doReaddir(fuse_req_t req, fuse_ino_t ino, size_t size, off_t off,
      fuse_file_info *fi, const bool &plus) {
1239    (void) off;
1240    internalInode_st *inode = this->getIntInode(ino);
1241    fd_st *fd;
1242    fd = (fd_st *) fi->fh;
1243
1244    char *buf, *p;
1245    size_t rem, currSize;
1246
1247    buf = (char *) calloc(size, 1);
1248    if (nullptr == buf)
1249      return (void) fuse_reply_err(req, ENOMEM);
1250
1251    p = buf;
1252    rem = size;
1253    currSize = 0;
1254
1255    if (fd->firstCall) {
1256      fd->firstCall = false;
1257      size_t entrySize = this->dirBufAdd(req, p, currSize, ".", *inode, plus);
1258      p += entrySize;
1259      rem -= entrySize;
1260      currSize += entrySize;
1261
1262//      Dl other blocks and inodes
1263      int idx = this->INIT_DL;
1264      fd->blkThr = new boost::thread(
1265          bind(&Mtfs::dlBlocks, this, inode->inode, &fd->blkDl, blockType::
      DIR_BLOCK, idx));
1266
1267      fd->inoDl.fifoMu = new mutex();
1268      fd->inoDl.endMu = new mutex();
1269      fd->inoDl.sem = new Semaphore();
1270      fd->inoDl.fifo.inodeQueue = new queue<pair<string, inode_t>>();
1271
1272      fd->inoThr = new boost::thread(bind(&Mtfs::dlInodes, this, &fd->blkDl, &
      fd->inoDl));
1273    }
1274
1275    unique_lock<mutex> inoEndLock(*fd->inoDl.endMu, defer_lock);
1276    unique_lock<mutex> inoFifoLock(*fd->inoDl.fifoMu, defer_lock);
1277    lock(inoEndLock, inoFifoLock);
1278    while (!(fd->inoDl.end && fd->inoDl.fifo.inodeQueue->empty())) {
1279      inoEndLock.unlock();
1280      inoFifoLock.unlock();
1281
1282      fd->inoDl.sem->wait();
1283
1284      internalInode_st *intInode;
1285      intInode = new internalInode_st();
```

```
1286 //       shared_ptr<internalInode_st> intInode(new internalInode_st());
1287       lock(inoEndLock, inoFifoLock);
1288       if (fd->inoDl.end && fd->inoDl.fifo.inodeQueue->empty())
1289         break;
1290       inoEndLock.unlock();
1291 
1292       string entryName = fd->inoDl.fifo.inodeQueue->front().first;
1293       intInode->inode = fd->inoDl.fifo.inodeQueue->front().second;
1294       fd->inoDl.fifo.inodeQueue->pop();
1295       inoFifoLock.unlock();
1296 
1297 
1298       size_t entrySize = this->dirBufAdd(req, p, currSize, entryName, *intInode
     , plus);
1299 
1300       if (entrySize > rem) {
1301         lock(inoEndLock, inoFifoLock);
1302         break;
1303       }
1304 
1305 //       p += entrySize;
1306       rem -= entrySize;
1307       currSize += entrySize;
1308 
1309       lock(inoEndLock, inoFifoLock);
1310       break;
1311     }
1312     inoEndLock.unlock();
1313     inoFifoLock.unlock();
1314     fuse_reply_buf(req, buf, size - rem);
1315   }
1316 
1317   size_t Mtfs::dirBufAdd(fuse_req_t &req, char *buf, size_t &currentSize, std::
     string name, internalInode_st &inode,
1318                          const bool &plus) {
1319     size_t entSize = 0;
1320 
1321     if (plus) {
1322       fuse_entry_param *p;
1323       p = new fuse_entry_param();
1324       buildParam(inode, *p);
1325 
1326       entSize += fuse_add_direntry_plus(req, nullptr, 0, name.c_str(), nullptr,
     0);
1327       fuse_add_direntry_plus(req, buf, entSize, name.c_str(), p, currentSize +
     entSize);
1328     } else {
1329       struct stat stbuf{};
1330       memset(&stbuf, 0, sizeof(stbuf));
1331       buildStat(inode, stbuf);
1332 
1333       entSize += fuse_add_direntry(req, nullptr, 0, name.c_str(), nullptr, 0);
1334       fuse_add_direntry(req, buf, entSize, name.c_str(), &stbuf, currentSize +
     entSize);
1335     }
1336     return entSize;
1337   }
1338 
```

```
1339  void Mtfs::buildParam(const internalInode_st &inode, fuse_entry_param &param)
        {
1340    param.ino = (fuse_ino_t) &inode;
1341
1342    this->buildStat(inode, param.attr);
1343
1344    param.generation = 1;
1345    param.attr_timeout = 0.0;
1346    param.entry_timeout = 0.0;
1347  }
1348
1349  void Mtfs::buildStat(const internalInode_st &inode, struct stat &st) {
1350    st.st_dev = 0;
1351    st.st_ino = (__ino_t) &inode;
1352
1353    st.st_mode = inode.inode.accesRight;
1354    st.st_nlink = inode.inode.linkCount;
1355    st.st_uid = inode.inode.uid;
1356    st.st_gid = inode.inode.gid;
1357    st.st_size = inode.inode.size;
1358    time_t time = inode.inode.atime;
1359    st.st_atim.tv_sec = time;
1360    st.st_ctim.tv_sec = time;
1361    st.st_mtim.tv_sec = time;
1362    st.st_blksize = this->blockSize;
1363    st.st_blocks = inode.inode.dataBlocks.size();
1364  }
1365
1366  ruleInfo_t Mtfs::getRuleInfo(const inode_t &inode) {
1367    return {inode.uid, inode.gid, inode.atime};
1368  }
1369
1370  internalInode_st *Mtfs::newInode(const mode_t &mode, const fuse_ctx *ctx) {
1371    internalInode_st *inode;
1372    inode = new internalInode_st();
1373
1374    inode->inode.accesRight = mode;
1375    inode->inode.uid = ctx->uid;
1376    inode->inode.gid = ctx->gid;
1377    if ((mode & S_IFDIR) != 0)
1378      inode->inode.linkCount = 2;
1379
1380    return inode;
1381  }
1382
1383  uint64_t Mtfs::now() {
1384    return (uint64_t) time(nullptr);
1385  }
1386
1387  /**
1388   * Init metas blocs
1389   *
1390   * @param parentInode
1391   * @param ids
1392   * @param type
1393   * @param thPool
1394   */
1395  void Mtfs::initMetas(const internalInode_st &parentInode, const vector<
       ident_t> &ids, const blockType &type,
```

```
1396                boost::threadpool::pool *thPool) {
1397     blockInfo_t metas = blockInfo_t();
1398     metas.lastAccess = (uint64_t) time(nullptr);
1399     metas.referenceId = parentInode.idents;
1400
1401     for (auto &&id :ids) {
1402       metas.id = id;
1403
1404       switch (type) {
1405         case INODE:
1406           if (nullptr != thPool)
1407             thPool->schedule(bind(&Acces::putMetas, this->inodes, id, metas,
     type));
1408           else
1409             this->inodes->putMetas(id, metas, type);
1410           break;
1411         case DIR_BLOCK:
1412           if (nullptr != thPool)
1413             thPool->schedule(bind(&Acces::putMetas, this->dirBlocks, id, metas,
      type));
1414           else
1415             this->dirBlocks->putMetas(id, metas, type);
1416           break;
1417         case DATA_BLOCK:
1418           if (nullptr != thPool)
1419             thPool->schedule(bind(&Acces::putMetas, this->blocks, id, metas,
     type));
1420           else
1421             this->blocks->putMetas(id, metas, type);
1422           break;
1423         default:
1424           break;
1425       }
1426     }
1427   }
1428
1429   int Mtfs::doUnlink(internalInode_st *parent, const std::string name) {
1430
1431     for (auto &&dBlkIds :parent->inode.dataBlocks) {
1432       dirBlock_t dBlk = dirBlock_t();
1433
1434       this->dirBlocks->get(dBlkIds.front(), &dBlk, blockType::DIR_BLOCK);
1435
1436       if (dBlk.entries.end() != dBlk.entries.find(name))
1437         return this->delEntry(dBlkIds, dBlk, name);
1438     }
1439     return ENOENT;
1440   }
1441
1442   int Mtfs::delEntry(std::vector<ident_t> &ids, dirBlock_t &blk, const std::
     string &name) {
1443     vector<ident_t> inodeIds = blk.entries.find(name)->second;
1444
1445     inode_t inode = inode_t();
1446     this->inodes->get(inodeIds.front(), &inode, blockType::INODE);
1447
1448     if (0 < (inode.accesRight & S_IFDIR))
1449       return EISDIR;
1450
```

```
1451      blk.entries.erase(name);
1452      pool upPool(SIMULT_UP);
1453
1454      for (auto &&id :ids) {
1455        upPool.schedule(bind(&Acces::put, this->dirBlocks, id, &blk, blockType::
      DIR_BLOCK));
1456      }
1457
1458      for (auto &&dataBlkIds :inode.dataBlocks) {
1459        for (auto &&blkId :dataBlkIds) {
1460          this->blocks->del(blkId, blockType::DATA_BLOCK);
1461        }
1462      }
1463
1464      for (auto &&inodeId :inodeIds) {
1465        this->inodes->del(inodeId, blockType::INODE);
1466      }
1467
1468      return 0;
1469    }
1470
1471
1472  }  // namespace mtfs
```

Listing 3.19 – "core/Mtfs.cpp"

3.4.4 Pool

Pool.h

```
1  /**
2   * \file Pool.h
3   * \brief
4   * \author David Wittwer
5   * \version 0.0.1
6   * \copyright GNU Publis License V3
7   *
8   * This file is part of MTFS.
9
10     MTFS is free software: you can redistribute it and/or modify
11     it under the terms of the GNU General Public License as published by
12     the Free Software Foundation, either version 3 of the License, or
13     (at your option) any later version.
14
15     Foobar is distributed in the hope that it will be useful,
16     but WITHOUT ANY WARRANTY; without even the implied warranty of
17     MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
18     GNU General Public License for more details.
19
20     You should have received a copy of the GNU General Public License
21     along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
22   */
23
24 #ifndef FILESTORAGE_POOL_H
25 #define FILESTORAGE_POOL_H
26
27 #include <string>
28 #include <vector>
```

```
29 #include <mtfs/structs.h>
30 //#include <mtfs/Volume.h>
31 #include <mtfs/Rule.h>
32
33 namespace mtfs {
34   class Volume;
35
36   class Pool {
37
38   public:
39     static constexpr const char *POOLS = "pools";
40
41 //     STATUS CODE
42     static const int SUCCESS = 0;
43     static const int VOLUME_ID_EXIST = 1;
44     static const int NO_VALID_VOLUME = 2;
45
46
47   public:
48     Pool(const size_t &blkSize);
49
50     virtual ~Pool();
51
52     static bool validate(const rapidjson::Value &pool);
53
54     static void
55     structToJson(const pool_t &pool, rapidjson::Value &dest, rapidjson::
     Document::AllocatorType &allocator);
56
57     static void jsonToStruct(rapidjson::Value &src, pool_t &pool);
58
59     int addVolume(uint32_t volumeId, Volume *volume, Rule *rule);
60
61     int add(const ruleInfo_t &info, std::vector<ident_t> &idents, const
     blockType &type, const int &nb = 1);
62
63     int del(const uint32_t &volumeId, const uint64_t &id, const blockType &type
     );
64
65     int get(const uint32_t &volumeId, const uint64_t &id, void *data, const
     blockType &type);
66
67     int put(const uint32_t &volumeId, const uint64_t &id, const void *data,
     const blockType &type);
68
69     int getMetas(const uint32_t &volumeId, const uint64_t &id, blockInfo_t &
     metas, const blockType &type);
70
71     int putMetas(const uint32_t &volumeId, const uint64_t &id, const
     blockInfo_t &metas, const blockType &type);
72
73     void
74     doMigration(std::map<ident_t, ident_t> &movedBlk, std::vector<ident_t> &
     unsatisfyBlk, const blockType &type);
75
76
77   private:
78     const size_t blockSize;
79
```

```
80      std::map<uint32_t, Volume *> volumes;
81      std::map<uint32_t, Rule *> rules;
82
83
84      int getValidVolumes(const ruleInfo_t &info, std::vector<uint32_t> &
        volumeIds);
85    };
86
87  }  // namespace mtfs
88  #endif
```

Listing 3.20 – "core/Pool.h"

Pool.cpp

```
1   /**
2    * \file Pool.cpp
3    * \brief
4    * \author David Wittwer
5    * \version 0.0.1
6    * \copyright GNU Publis License V3
7    *
8    * This file is part of MTFS.
9
10     MTFS is free software: you can redistribute it and/or modify
11     it under the terms of the GNU General Public License as published by
12     the Free Software Foundation, either version 3 of the License, or
13     (at your option) any later version.
14
15     Foobar is distributed in the hope that it will be useful,
16     but WITHOUT ANY WARRANTY; without even the implied warranty of
17     MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
18     GNU General Public License for more details.
19
20     You should have received a copy of the GNU General Public License
21     along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
22   */
23
24  #include <utils/Logger.h>
25  #include "mtfs/Pool.h"
26
27  using namespace std;
28
29  namespace mtfs {
30    Pool::Pool(const size_t &blkSize) : blockSize(blkSize) {}
31
32    Pool::~Pool() {
33      for (auto &&vol: this->volumes) {
34        delete vol.second;
35      }
36      for (auto &&rule: this->rules) {
37        delete rule.second;
38      }
39    }
40
41    bool Pool::validate(const rapidjson::Value &pool) {
42      if (!pool.HasMember(mtfs::Volume::VOLUMES))
43        throw invalid_argument("Volumes missing!");
44      if (!pool[mtfs::Volume::VOLUMES].IsObject())
```

```
45        throw invalid_argument("Volumes is not a object");
46
47      int migration = -1;
48      if (pool[mtfs::Volume::VOLUMES].MemberCount() <= 0)
49        throw invalid_argument("Number of volumes invalid!");
50      else if (pool[mtfs::Volume::VOLUMES].MemberCount() != 1) {
51        if (!pool.HasMember(Rule::MIGRATION))
52          throw invalid_argument("Migration missing!");
53
54        migration = pool[Rule::MIGRATION].GetInt();
55      }
56
57      for (auto &m: pool[mtfs::Volume::VOLUMES].GetObject()) {
58        if (Rule::rulesAreValid(migration, m.value) != Rule::VALID_RULES)
59          throw invalid_argument(string("Rules invalid for volume '") + m.name.
      GetString() + "'!");
60
61        if (!Volume::validate(m.value))
62          throw invalid_argument(string("Volume '") + m.name.GetString() + "'
      invalid!");
63      }
64
65      return true;
66    }
67
68    void Pool::structToJson(const pool_t &pool, rapidjson::Value &dest, rapidjson
      ::Document::AllocatorType &allocator) {
69      dest.AddMember(rapidjson::StringRef(Rule::MIGRATION), rapidjson::Value(pool
      .migration), allocator);
70
71      pool.rule->toJson(dest, allocator);
72
73      rapidjson::Value volumes(rapidjson::kObjectType);
74      for (auto &&item : pool.volumes) {
75        rapidjson::Value volume(rapidjson::kObjectType);
76
77        Volume::structToJson(item.second, volume, allocator);
78
79        string id = to_string(item.first);
80        rapidjson::Value index(id.c_str(), (rapidjson::SizeType) id.size(),
      allocator);
81        volumes.AddMember(index, volume, allocator);
82      }
83
84      dest.AddMember(rapidjson::StringRef(Volume::VOLUMES), volumes, allocator);
85    }
86
87    void Pool::jsonToStruct(rapidjson::Value &src, pool_t &pool) {
88      assert(src.HasMember(Rule::MIGRATION));
89      pool.migration = src[Rule::MIGRATION].GetInt();
90
91      assert(src.HasMember(Volume::VOLUMES));
92      for (auto &&item :src[Volume::VOLUMES].GetObject()) {
93        uint32_t id = (uint32_t) stoul(item.name.GetString());
94        volume_t volume;
95        memset(&volume, 0, sizeof(volume_t));
96        volume.params.clear();
97
98        volume.rule = Rule::buildRule(pool.migration, item.value);
```

```
99
100       Volume::jsonToStruct(item.value, volume);
101
102       pool.volumes.insert(make_pair(id, volume));
103     }
104
105   }
106
107   int Pool::addVolume(uint32_t volumeId, Volume *volume, Rule *rule) {
108     if (this->volumes.find(volumeId) != this->volumes.end() && this->rules.find
      (volumeId) != this->rules.end())
109       return VOLUME_ID_EXIST;
110
111     this->volumes[volumeId] = volume;
112     this->rules[volumeId] = rule;
113
114     rule->configureStorage(volume);
115
116     return 0;
117   }
118
119   int Pool::add(const ruleInfo_t &info, std::vector<ident_t> &idents, const
      blockType &type, const int &nb) {
120     int ret;
121     vector<uint32_t> volumeIds;
122     if (0 != (ret = this->getValidVolumes(info, volumeIds))) {
123       return ret;
124     }
125
126     if (0 == volumeIds.size())
127       return NO_VALID_VOLUME;
128
129     if (nb <= volumeIds.size()) {
130       for (int i = 0; i < nb; i++) {
131         uint64_t id = 0;
132         const uint32_t vid = volumeIds[i];
133
134         this->volumes[vid]->add(id, type);
135
136         idents.push_back(ident_t(id, vid));
137       }
138     } else {
139       int blkPerPool = (int) (nb / volumeIds.size());
140       int remainder = (int) (nb % volumeIds.size());
141       for (auto &&vid: volumeIds) {
142         vector<uint64_t> tmpIds;
143         int nbToAllocate = blkPerPool;
144
145         if (0 < remainder) {
146           nbToAllocate++;
147           remainder--;
148         }
149
150         this->volumes[vid]->add(tmpIds, nbToAllocate, type);
151
152         for (auto &&tmpId: tmpIds) {
153           idents.push_back(ident_t(tmpId, vid));
154         }
155       }
```

```
156     }
157
158     return ret;
159   }
160
161   int Pool::del(const uint32_t &volumeId, const uint64_t &id, const blockType &
      type) {
162     return this->volumes[volumeId]->del(id, type);
163   }
164
165   int Pool::get(const uint32_t &volumeId, const uint64_t &id, void *data, const
       blockType &type) {
166     return this->volumes[volumeId]->get(id, data, type);
167   }
168
169   int Pool::put(const uint32_t &volumeId, const uint64_t &id, const void *data,
       const blockType &type) {
170     return this->volumes[volumeId]->put(id, data, type);
171   }
172
173   int Pool::getMetas(const uint32_t &volumeId, const uint64_t &id, blockInfo_t
      &metas, const blockType &type) {
174     return this->volumes[volumeId]->getMetas(id, metas, type);
175   }
176
177   int Pool::putMetas(const uint32_t &volumeId, const uint64_t &id, const
      blockInfo_t &metas, const blockType &type) {
178     return this->volumes[volumeId]->putMetas(id, metas, type);
179   }
180
181   int Pool::getValidVolumes(const ruleInfo_t &info, vector<uint32_t> &volumeIds
      ) {
182     for (auto &&item: this->rules) {
183       if (item.second->satisfyRules(info))
184         volumeIds.push_back(item.first);
185     }
186     return 0;
187   }
188
189   void
190   Pool::doMigration(std::map<ident_t, ident_t> &movedBlk, std::vector<ident_t>
      &unsatisfyBlk, const blockType &type) {
191     for (auto &&volume :this->volumes) {
192       Logger::getInstance()->log("Pool.doMigration", "do migration for volume:
      " + to_string(volume.first),
193                                  Logger::L_DEBUG);
194       vector<blockInfo_t> unsatisfy;
195       unsatisfy.clear();
196       volume.second->getUnsatisfy(unsatisfy, type);
197
198       for (auto &&blkInfos :unsatisfy) {
199         ident_t oldIdent(blkInfos.id.id, volume.first);
200         blkInfos.id.volumeId = volume.first;
201
202         ruleInfo_t info = ruleInfo_t();
203         info.lastAccess = blkInfos.lastAccess;
204
205         vector<uint32_t> newVolumes;
206         this->getValidVolumes(info, newVolumes);
```

```
207
208         ident_t newIdent(0, newVolumes.front());
209         this->volumes[newIdent.volumeId]->add(newIdent.id, type);
210
211         if (oldIdent.volumeId == newIdent.volumeId) {
212           continue;
213         }
214
215         void *datas = nullptr;
216         switch (type) {
217           case INODE:
218             datas = new inode_t();
219             break;
220           case DIR_BLOCK:
221             datas = new dirBlock_t();
222             break;
223           case DATA_BLOCK:
224             datas = new uint8_t[this->blockSize];
225             break;
226           default:
227             continue;
228         }
229         this->volumes[oldIdent.volumeId]->get(oldIdent.id, datas, type);
230
231         this->volumes[newIdent.volumeId]->put(newIdent.id, datas, type);
232         this->volumes[newIdent.volumeId]->putMetas(newIdent.id, blkInfos, type)
    ;
233
234         movedBlk.emplace(oldIdent, newIdent);
235
236 //         this->volumes[oldIdent.volumeId]->del(oldIdent.id, type);
237
238         switch (type) {
239           case INODE:
240             delete ((inode_t *) datas);
241             break;
242           case DIR_BLOCK:
243             delete ((dirBlock_t *) datas);
244             break;
245           case DATA_BLOCK:
246             delete[]((uint8_t *) datas);
247             break;
248           default:
249             break;
250         }
251       }
252
253       unsigned long nb = unsatisfy.size();
254
255       if (0 != nb)
256         Logger::getInstance()->log("Pool.doMigration", "Block need to move: " +
     to_string(nb), Logger::L_DEBUG);
257     }
258   }
259
260
261 }  // namespace mtfs
```

Listing 3.21 – "core/Pool.cpp"

3.4.5 PoolManager

PoolManager.h

```
/**
 * \file PoolManager.h
 * \brief
 * \author David Wittwer
 * \version 0.0.1
 * \copyright GNU Publis License V3
 *
 * This file is part of MTFS.

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    along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
 */

#ifndef FILESTORAGE_POOL_MANAGER_H
#define FILESTORAGE_POOL_MANAGER_H

#include <string>
#include <vector>
#include <list>
#include <set>
#include <iostream>
#include <mutex>
#include <assert.h>

#include "mtfs/Acces.h"
#include "mtfs/Pool.h"

namespace mtfs {
  class Pool;

  class Acces;

  class PoolManager : public Acces {

  public:
    static const int SUCCESS = 0;
    static const int POOL_ID_EXIST = 1;
    static const int NO_VALID_POOL = 2;
    static const int IS_LOCKED = 3;

  private:

    std::map<uint32_t, Pool *> pools;
    std::map<uint32_t, Rule *> rules;

    std::mutex inodeMutex;
```

```
57      std::set<ident_t> lockedInodes;
58      std::recursive_mutex inodeTransMutex;
59      std::map<ident_t, ident_t> inodeTranslateMap;
60
61      std::mutex dirMutex;
62      std::set<ident_t> lockedDirBlock;
63      std::recursive_mutex dirTransMutex;
64      std::map<ident_t, ident_t> dirBlockTranslateMap;
65
66      std::mutex blockMutex;
67      std::set<ident_t> lockedBlocks;
68      std::recursive_mutex blockTransMutex;
69      std::map<ident_t, ident_t> blockTranslateMap;
70
71
72    public:
73      virtual ~PoolManager();
74
75      int addPool(uint32_t poolId, Pool *pool, Rule *rule);
76
77      int add(const ruleInfo_t &info, std::vector<ident_t> &ids, const blockType
        type, const size_t nb) override;
78
79      int del(const ident_t &id, const blockType type) override;
80
81      int get(const ident_t &id, void *data, const blockType type) override;
82
83      int put(const ident_t &id, const void *data, const blockType type) override
        ;
84
85      int getMetas(const ident_t &id, blockInfo_t &metas, const blockType type)
        override;
86
87      int putMetas(const ident_t &id, const blockInfo_t &metas, const blockType
        type) override;
88
89      void doMigration(const blockType type);
90
91    private:
92
93      bool isLocked(const ident_t &id, const blockType &type);
94
95      bool lock(const ident_t &id, const blockType &type);
96
97      bool unlock(const ident_t &id, const blockType &type);
98
99      bool hasMoved(const ident_t &id, ident_t &newId, const blockType &type);
100
101     int getValidPools(const ruleInfo_t &info, std::vector<uint32_t> &poolIds);
102
103     void dumpTranslateMap(const int &nb, const blockType &type);
104
105     const int moveBlk(const ident_t &old, const ident_t &cur, const blockType &
        type);
106   };
107
108 }  // namespace mtfs
109 #endif
```

Listing 3.22 – "core/PoolManager.h"

PoolManager.cpp

```
/**
 * \file PoolManager.cpp
 * \brief
 * \author David Wittwer
 * \version 0.0.1
 * \copyright GNU Publis License V3
 *
 * This file is part of MTFS.

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 */

#include <mtfs/PoolManager.h>
#include <utils/Logger.h>

namespace mtfs {
  using namespace std;

  PoolManager::~PoolManager() {
//    dumpTranslateMap(INT_MAX, INODE);
//    dumpTranslateMap(INT_MAX, DIR_BLOCK);
//    dumpTranslateMap(INT_MAX, DATA_BLOCK);
    for (auto &&pool: this->pools) {
      delete pool.second;
    }

    for (auto &&rule: this->rules) {
      delete rule.second;
    }
  }

  int PoolManager::addPool(uint32_t poolId, Pool *pool, Rule *rule) {
    if (pools.find(poolId) != pools.end())
      return POOL_ID_EXIST;

    pools[poolId] = pool;
    rules[poolId] = rule;

    return SUCCESS;
  }

```

```
53  int PoolManager::add(const ruleInfo_t &info, std::vector<ident_t> &ids, const
      blockType type,
54              const size_t nb) {
55    int ret;
56    vector<uint32_t> poolIds;
57    if (0 != (ret = this->getValidPools(info, poolIds))) {
58      return ret;
59    }
60    vector<ident_t> tmpIdent;
61
62    if (nb <= poolIds.size()) {
63      for (auto &&id: poolIds) {
64        tmpIdent.clear();
65
66        this->pools[id]->add(info, tmpIdent, type);
67
68        for (auto &&ident: tmpIdent) {
69          ident.poolId = id;
70          ids.push_back(ident);
71        }
72      }
73    } else {
74      int blkPerPool = (int) (nb / poolIds.size());
75      int remainder = (int) (nb % poolIds.size());
76      for (auto &&id: poolIds) {
77        tmpIdent.clear();
78
79        int nbToAlloc = blkPerPool;
80        if (0 < remainder) {
81          nbToAlloc++;
82          remainder--;
83        }
84
85        this->pools[id]->add(info, tmpIdent, type, nbToAlloc);
86
87        for (auto &&ident: tmpIdent) {
88          ident.poolId = id;
89          ids.push_back(ident);
90        }
91      }
92    }
93
94    return ret;
95  }
96
97  int PoolManager::del(const ident_t &id, const blockType type) {
98    int ret = IS_LOCKED;
99
100   ident_t newId = id;
101   this->hasMoved(id, newId, type);
102
103   if (!this->isLocked(newId, type))
104     ret = this->pools[newId.poolId]->del(newId.volumeId, newId.id, type);
105
106   return ret;
107 }
108
109 int PoolManager::get(const ident_t &id, void *data, const blockType type) {
110   int ret = IS_LOCKED;
```

```
111
112     ident_t newId = id;
113     this->hasMoved(id, newId, type);
114
115     if (!this->isLocked(newId, type)) {
116       string message = "get ";
117
118       switch (type) {
119         case INODE:
120           message += "inode ";
121           break;
122         case DIR_BLOCK:
123           message += "dir block ";
124           break;
125         case DATA_BLOCK:
126           message += "dat block ";
127           break;
128         case SUPERBLOCK:
129           message += "superblock ";
130           break;
131       }
132
133       message += newId.toString();
134
135       Logger::getInstance()->log("POOL_MANAGER", message, Logger::L_DEBUG);
136       ret = this->pools[newId.poolId]->get(newId.volumeId, newId.id, data, type
    );
137     }
138
139     return ret;
140   }
141
142   int PoolManager::put(const ident_t &id, const void *data, const blockType
     type) {
143     int ret = IS_LOCKED;
144
145     ident_t newId = id;
146     this->hasMoved(id, newId, type);
147
148     if (this->pools.end() == this->pools.find(newId.poolId))
149       throw out_of_range("Invalid pool id " + newId.poolId);
150
151     if (this->lock(newId, type)) {
152       ret = this->pools[newId.poolId]->put(newId.volumeId, newId.id, data, type
    );
153       this->unlock(newId, type);
154     }
155
156     return ret;
157   }
158
159   int PoolManager::getMetas(const ident_t &id, blockInfo_t &metas, const
     blockType type) {
160     int ret = IS_LOCKED;
161
162     ident_t newId = id;
163     this->hasMoved(id, newId, type);
164
165     if (!this->isLocked(newId, type))
```

```
166       ret = this->pools[newId.poolId]->getMetas(newId.volumeId, newId.id, metas
    , type);
167
168     return ret;
169   }
170
171   int PoolManager::putMetas(const ident_t &id, const blockInfo_t &metas, const
    blockType type) {
172     int ret = IS_LOCKED;
173
174     ident_t newId = id;
175     this->hasMoved(id, newId, type);
176
177     if (this->pools.end() == this->pools.find(newId.poolId))
178       throw out_of_range("Invalid pool id " + newId.poolId);
179
180     if (this->lock(newId, type)) {
181       ret = this->pools[newId.poolId]->putMetas(newId.volumeId, newId.id, metas
    , type);
182       this->unlock(newId, type);
183     }
184
185     return ret;
186   }
187
188   void PoolManager::doMigration(const blockType type) {
189     vector<ident_t> unsatisfyBlk;
190
191 //     this->dumpTranslateMap(10, type);
192
193     for (auto &&pool: this->pools) {
194       map<ident_t, ident_t> tmpMovedBlk;
195       pool.second->doMigration(tmpMovedBlk, unsatisfyBlk, type);
196       for (auto &&item :tmpMovedBlk) {
197         ident_t key = item.first;
198         ident_t val = item.second;
199
200         key.poolId = pool.first;
201         val.poolId = pool.first;
202         recursive_mutex *mu = nullptr;
203         map<ident_t, ident_t> *map = nullptr;
204         switch (type) {
205           case INODE:
206             mu = &this->inodeTransMutex;
207             map = &this->inodeTranslateMap;
208             break;
209           case DIR_BLOCK:
210             mu = &this->dirTransMutex;
211             map = &this->dirBlockTranslateMap;
212             break;
213           case DATA_BLOCK:
214             mu = &this->blockTransMutex;
215             map = &this->blockTranslateMap;
216             break;
217           case SUPERBLOCK:
218             continue;
219             break;
220         }
221         unique_lock<recursive_mutex> lk(*mu);
```

```
222         map->emplace(key, val);
223       }
224
225       Logger::getInstance()->log("Poolmanager", "endMig", Logger::level::
    L_DEBUG);
226     }
227   }
228
229   bool PoolManager::isLocked(const ident_t &id, const blockType &type) {
230     mutex *mu = nullptr;
231     set<ident_t> *lSet = nullptr;
232
233     switch (type) {
234       case INODE:
235         mu = &this->inodeMutex;
236         lSet = &this->lockedInodes;
237         break;
238       case DIR_BLOCK:
239         mu = &this->dirMutex;
240         lSet = &this->lockedDirBlock;
241         break;
242       case DATA_BLOCK:
243         mu = &this->blockMutex;
244         lSet = &this->lockedBlocks;
245         break;
246     }
247
248     if (nullptr == mu || nullptr == lSet)
249       return false;
250
251     unique_lock<mutex> lk(*mu);
252     return lSet->find(id) != lSet->end();
253   }
254
255   bool PoolManager::lock(const ident_t &id, const blockType &type) {
256     mutex *mu = nullptr;
257     set<ident_t> *lSet = nullptr;
258
259     switch (type) {
260       case INODE:
261         mu = &this->inodeMutex;
262         lSet = &this->lockedInodes;
263         break;
264       case DIR_BLOCK:
265         mu = &this->dirMutex;
266         lSet = &this->lockedDirBlock;
267         break;
268       case DATA_BLOCK:
269         mu = &this->blockMutex;
270         lSet = &this->lockedBlocks;
271         break;
272       default:
273 //        TODO log error
274         return false;
275         break;
276     }
277
278     unique_lock<mutex> lk(*mu);
279     if (lSet->find(id) != lSet->end())
```

```
280       return false;
281
282     lSet->insert(id);
283
284     return true;
285   }
286
287   bool PoolManager::unlock(const ident_t &id, const blockType &type) {
288     mutex *mu = nullptr;
289     set<ident_t> *lSet = nullptr;
290
291     switch (type) {
292       case INODE:
293         mu = &this->inodeMutex;
294         lSet = &this->lockedInodes;
295         break;
296       case DIR_BLOCK:
297         mu = &this->dirMutex;
298         lSet = &this->lockedDirBlock;
299         break;
300       case DATA_BLOCK:
301         mu = &this->blockMutex;
302         lSet = &this->lockedBlocks;
303         break;
304       default:
305 //        TODO log error
306         return false;
307         break;
308     }
309
310     unique_lock<mutex> lk(*mu);
311     if (lSet->find(id) == lSet->end())
312       return false;
313
314     lSet->erase(id);
315
316     return true;
317   }
318
319   bool PoolManager::hasMoved(const ident_t &id, ident_t &newId, const blockType
       &type) {
320     recursive_mutex *mu = nullptr;
321     map<ident_t, ident_t> *transMap = nullptr;
322
323     switch (type) {
324       case INODE:
325         mu = &this->inodeTransMutex;
326         transMap = &this->inodeTranslateMap;
327         break;
328       case DIR_BLOCK:
329         mu = &this->dirTransMutex;
330         transMap = &this->dirBlockTranslateMap;
331         break;
332       case DATA_BLOCK:
333         mu = &this->blockTransMutex;
334         transMap = &this->blockTranslateMap;
335         break;
336       default:
337         return false;
```

```
338     }
339
340     assert(mu != nullptr);
341     assert(transMap != nullptr);
342
343     unique_lock<recursive_mutex> lk(*mu);
344     if (transMap->find(id) != transMap->end()) {
345       newId = (*transMap)[id];
346       return true;
347     }
348
349     return false;
350   }
351
352   int PoolManager::getValidPools(const ruleInfo_t &info, std::vector<uint32_t>
       &poolIds) {
353     for (auto &&item: this->rules) {
354       if (item.second->satisfyRules(info))
355         poolIds.push_back(item.first);
356     }
357
358     return SUCCESS;
359   }
360
361   void PoolManager::dumpTranslateMap(const int &nb, const blockType &type) {
362
363     recursive_mutex *mu;
364     map<ident_t, ident_t> *tm;
365     switch (type) {
366       case INODE:
367         mu = &this->inodeTransMutex;
368         tm = &this->inodeTranslateMap;
369         break;
370       case DIR_BLOCK:
371         mu = &this->dirTransMutex;
372         tm = &this->dirBlockTranslateMap;
373         break;
374       case DATA_BLOCK:
375         mu = &this->blockTransMutex;
376         tm = &this->blockTranslateMap;
377         break;
378       default:
379         return;
380     }
381
382     unique_lock<recursive_mutex> lk(*mu);
383     int i = 0;
384     for (auto &&item :*tm) {
385       if (nb == i)
386         break;
387       if (SUCCESS == this->moveBlk(item.first, item.second, type)) {
388         tm->erase(item.first);
389       }
390       i++;
391     }
392   }
393
394   const int PoolManager::moveBlk(const ident_t &old, const ident_t &cur, const
       blockType &type) {
```

```
395     blockInfo_t metas{};
396     this->pools[cur.poolId]->getMetas(cur.volumeId, cur.id, metas, type);
397     dirBlock_t dirBlock{};
398 
399     switch (type) {
400       case INODE:
401         this->get(metas.referenceId.front(), &dirBlock, DIR_BLOCK);
402         for (auto &&item :dirBlock.entries) {
403           for (auto &i : item.second) {
404             if (old == i)
405               i = cur;
406           }
407         }
408         for (auto &&ref :metas.referenceId) {
409           this->put(ref, &dirBlock, DIR_BLOCK);
410         }
411         break;
412       case DIR_BLOCK:
413       case DATA_BLOCK:
414         inode_t inode{};
415         this->get(metas.referenceId.front(), &inode, INODE);
416 
417         for (auto &&blks :inode.dataBlocks) {
418           for (auto &blk :blks) {
419             if (old == blk)
420               blk = cur;
421           }
422         }
423         for (auto &&ref :metas.referenceId) {
424           this->put(ref, &inode, INODE);
425         }
426         break;
427     }
428 
429     return SUCCESS;
430   }
431 
432 }  // namespace mtfs
```

Listing 3.23 – "core/PoolManager.cpp"

3.4.6 Rule

Rule.h

```
1  /**
2   * \file Rule.h
3   * \brief
4   * \author David Wittwer
5   * \version 0.0.1
6   * \copyright GNU Publis License V3
7   *
8   * This file is part of MTFS.
9   *
10    MTFS is free software: you can redistribute it and/or modify
11    it under the terms of the GNU General Public License as published by
12    the Free Software Foundation, either version 3 of the License, or
13    (at your option) any later version.
```

```
14
15      Foobar is distributed in the hope that it will be useful,
16      but WITHOUT ANY WARRANTY; without even the implied warranty of
17      MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
18      GNU General Public License for more details.
19
20      You should have received a copy of the GNU General Public License
21      along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
22  */
23
24 #ifndef FILESTORAGE_RULE_H
25 #define FILESTORAGE_RULE_H
26
27 #include <string>
28 #include <vector>
29 #include <list>
30 #include <iostream>
31 #include <assert.h>
32 #include <rapidjson/schema.h>
33 #include <mtfs/structs.h>
34 #include <mtfs/Volume.h>
35
36 /**
37  *
38  */
39 namespace mtfs {
40   class Pool;
41
42   class Volume;
43
44   /**
45    * @interface
46    */
47   class Rule {
48   public:
49     static constexpr const char *MIGRATION = "migration";     ///< Migration
      name in the config file
50
51     static const int NO_MIGRATION = -1;     ///< No migration value
52     static const int TIME_MIGRATION = 0;     ///< Time migration value
53     static const int RIGHT_MIGRATION = 1;     ///< User right migration
54
55     static const int SUCCESS = 0;     ///< Success code.
56     static const int VALID_RULES = 0;     ///< Valid rule code.
57     static const int INVALID_RULES = -1;     ///< Invalid rule code.
58     static const int UNKNOW_MIGRATION = -2;     ///< Unknow migration code.
59   public:
60
61     /**
62      * @brief Copy JSON config.
63      *
64      * @param migration   Migration type.
65      * @param source    JSON source config.
66      * @param destination   JSON destination config.
67      * @param allocator   Allocator for destination.
68      *
69      * @return SUCCESS if no error or corresponding code.
70      */
```

```
71      static int copyConfig(int migration, rapidjson::Document &source, rapidjson
        ::Value &destination,
72                  rapidjson::Document::AllocatorType &allocator);
73
74      /**
75       * @brief Check if rule config is valid.
76       *
77       * @param migration Migration type.
78       * @param value Json config.
79       * @return VALID_RULES or INVALID_RULES
80       */
81      static int rulesAreValid(int migration, const rapidjson::Value &value);
82
83      /**
84       * @brief Build a Rule object.
85       *
86       * @param migration Migration type.
87       * @param value Json Config.
88       *
89       * @return Pointer on new Rule or nullptr if fail.
90       */
91      static Rule *buildRule(int migration, const rapidjson::Value &value);
92
93      /**
94       * Dump object to Json.
95       *
96       * @param json
97       * @param allocator
98       * @return
99       */
100     virtual bool toJson(rapidjson::Value &json, rapidjson::Document::
        AllocatorType &allocator)=0;
101
102     /**
103      * @brief Check if the block or inode satisfy rules.
104      * @param info Info of Block/Inode
105      *
106      * @return true or false.
107      */
108     virtual bool satisfyRules(mtfs::ruleInfo_t info)=0;
109
110     /**
111      * Configure volume storage
112      * @param volume
113      * @return
114      */
115     virtual int configureStorage(Volume *volume);
116
117     /**
118      * Configure pool storage
119      * @param volume
120      * @return
121      */
122     virtual int configureStorage(Pool *pool);
123   };
124
125 }  // namespace mtfs
126 #endif
```

Listing 3.24 – "core/Rule.h"

Rule.cpp

```
/**
 * \file Rule.cpp
 * \brief
 * \author David Wittwer
 * \version 0.0.1
 * \copyright GNU Publis License V3
 *
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    along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
 */

#include <mtfs/TimeRule.h>
#include <mtfs/UserRightRule.h>
#include <pwd.h>

namespace mtfs {

  int Rule::copyConfig(int migration, rapidjson::Document &source, rapidjson::
    Value &destination,
              rapidjson::Document::AllocatorType &allocator) {
    switch (migration) {
      case TIME_MIGRATION:
        return TimeRule::copyConfig(source, destination, allocator);
      case RIGHT_MIGRATION:
        return UserRightRule::copyConfig(source, destination, allocator);
      default:
        return UNKNOW_MIGRATION;
    }
  }

  int Rule::rulesAreValid(int migration, const rapidjson::Value &value) {
    switch (migration) {
      case NO_MIGRATION:
        return SUCCESS;
      case TIME_MIGRATION:
        return TimeRule::rulesAreValid(value);
      case RIGHT_MIGRATION:
        return UserRightRule::rulesAreValid(value);
      default:
        return UNKNOW_MIGRATION;
    }
```

```
53   }
54
55   Rule *Rule::buildRule(int migration, const rapidjson::Value &value) {
56     Rule *rule = nullptr;
57     if (migration == NO_MIGRATION)
58       rule = nullptr;
59     else if (migration == TIME_MIGRATION) {
60       uint64_t ll = 0, hl = 0;
61
62       if (value.HasMember(TimeRule::TIME_LOW_LIMIT))
63         ll = value[TimeRule::TIME_LOW_LIMIT].GetUint64();
64
65       if (value.HasMember(TimeRule::TIME_HIGH_LIMIT))
66         hl = value[TimeRule::TIME_HIGH_LIMIT].GetUint64();
67
68       rule = new TimeRule(ll, hl);
69     } else if (migration == RIGHT_MIGRATION) {
70       UserRightRule *uRule = new UserRightRule();
71
72       if (value.HasMember(UserRightRule::ALLOW_USER))
73         for (auto &ua: value[UserRightRule::ALLOW_USER].GetArray())
74           uRule->addAllowUid(getpwnam(ua.GetString())->pw_uid);
75
76       if (value.HasMember(UserRightRule::DENY_USER))
77         for (auto &ud: value[UserRightRule::DENY_USER].GetArray())
78           uRule->addDenyUid(getpwnam(ud.GetString())->pw_uid);
79
80       if (value.HasMember(UserRightRule::ALLOW_GROUP))
81         for (auto &ga: value[UserRightRule::ALLOW_GROUP].GetArray())
82           uRule->addAllowGid(getpwnam(ga.GetString())->pw_gid);
83
84       if (value.HasMember(UserRightRule::DENY_GROUP))
85         for (auto &ga: value[UserRightRule::DENY_GROUP].GetArray())
86           uRule->addDenyGid(getpwnam(ga.GetString())->pw_gid);
87
88       rule = uRule;
89     }
90     return rule;
91   }
92
93   int Rule::configureStorage(Volume *volume) {
94     volume->setIsTimeVolume(false);
95
96     return ENOSYS;
97   }
98
99   int Rule::configureStorage(Pool *pool) {
100    (void) pool;
101
102    return ENOSYS;
103  }
104
105 }
```

Listing 3.25 – "core/Rule.cpp"

3.4.7 TimeRule

TimeRule.h

```
/**
 * \file TimeRule.h
 * \brief
 * \author David Wittwer
 * \version 0.0.1
 * \copyright GNU Publis License V3
 *
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 */

#ifndef FILESTORAGE_TIME_RULE_H
#define FILESTORAGE_TIME_RULE_H

#include <string>
#include <vector>
#include <list>
#include <iostream>
#include <assert.h>

#include <mtfs/Rule.h>

namespace mtfs {
  class TimeRule : public Rule {
  public:
    static constexpr const char *TIME_LOW_LIMIT = "lowLimit";
    static constexpr const char *TIME_HIGH_LIMIT = "highLimit";

  private:
    uint64_t lowerLimit;
    uint64_t higerLimit;

  public:
    static int copyConfig(rapidjson::Document &source, rapidjson::Value &
    destination,
                rapidjson::Document::AllocatorType &allocator);

    static int rulesAreValid(const rapidjson::Value &value);

    TimeRule(uint64_t lowerLimit, uint64_t higerLimit);

    bool satisfyRules(ruleInfo_st info) override;

```

```
55      bool toJson(rapidjson::Value &json, rapidjson::Document::AllocatorType &
        allocator) override;
56
57      int configureStorage(Volume *volume) override;
58
59      int configureStorage(Pool *pool) override;
60
61    private:
62      uint64_t now();
63    };
64
65  }  // namespace mtfs
66  #endif
```

Listing 3.26 – "core/TimeRule.h"

TimeRule.cpp

```
1   /**
2    * \file TimeRule.cpp
3    * \brief
4    * \author David Wittwer
5    * \version 0.0.1
6    * \copyright GNU Publis License V3
7    *
8    * This file is part of MTFS.
9
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13     (at your option) any later version.
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18     GNU General Public License for more details.
19
20     You should have received a copy of the GNU General Public License
21     along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
22   */
23
24  #include "mtfs/TimeRule.h"
25
26  namespace mtfs {
27    TimeRule::TimeRule(uint64_t lowerLimit, uint64_t higerLimit) : lowerLimit(
       lowerLimit),
28                                                    higerLimit(higerLimit) {}
29
30    bool TimeRule::satisfyRules(ruleInfo_st info) {
31      uint64_t now = this->now();
32      uint64_t delay = now - info.lastAccess;
33
34      if (0 == this->lowerLimit && 0 == this->higerLimit)
35        return true;
36      else if (0 == this->lowerLimit)
37        return delay <= this->higerLimit;
38      else if (0 == this->higerLimit)
39        return delay >= this->lowerLimit;
40      else
```

```
41      return this->lowerLimit <= delay <= this->higerLimit;
42  }
43
44  int TimeRule::copyConfig(rapidjson::Document &source, rapidjson::Value &
    destination,
45              rapidjson::Document::AllocatorType &allocator) {
46
47    if (source.HasMember(TIME_LOW_LIMIT))
48      destination.AddMember(rapidjson::StringRef(TIME_LOW_LIMIT), source[
    TIME_LOW_LIMIT], allocator);
49
50    if (source.HasMember(TIME_HIGH_LIMIT))
51      destination.AddMember(rapidjson::StringRef(TIME_HIGH_LIMIT), source[
    TIME_HIGH_LIMIT], allocator);
52
53    return SUCCESS;
54  }
55
56  int TimeRule::rulesAreValid(const rapidjson::Value &value) {
57    if (value.HasMember(TIME_LOW_LIMIT) || value.HasMember(TIME_HIGH_LIMIT)) {
58      return VALID_RULES;
59    } else {
60      return INVALID_RULES;
61    }
62  }
63
64  bool TimeRule::toJson(rapidjson::Value &json, rapidjson::Document::
    AllocatorType &allocator) {
65
66    rapidjson::Value v;
67
68    if (this->lowerLimit != 0) {
69      v.SetUint64(this->lowerLimit);
70      json.AddMember(rapidjson::StringRef(TIME_LOW_LIMIT), v, allocator);
71    }
72
73    if (this->higerLimit != 0) {
74      v.SetUint64(this->higerLimit);
75      json.AddMember(rapidjson::StringRef(TIME_HIGH_LIMIT), v, allocator);
76    }
77
78    return true;
79  }
80
81  uint64_t TimeRule::now() {
82    return (uint64_t) time(NULL);
83  }
84
85  int TimeRule::configureStorage(Volume *volume) {
86    volume->setMinDelay(this->lowerLimit);
87    volume->setMaxDelay(this->higerLimit);
88    volume->setIsTimeVolume(true);
89
90    return 0;
91  }
92
93  int TimeRule::configureStorage(Pool *pool) {
94    return 0;
95  }
```

```
96
97 }  // namespace mtfs
```

Listing 3.27 – "core/TimeRule.cpp"

3.4.8 UserRightRule

UserRightRule.h

```
1  /**
2   * \file UserRightRule.h
3   * \brief
4   * \author David Wittwer
5   * \version 0.0.1
6   * \copyright GNU Publis License V3
7   *
8   * This file is part of MTFS.
9
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18     GNU General Public License for more details.
19
20     You should have received a copy of the GNU General Public License
21     along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
22  */
23
24 #ifndef FILESTORAGE_USER_GROUP_RULE_H
25 #define FILESTORAGE_USER_GROUP_RULE_H
26
27 #include <string>
28 #include <vector>
29 #include <list>
30 #include <iostream>
31 #include <assert.h>
32
33 #include "mtfs/Rule.h"
34
35 namespace mtfs {
36   class UserRightRule : public Rule {
37   public:
38     static constexpr const char *ALLOW_USER = "allowUsers";
39     static constexpr const char *DENY_USER = "denyUsers";
40     static constexpr const char *ALLOW_GROUP = "allowGroups";
41     static constexpr const char *DENY_GROUP = "denyGroups";
42
43   private:
44     std::vector<uid_t> uidAllowed;
45
46     std::vector<uid_t> uidDenied;
47
48     std::vector<gid_t> gidAllowed;
49
```

```
50      std::vector<gid_t> gidDenied;
51
52    public:
53      static int copyConfig(rapidjson::Document &source, rapidjson::Value &
      destination,
54                  rapidjson::Document::AllocatorType &allocator);
55
56      static int rulesAreValid(const rapidjson::Value &value);
57
58      void addAllowUid(uid_t uid);
59
60      void addDenyUid(uid_t uid);
61
62      void addAllowGid(gid_t gid);
63
64      void addDenyGid(gid_t gid);
65
66      bool toJson(rapidjson::Value &json, rapidjson::Document::AllocatorType &
      allocator) override;
67
68      bool satisfyRules(ruleInfo_st info) override;
69
70    };
71
72  }  // namespace mtfs
73  #endif
```

Listing 3.28 – "core/UserRightRule.h"

UserRightRule.cpp

```
1   /**
2    * \file UserRightRule.cpp
3    * \brief
4    * \author David Wittwer
5    * \version 0.0.1
6    * \copyright GNU Publis License V3
7    *
8    * This file is part of MTFS.
9
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13     (at your option) any later version.
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18     GNU General Public License for more details.
19
20     You should have received a copy of the GNU General Public License
21     along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
22   */
23
24  #include <pwd.h>
25  #include "mtfs/UserRightRule.h"
26
27  namespace mtfs {
```

```
28  int UserRightRule::copyConfig(rapidjson::Document &source, rapidjson::Value &
      destination,
29                    rapidjson::Document::AllocatorType &allocator) {
30  //    TODO copy config
31      if (source.HasMember(ALLOW_USER))
32        destination.AddMember(rapidjson::StringRef(ALLOW_USER), source[ALLOW_USER
      ], allocator);
33
34      if (source.HasMember(DENY_USER))
35        destination.AddMember(rapidjson::StringRef(DENY_USER), source[DENY_USER],
       allocator);
36
37      if (source.HasMember(ALLOW_GROUP))
38        destination.AddMember(rapidjson::StringRef(ALLOW_GROUP), source[
      ALLOW_GROUP], allocator);
39
40      if (source.HasMember(DENY_GROUP))
41        destination.AddMember(rapidjson::StringRef(DENY_GROUP), source[DENY_GROUP
      ], allocator);
42
43      return SUCCESS;
44    }
45
46    int UserRightRule::rulesAreValid(const rapidjson::Value &value) {
47      if (value.HasMember(ALLOW_USER) || value.HasMember(ALLOW_GROUP) ||
48          value.HasMember(DENY_USER) || value.HasMember(DENY_GROUP)) {
49        return VALID_RULES;
50      } else {
51        return INVALID_RULES;
52      }
53    }
54
55    void UserRightRule::addAllowUid(uid_t uid) {
56      uidAllowed.push_back(uid);
57    }
58
59    void UserRightRule::addDenyUid(uid_t uid) {
60      uidDenied.push_back(uid);
61    }
62
63    void UserRightRule::addAllowGid(gid_t gid) {
64      gidAllowed.push_back(gid);
65    }
66
67    void UserRightRule::addDenyGid(gid_t gid) {
68      gidDenied.push_back(gid);
69    }
70
71    bool UserRightRule::satisfyRules(ruleInfo_st info) {
72      return true;
73    }
74
75    bool UserRightRule::toJson(rapidjson::Value &json, rapidjson::Document::
      AllocatorType &allocator) {
76
77      rapidjson::Value v;
78      rapidjson::Value a(rapidjson::kArrayType);
79
80      struct passwd *pw;
```

```
81      char buffer[50];
82      memset(buffer, 0, 50 * sizeof(char));
83
84      if (this->uidAllowed.size() != 0) {
85        for (auto &&allowed : this->uidAllowed) {
86          pw = getpwuid(allowed);
87          int len = sprintf(buffer, "%s", pw->pw_name);
88          v.SetString(buffer, (rapidjson::SizeType) len, allocator);
89          a.PushBack(v, allocator);
90        }
91        json.AddMember(rapidjson::StringRef(ALLOW_USER), a, allocator);
92      }
93
94      if (this->uidDenied.size() != 0) {
95        for (auto &&denied : this->uidDenied) {
96          pw = getpwuid(denied);
97          int len = sprintf(buffer, "%s", pw->pw_name);
98          v.SetString(buffer, (rapidjson::SizeType) len, allocator);
99          a.PushBack(v, allocator);
100       }
101       json.AddMember(rapidjson::StringRef(DENY_USER), a, allocator);
102     }
103
104     if (this->gidAllowed.size() != 0) {
105       for (auto &&allowed : this->gidAllowed) {
106         pw = getpwuid(allowed);
107         int len = sprintf(buffer, "%s", pw->pw_name);
108         v.SetString(buffer, (rapidjson::SizeType) len, allocator);
109         a.PushBack(v, allocator);
110       }
111       json.AddMember(rapidjson::StringRef(ALLOW_GROUP), a, allocator);
112     }
113
114     if (this->gidDenied.size() != 0) {
115       for (auto &&denied : this->gidDenied) {
116         pw = getpwuid(denied);
117         int len = sprintf(buffer, "%s", pw->pw_name);
118         v.SetString(buffer, (rapidjson::SizeType) len, allocator);
119         a.PushBack(v, allocator);
120       }
121       json.AddMember(rapidjson::StringRef(DENY_GROUP), a, allocator);
122     }
123
124     return true;
125   }
126
127 }  // namespace mtfs
```

Listing 3.29 – "core/UserRightRule.cpp"

3.4.9 Volume

Volume.h

```
1 /**
2  * \file Volume.h
3  * \brief
4  * \author David Wittwer
```

```
 * \version 0.0.1
 * \copyright GNU Publis License V3
 *
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 */

#ifndef FILESTORAGE_VOLUME_H
#define FILESTORAGE_VOLUME_H

#include <string>
#include <vector>
#include <climits>

#include <rapidjson/document.h>
#include <mtfs/structs.h>
#include <pluginSystem/Plugin.h>
#include <mutex>

namespace mtfs {
  class Volume {

  public:
    static constexpr const char *VOLUMES = "volumes";

  private:
    static const uint64_t NEW_DELAY = 50;

    pluginSystem::Plugin *plugin;

    bool isTimeVolume;
    uint64_t minDelay;
    uint64_t maxDelay;

    std::mutex iaMutex;
    std::map<uint64_t, uint64_t> inodesAccess;
    std::mutex daMutex;
    std::map<uint64_t, uint64_t> dirBlockAccess;
    std::mutex baMutex;
    std::map<uint64_t, uint64_t> blocksAccess;

    std::mutex niMutex;
    std::map<uint64_t, uint64_t> newInode;
    std::mutex ndMutex;
    std::map<uint64_t, uint64_t> newDir;
    std::mutex nbMutex;
    std::map<uint64_t, uint64_t> newData;
```

```
64
65    public:
66      virtual ~Volume();
67
68      void setMinDelay(uint64_t minDelay);
69
70      void setMaxDelay(uint64_t maxDelay);
71
72      void setIsTimeVolume(bool b);
73
74      static bool validate(const rapidjson::Value &volume);
75
76      static void
77      structToJson(const volume_t &volume, rapidjson::Value &dest, rapidjson::
     Document::AllocatorType &allocator);
78
79      static void jsonToStruct(rapidjson::Value &src, volume_t &volume);
80
81      explicit Volume(pluginSystem::Plugin *plugin);
82
83      int add(uint64_t &id, const blockType &type);
84
85      int add(std::vector<uint64_t> &ids, const int &nb, const blockType &type);
86
87      int del(const uint64_t &id, const blockType &type);
88
89      int get(const uint64_t &id, void *data, const blockType &type);
90
91      int put(const uint64_t &id, const void *data, const blockType &type);
92
93      int getMetas(const uint64_t &id, blockInfo_t &metas, const blockType &type)
     ;
94
95      int putMetas(const uint64_t &id, const blockInfo_t &metas, const blockType
     &type);
96
97      int getUnsatisfy(std::vector<blockInfo_t> &unsatisfy, const blockType &type
     , int limit = INT_MAX);
98
99    private:
100     int getOutOfTime(std::vector<uint64_t> &blocks, const blockType &type);
101
102     bool updateLastAccess(const uint64_t &id, const blockType &type);
103
104     void purgeNewMap(const blockType &type);
105   };
106
107 }  // namespace mtfs
108 #endif
```

Listing 3.30 – "core/Volume.h"

Volume.cpp

```
1 /**
2  * \file Volume.cpp
3  * \brief
4  * \author David Wittwer
5  * \version 0.0.1
```

```
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 *
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 */

#include <pluginSystem/PluginManager.h>
#include <thread>
#include <boost/thread.hpp>
#include <boost/threadpool/pool.hpp>
#include "mtfs/Volume.h"
#include <mtfs/Rule.h>

using namespace std;

namespace mtfs {

  Volume::Volume(pluginSystem::Plugin *plugin) : plugin(plugin), minDelay(0),
   maxDelay(0) {}

  Volume::~Volume() {
    plugin->detach();

    pluginSystem::PluginManager::getInstance()->freePlugin(this->plugin->
   getName(), this->plugin);
  }

  bool Volume::validate(const rapidjson::Value &volume) {
    if (!volume.HasMember(pluginSystem::Plugin::TYPE))
      return false;

    if (!volume.HasMember(pluginSystem::Plugin::PARAMS))
      return false;

    string volType = volume[pluginSystem::Plugin::TYPE].GetString();

    pluginSystem::PluginManager *manager = pluginSystem::PluginManager::
   getInstance();

    pluginSystem::Plugin *plugin = manager->getPlugin(volType);
    if (nullptr == plugin)
      return false;

    pluginSystem::pluginInfo_t info;

    if (manager->getInfo(volType, info) != pluginSystem::PluginManager::SUCCESS
   )
```

```
61        return false;
62
63      for (auto &&inf : info.params) {
64        if (!volume[pluginSystem::Plugin::PARAMS].HasMember(inf.c_str()))
65          return false;
66      }
67
68  //    vector<string> infos = plugin->getInfos();
69  //    infos.erase(infos.begin());
70  //    for (auto i:infos)
71  //      if (!volume.HasMember(i.c_str()))
72  //        return false;
73
74      return true;
75    }
76
77    void Volume::structToJson(const volume_t &volume, rapidjson::Value &dest,
78                  rapidjson::Document::AllocatorType &allocator) {
79      volume.rule->toJson(dest, allocator);
80
81      rapidjson::Value v;
82
83      v.SetString(rapidjson::StringRef(volume.pluginName.c_str()));
84      dest.AddMember(rapidjson::StringRef(pluginSystem::Plugin::TYPE), v,
       allocator);
85
86      rapidjson::Value p(rapidjson::kObjectType);
87      for (auto &&item : volume.params) {
88        v.SetString(rapidjson::StringRef(item.second.c_str()));
89        p.AddMember(rapidjson::StringRef(item.first.c_str()), v, allocator);
90      }
91      dest.AddMember(rapidjson::StringRef(pluginSystem::Plugin::PARAMS), p,
       allocator);
92    }
93
94    void Volume::jsonToStruct(rapidjson::Value &src, volume_t &volume) {
95      assert(src.HasMember(pluginSystem::Plugin::TYPE));
96      volume.pluginName = src[pluginSystem::Plugin::TYPE].GetString();
97
98      assert(src.HasMember(pluginSystem::Plugin::PARAMS));
99      for (auto &&item : src[pluginSystem::Plugin::PARAMS].GetObject()) {
100       volume.params.insert(make_pair(item.name.GetString(), item.value.
       GetString()));
101     }
102   }
103
104   int Volume::add(uint64_t &id, const blockType &type) {
105     int ret;
106     ret = this->plugin->add(&id, type);
107
108     if (ENOSYS == ret) {
109 //      TODO log noimplemented
110     }
111     mutex *mu = nullptr;
112     map<uint64_t, uint64_t> *ma = nullptr;
113
114     switch (type) {
115       case INODE:
116         mu = &this->niMutex;
```

```
117         ma = &this->newInode;
118         break;
119       case DIR_BLOCK:
120         mu = &this->ndMutex;
121         ma = &this->newData;
122         break;
123       case DATA_BLOCK:
124         mu = &this->nbMutex;
125         ma = &this->newData;
126         break;
127       default:
128         return ENOSYS;
129     }
130
131     //      add id in newBlock map
132     unique_lock<mutex> lk(*mu);
133     ma->emplace(id, time(nullptr));
134     lk.unlock();
135
136     return ret;
137   }
138
139   int Volume::add(std::vector<uint64_t> &ids, const int &nb, const blockType &
      type) {
140     boost::threadpool::pool thPool((size_t) nb);
141
142     vector<uint64_t *> tmp;
143     for (int i = 0; i < nb; ++i) {
144       uint64_t *id;
145       id = new uint64_t();
146       tmp.push_back(id);
147       thPool.schedule(bind(&pluginSystem::Plugin::add, this->plugin, id, type))
      ;
148     }
149
150     thPool.wait();
151
152     mutex *mu = nullptr;
153     map<uint64_t, uint64_t> *ma = nullptr;
154
155     switch (type) {
156       case INODE:
157         mu = &this->niMutex;
158         ma = &this->newInode;
159         break;
160       case DIR_BLOCK:
161         mu = &this->ndMutex;
162         ma = &this->newData;
163         break;
164       case DATA_BLOCK:
165         mu = &this->nbMutex;
166         ma = &this->newData;
167         break;
168       default:
169         return ENOSYS;
170     }
171
172     for (auto &&item: tmp) {
173 //      add id in newBlock map
```

```
174       unique_lock<mutex> lk(*mu);
175       ma->emplace(*item, time(nullptr));
176       lk.unlock();
177
178       ids.push_back(*item);
179       delete item;
180     }
181
182     return 0;
183   }
184
185   int Volume::del(const uint64_t &id, const blockType &type) {
186     int ret;
187     ret = this->plugin->del(id, type);
188
189     if (ENOSYS == ret) {
190 //        TODO log noimplemented
191     }
192
193     map<uint64_t, uint64_t> *access = nullptr;
194     mutex *mu;
195     switch (type) {
196       case INODE:
197         mu = &this->iaMutex;
198         access = &this->inodesAccess;
199         break;
200       case DIR_BLOCK:
201         mu = &this->daMutex;
202         access = &this->dirBlockAccess;
203         break;
204       case DATA_BLOCK:
205         mu = &this->baMutex;
206         access = &this->blocksAccess;
207         break;
208       default:
209         return ENOSYS;
210     }
211
212     unique_lock<mutex> lk(*mu);
213     access->erase(id);
214     lk.unlock();
215
216     return ret;
217   }
218
219   int Volume::get(const uint64_t &id, void *data, const blockType &type) {
220     int ret;
221     ret = this->plugin->get(id, data, type, false);
222
223     if (ENOSYS == ret) {
224 //        TODO log noimplemented
225     }
226
227     this->updateLastAccess(id, type);
228
229     return ret;
230   }
231
```

```
232   int Volume::put(const uint64_t &id, const void *data, const blockType &type)
      {
233     int ret;
234     ret = this->plugin->put(id, data, type, false);
235
236     if (ENOSYS == ret) {
237 //        TODO log noimplemented
238     }
239
240     this->updateLastAccess(id, type);
241
242     return ret;
243   }
244
245   int Volume::getMetas(const uint64_t &id, blockInfo_t &metas, const blockType
      &type) {
246     int ret;
247     if (EXIT_SUCCESS != (ret = this->plugin->get(id, &metas, type, true))) {
248       return ret;
249     }
250
251     map<uint64_t, uint64_t> *access = nullptr;
252     mutex *mu;
253     switch (type) {
254       case INODE:
255         mu = &this->iaMutex;
256         access = &this->inodesAccess;
257         break;
258       case DIR_BLOCK:
259         mu = &this->daMutex;
260         access = &this->dirBlockAccess;
261         break;
262       case DATA_BLOCK:
263         mu = &this->baMutex;
264         access = &this->blocksAccess;
265         break;
266       default:
267         return ENOSYS;
268     }
269
270     unique_lock<mutex> lk(*mu);
271     if (access->end() == access->find(id))
272       (*access)[id] = metas.lastAccess;
273
274     return ret;
275   }
276
277   int Volume::putMetas(const uint64_t &id, const blockInfo_t &metas, const
      blockType &type) {
278     if (0 == id && INODE == type)
279       return EXIT_SUCCESS;
280
281     int ret;
282     if (EXIT_SUCCESS != (ret = this->plugin->put(id, &metas, type, true))) {
283       return ret;
284     }
285
286     map<uint64_t, uint64_t> *access = nullptr;
287     mutex *mu;
```

```
288     switch (type) {
289       case INODE:
290         mu = &this->iaMutex;
291         access = &this->inodesAccess;
292         break;
293       case DIR_BLOCK:
294         mu = &this->daMutex;
295         access = &this->dirBlockAccess;
296         break;
297       case DATA_BLOCK:
298         mu = &this->baMutex;
299         access = &this->blocksAccess;
300         break;
301       default:
302         return ENOSYS;
303     }
304
305     unique_lock<mutex> lk(*mu);
306     (*access)[id] = metas.lastAccess;
307
308     return ret;
309   }
310
311   bool Volume::updateLastAccess(const uint64_t &id, const blockType &type) {
312     blockInfo_t metas = blockInfo_t();
313     this->getMetas(id, metas, type);
314
315     metas.lastAccess = static_cast<uint64_t>(time(nullptr));
316     this->putMetas(id, metas, type);
317
318     return true;
319   }
320
321   void Volume::setMinDelay(uint64_t minDelay) {
322     this->minDelay = minDelay;
323   }
324
325   void Volume::setMaxDelay(uint64_t maxDelay) {
326     this->maxDelay = maxDelay;
327   }
328
329   void Volume::setIsTimeVolume(bool b) {
330     this->isTimeVolume = b;
331   }
332
333   int Volume::getUnsatisfy(vector<blockInfo_t> &unsatisfy, const blockType &
       type, const int limit) {
334     this->purgeNewMap(type);
335
336     int nb = 0;
337     if (this->isTimeVolume) {
338       vector<uint64_t> under;
339       this->getOutOfTime(under, type);
340
341       for (auto &&blk :under) {
342         blockInfo_t info = blockInfo_t();
343         this->getMetas(blk, info, type);
344         info.id.id = blk;
345
```

```
346         unsatisfy.push_back(info);
347
348         nb++;
349         if (limit == nb)
350           return 0;
351       }
352     }
353
354     return 0;
355   }
356
357   int Volume::getOutOfTime(vector<uint64_t> &blocks, const blockType &type) {
358     uint64_t now;
359     now = (uint64_t) time(nullptr);
360     const uint64_t maxTimestamp = now - this->minDelay;
361     const uint64_t minTimestamp = 0 == this->maxDelay ? 0 : now - this->
      maxDelay;
362
363     mutex *mu;
364     map<uint64_t, uint64_t> *mp;
365     mutex *newMut;
366     map<uint64_t, uint64_t> *newMap;
367     switch (type) {
368       case INODE:
369         mu = &this->iaMutex;
370         mp = &this->inodesAccess;
371         newMut = &this->niMutex;
372         newMap = &this->newInode;
373         break;
374       case DIR_BLOCK:
375         mu = &this->daMutex;
376         mp = &this->dirBlockAccess;
377         newMut = &this->ndMutex;
378         newMap = &this->newDir;
379         break;
380       case DATA_BLOCK:
381         mu = &this->baMutex;
382         mp = &this->blocksAccess;
383         newMut = &this->ndMutex;
384         newMap = &this->newData;
385         break;
386       default:
387         return ENOSYS;
388     }
389
390     unique_lock<mutex> lk(*mu);
391     for (auto &&item :*mp) {
392       if (0 == item.first && INODE == type)
393         continue;
394       unique_lock<mutex> nlk(*newMut);
395       if (newMap->end() != newMap->find(item.first)) {
396         nlk.unlock();
397         continue;
398       }
399       nlk.unlock();
400
401       if (!(maxTimestamp > item.second && minTimestamp < item.second))
402         blocks.push_back(item.first);
403     }
```

```
404
405     return 0;
406   }
407
408   void Volume::purgeNewMap(const blockType &type) {
409     mutex *mu = nullptr;
410     map<uint64_t, uint64_t> *ma = nullptr;
411
412     switch (type) {
413       case INODE:
414         mu = &this->niMutex;
415         ma = &this->newInode;
416         break;
417       case DIR_BLOCK:
418         mu = &this->ndMutex;
419         ma = &this->newData;
420         break;
421       case DATA_BLOCK:
422         mu = &this->nbMutex;
423         ma = &this->newData;
424         break;
425       default:
426         return;
427     }
428
429     uint64_t newTimestamp = time(nullptr) - NEW_DELAY;
430
431     unique_lock<mutex> lk(*mu);
432     for (auto &&item :*ma) {
433       if (newTimestamp > item.second)
434         ma->erase(item.first);
435     }
436   }
437
438 }  // namespace mtfs
```

Listing 3.31 – "core/Volume.cpp"

3.5 *Migrator*

3.5.1 Migrator.h

```
1  /**
2   * \file Migrator.h
3   * \brief
4   * \author David Wittwer
5   * \version 0.0.1
6   * \copyright GNU Publis License V3
7   *
8   * This file is part of MTFS.
9
10    MTFS is free software: you can redistribute it and/or modify
11    it under the terms of the GNU General Public License as published by
12    the Free Software Foundation, either version 3 of the License, or
13    (at your option) any later version.
14
15    Foobar is distributed in the hope that it will be useful,
```

```
16      but WITHOUT ANY WARRANTY; without even the implied warranty of
17      MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
18      GNU General Public License for more details.
19
20      You should have received a copy of the GNU General Public License
21      along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
22   */
23
24
25  #ifndef MTFS_MIGRATOR_H
26  #define MTFS_MIGRATOR_H
27
28  #include <mutex>
29  #include <condition_variable>
30  #include "PoolManager.h"
31
32  namespace mtfs {
33    class Migrator {
34    private:
35      static const int MIGRATION_DELAY = 10;
36
37    public:
38      struct info_st {
39        std::mutex *endMutex;
40        std::condition_variable condV;
41        bool end;
42        PoolManager *poolManager;
43
44        info_st() : endMutex(new std::mutex), end(false) {};
45
46        ~info_st() {
47          delete endMutex;
48        }
49      };
50
51      static void main(info_st *infos);
52    };
53  }
54
55
56  #endif //MTFS_MIGRATOR_H
```

Listing 3.32 – "migrator/Migrator.h"

3.5.2 Migrator.cpp

```
1   /**
2    * \file Migrator.cpp
3    * \brief
4    * \author David Wittwer
5    * \version 0.0.1
6    * \copyright GNU Publis License V3
7    *
8    * This file is part of MTFS.
9
10     MTFS is free software: you can redistribute it and/or modify
11     it under the terms of the GNU General Public License as published by
12     the Free Software Foundation, either version 3 of the License, or
```

```
13      (at your option) any later version.
14
15      Foobar is distributed in the hope that it will be useful,
16      but WITHOUT ANY WARRANTY; without even the implied warranty of
17      MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
18      GNU General Public License for more details.
19
20      You should have received a copy of the GNU General Public License
21      along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
22  */
23
24 #include <zconf.h>
25 #include <iostream>
26 #include <utils/Logger.h>
27 #include "mtfs/Migrator.h"
28
29 #define MIGRATION_DELAY chrono::seconds(30)
30
31 using namespace std;
32
33 void mtfs::Migrator::main(info_st *infos) {
34
35   unique_lock<mutex> lk(*infos->endMutex);
36   while (!infos->end) {
37     lk.unlock();
38
39     lk.lock();
40     infos->condV.wait_for(lk, MIGRATION_DELAY);
41     if (infos->end)
42       break;
43     lk.unlock();
44
45 //    Do migration;
46     Logger::getInstance()->log("MIGRATOR", "start inode migration", Logger::
    L_DEBUG);
47     infos->poolManager->doMigration(blockType::INODE);
48     Logger::getInstance()->log("MIGRATOR", "start dirblock migration", Logger::
    L_DEBUG);
49     infos->poolManager->doMigration(blockType::DIR_BLOCK);
50     Logger::getInstance()->log("MIGRATOR", "start datablock migration", Logger
    ::L_DEBUG);
51     infos->poolManager->doMigration(blockType::DATA_BLOCK);
52     Logger::getInstance()->log("MIGRATOR", "end migration", Logger::L_DEBUG);
53
54     lk.lock();
55   }
56   lk.unlock();
57
58 }
```

Listing 3.33 – "migrator/Migrator.cpp"

3.6 Tests

3.7 Migration test

Listing 3.34 – "migrationTests.py"

3.8 test de vitesse

```
/**
 * \file main.cpp
 * \brief
 * \author David Wittwer
 * \version 0.0.1
 * \copyright GNU Publis License V3
 *
 * This file is part of MTFS.

    MTFS is free software: you can redistribute it and/or modify
    it under the terms of the GNU General Public License as published by
    the Free Software Foundation, either version 3 of the License, or
    (at your option) any later version.

    Foobar is distributed in the hope that it will be useful,
    but WITHOUT ANY WARRANTY; without even the implied warranty of
    MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
    GNU General Public License for more details.

    You should have received a copy of the GNU General Public License
    along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
 */

#include <iostream>
#include <boost/filesystem.hpp>
#include <fcntl.h>

#define FIRST_SIZE 512
#define LAST_SIZE 131072
#define SAMPLE 5
#define LOOP 50

#define FILENAME "/tmp/mtfs/test24"

using namespace std;

int main(int argc, char **argv) {
  cout << "Start Mtfs perfs tests" << endl;

  ofstream file("sample.csv");

  creat(FILENAME, S_IRUSR | S_IWUSR | S_IRGRP | S_IWGRP | S_IROTH | S_IWOTH);

  file << "octets ";
  for (int i = 1; i <= LOOP; ++i) {
    file << to_string(i) << " ";
  }
  file << endl;

  string readTable, writeTable;

  for (size_t i = FIRST_SIZE; i <= LAST_SIZE; i *= 2) {
```

```
53      string readRow, writeRow;
54      readRow = to_string(i);
55      writeRow = to_string(i);
56
57      for (int j = 0; j < LOOP; ++j) {
58        char buffer[i + 1];
59        char *rbuffer = static_cast<char *>(calloc(sizeof(char), i + 1));
60        for (int k = 0; k < i; ++k) {
61          buffer[k] = 'a';
62        }
63
64        clock_t writeSum = 0;
65        clock_t readSum = 0;
66
67        for (int l = 0; l < SAMPLE; ++l) {
68          int fd = open(FILENAME, O_SYNC | O_RDWR);
69          if (fd <= 0) {
70            cerr << "open error " << strerror(errno) << endl;
71            break;
72          }
73          ssize_t nb = 0;
74          clock_t start;
75
76          start = clock();
77          do {
78            nb += write(fd, buffer, i);
79          } while (nb < i);
80          writeSum += clock() - start;
81
82          if (nb < 0) {
83            cerr << "write error " << strerror(errno) << endl;
84            break;
85          }
86
87          lseek(fd, 0, SEEK_SET);
88
89          start = clock();
90          do {
91            nb += read(fd, buffer, i);
92          } while (nb < i);
93          readSum += clock() - start;
94          close(fd);
95        }
96        float wm = (float) writeSum / SAMPLE;
97        float rm = (float) readSum / SAMPLE;
98  //      cout << to_string(m) << " " << to_string((m / CLOCKS_PER_SEC) * 1000)
      << endl;
99        writeRow += " " + to_string(wm);
100       readRow += " " + to_string(rm);
101 //      file << to_string(m) << " ";
102     }
103
104     writeTable += writeRow + "\n";
105     readTable += readRow + "\n";
106     cout << "size " << to_string(i) << endl;
107
108   }
109
110   file << readTable << endl << writeTable << endl;
```

```
111
112 }
```

Listing 3.35 – "speedTest.cpp"

3.9 Plugin tests

3.9.1 block device

```
1  /**
2   * \file blockDeviceTests.cpp
3   * \brief
4   * \author David Wittwer
5   * \version 0.0.1
6   * \copyright GNU Publis License V3
7   *
8   * This file is part of MTFS.
9
10     MTFS is free software: you can redistribute it and/or modify
11     it under the terms of the GNU General Public License as published by
12     the Free Software Foundation, either version 3 of the License, or
13     (at your option) any later version.
14
15     Foobar is distributed in the hope that it will be useful,
16     but WITHOUT ANY WARRANTY; without even the implied warranty of
17     MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
18     GNU General Public License for more details.
19
20     You should have received a copy of the GNU General Public License
21     along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
22  */
23
24 #include <gtest/gtest.h>
25 #include <BlockDevice/BlockDevice.h>
26 #include <mtfs/Mtfs.h>
27 //#include <mtfs/structs.h>
28
29
30 using namespace std;
31 using namespace pluginSystem;
32
33 #define HOME "/home/david/Cours/4eme/Travail_bachelor/Home/Plugins/"
34 #define BLOCK_SIZE 4096
35 #define DEVICE "/dev/tests"
36 #define FS_TYPE "ext4"
37
38 TEST(BlockDevice, attachDetach) {
39 #ifndef DEBUG
40   if (setuid(0) != 0)
41     cout << "fail setuid" << endl;
42 #endif
43
44   BlockDevice blockDevice;
45   map<string, string> params;
46   params.insert(make_pair("home", HOME));
47   params.insert(make_pair("blockSize", to_string(BLOCK_SIZE)));
48   params.insert(make_pair("devicePath", DEVICE));
```

```
49    params.insert(make_pair("fsType", FS_TYPE));
50    ASSERT_TRUE(blockDevice.attach(params));
51    ASSERT_TRUE(blockDevice.detach());
52  }
53
54  class BlockDeviceFixture : public ::testing::Test {
55  public:
56    BlockDeviceFixture() {
57      rootIdent.poolId = 0;
58      rootIdent.volumeId = 0;
59      rootIdent.id = 0;
60    }
61
62    virtual void SetUp() {
63      map<string, string> params;
64      params.insert(make_pair("home", HOME));
65      params.insert(make_pair("blockSize", "4096"));
66      params.insert(make_pair("devicePath", DEVICE));
67      params.insert(make_pair("fsType", FS_TYPE));
68      blockDevice.attach(params);
69    }
70
71    virtual void TearDown() {
72      blockDevice.detach();
73    }
74
75    ~BlockDeviceFixture() {
76    }
77
78    BlockDevice blockDevice;
79    mtfs::ident_t rootIdent;
80
81  };
82
83  TEST_F(BlockDeviceFixture, addInode) {
84    uint64_t inode = 0;
85    ASSERT_EQ(0, blockDevice.add(&inode, mtfs::blockType::INODE));
86    ASSERT_NE(0, inode);
87
88    uint64_t inode2 = 0;
89    ASSERT_EQ(0, blockDevice.add(&inode2, mtfs::blockType::INODE));
90    ASSERT_NE(0, inode2);
91    ASSERT_GT(inode2, inode);
92
93    uint64_t inode3 = 0;
94    ASSERT_EQ(0, blockDevice.add(&inode3, mtfs::blockType::INODE));
95  }
96
97  TEST_F(BlockDeviceFixture, delInode) {
98    uint64_t inode;
99    blockDevice.add(&inode, mtfs::blockType::INODE);
100   ASSERT_EQ(0, blockDevice.del(inode, mtfs::blockType::INODE));
101
102   uint64_t inode2;
103   blockDevice.add(&inode2, mtfs::blockType::INODE);
104   blockDevice.add(&inode2, mtfs::blockType::INODE);
105   blockDevice.add(&inode2, mtfs::blockType::INODE);
106   blockDevice.del(inode, mtfs::blockType::INODE);
107 }
```

```
108
109 TEST_F(BlockDeviceFixture, writeInode) {
110   uint64_t inodeId;
111   blockDevice.add(&inodeId, mtfs::blockType::INODE);
112
113   mtfs::ident_t oIdent;
114   oIdent.id = 42;
115   oIdent.volumeId = 1;
116   oIdent.poolId = 1;
117
118   mtfs::inode_t ino;
119   ino.accesRight = 0666;
120   ino.uid = 0;
121   ino.gid = 0;
122   ino.size = 1024;
123   ino.linkCount = 1;
124   ino.atime = (unsigned long &&) time(nullptr);
125
126   for (int i = 0; i < 4; ++i) {
127     vector<mtfs::ident_t> blocks;
128
129     for (uint j = 0; j < 3; ++j) {
130       mtfs::ident_t ident = mtfs::ident_t(1, j, i * 3 + j);
131
132       blocks.push_back(ident);
133     }
134     ino.dataBlocks.push_back(blocks);
135   }
136
137   ASSERT_EQ(0, blockDevice.put(inodeId, &ino, mtfs::blockType::INODE, false));
138 }
139
140 TEST_F(BlockDeviceFixture, readInode) {
141   mtfs::inode_t original, inode;
142   memset(&original, 0, sizeof(mtfs::inode_t));
143   memset(&inode, 0, sizeof(mtfs::inode_t));
144
145   original.accesRight = 0644;
146   original.uid = 1;
147   original.gid = 1;
148   original.size = 1024;
149   original.linkCount = 1;
150   original.atime = (unsigned long &&) time(nullptr);
151
152   for (int i = 0; i < 4; ++i) {
153     vector<mtfs::ident_t> blocks;
154
155     for (uint j = 0; j < 3; ++j) {
156       mtfs::ident_t ident = mtfs::ident_t(1, j, i * 3 + j);
157
158       blocks.push_back(ident);
159     }
160     original.dataBlocks.push_back(blocks);
161   }
162
163   uint64_t inodeId;
164   blockDevice.add(&inodeId, mtfs::blockType::INODE);
165   blockDevice.put(inodeId, &original, mtfs::blockType::INODE, false);
```

```
166   ASSERT_EQ(0, blockDevice.get(inodeId, &inode, mtfs::blockType::INODE, false))
        ;
167
168 //  cout << original.accesRight << " " << inode.accesRight << endl;
169   ASSERT_EQ(original, inode);
170   original.size = 2048;
171   blockDevice.put(inodeId, &original, mtfs::blockType::INODE, false);
172   ASSERT_EQ(0, blockDevice.get(inodeId, &inode, mtfs::blockType::INODE, false))
        ;
173 }
174
175 TEST_F(BlockDeviceFixture, addBlock) {
176   uint64_t block = 0;
177   ASSERT_EQ(0, blockDevice.add(&block, mtfs::blockType::DATA_BLOCK));
178   ASSERT_NE(0, block);
179
180   uint64_t block2 = 0;
181   ASSERT_EQ(0, blockDevice.add(&block2, mtfs::blockType::DATA_BLOCK));
182   ASSERT_NE(0, block2);
183   ASSERT_GT(block2, block);
184
185   uint64_t block3 = 0;
186   ASSERT_EQ(0, blockDevice.add(&block3, mtfs::blockType::DATA_BLOCK));
187 }
188
189 TEST_F(BlockDeviceFixture, delBlock) {
190   uint64_t block;
191   blockDevice.add(&block, mtfs::blockType::DATA_BLOCK);
192   ASSERT_EQ(0, blockDevice.del(block, mtfs::blockType::DATA_BLOCK));
193
194   uint64_t block2;
195   blockDevice.add(&block2, mtfs::blockType::DATA_BLOCK);
196   blockDevice.add(&block2, mtfs::blockType::DATA_BLOCK);
197   blockDevice.add(&block2, mtfs::blockType::DATA_BLOCK);
198   blockDevice.del(block, mtfs::blockType::DATA_BLOCK);
199 }
200
201 TEST_F(BlockDeviceFixture, writeBlock) {
202   uint8_t block[BLOCK_SIZE];
203   memset(block, 0, BLOCK_SIZE);
204   for (uint8_t i = 0; i < 50; ++i) {
205     block[i] = 'a';
206   }
207
208   uint64_t blockId;
209   blockDevice.add(&blockId, mtfs::blockType::DATA_BLOCK);
210   ASSERT_EQ(0, blockDevice.put(blockId, &block, mtfs::blockType::DATA_BLOCK,
        false));
211 }
212
213 TEST_F(BlockDeviceFixture, readBlock) {
214   uint8_t block[BLOCK_SIZE];
215   memset(block, 0, BLOCK_SIZE);
216
217   uint8_t readBlock[BLOCK_SIZE];
218   memset(readBlock, 0, BLOCK_SIZE);
219
220   for (int i = 0; i < 500; ++i) {
221     block[i] = (uint8_t) to_string(i)[0];
```

```
222   }
223
224   uint64_t blockId;
225   blockDevice.add(&blockId, mtfs::blockType::DATA_BLOCK);
226   blockDevice.put(blockId, &block, mtfs::blockType::DATA_BLOCK, false);
227
228   ASSERT_EQ(0, blockDevice.get(blockId, &readBlock, mtfs::blockType::DATA_BLOCK
        , false));
229   ASSERT_TRUE(0 == memcmp(block, readBlock, BLOCK_SIZE));
230 }
231
232 TEST_F(BlockDeviceFixture, rootInode) {
233   mtfs::inode_t inode;
234   inode.accesRight = 0444;
235   inode.uid = 1000;
236   inode.gid = 1000;
237   inode.size = 1024;
238   inode.linkCount = 2;
239   inode.atime = (uint64_t) time(nullptr);
240   inode.dataBlocks.clear();
241
242   mtfs::inode_t readInode;
243
244   ASSERT_EQ(0, blockDevice.put(0, &inode, mtfs::blockType::INODE, false));
245   ASSERT_EQ(0, blockDevice.get(0, &readInode, mtfs::blockType::INODE, false));
246   ASSERT_EQ(inode, readInode);
247 }
248
249 TEST_F(BlockDeviceFixture, superblock) {
250   mtfs::superblock_t superblock;
251   superblock.iCacheSz = superblock.dCacheSz = superblock.bCacheSz = superblock.
        blockSz = 4096;
252   superblock.migration = superblock.redundancy = 1;
253   superblock.pools.clear();
254   for (int i = 0; i < 5; ++i) {
255     mtfs::pool_t pool;
256     pool.migration = 0;
257     pool.rule = nullptr;
258     pool.volumes.clear();
259     superblock.pools[i] = pool;
260   }
261
262
263   ASSERT_TRUE(blockDevice.putSuperblock(superblock));
264 }
265
266 TEST_F(BlockDeviceFixture, putMetas) {
267   mtfs::blockInfo_t blockInfo;
268
269   mtfs::ident_t ident1(1, 1, 1);
270   mtfs::ident_t ident2(2, 2, 2);
271
272   blockInfo.referenceId.push_back(ident1);
273   blockInfo.referenceId.push_back(ident2);
274   blockInfo.lastAccess = (uint64_t) time(nullptr);
275
276   ASSERT_EQ(0, blockDevice.put(1, &blockInfo, mtfs::blockType::INODE, true));
277   ASSERT_EQ(0, blockDevice.put(1, &blockInfo, mtfs::blockType::DIR_BLOCK, true)
        );
```

```
278   ASSERT_EQ(0, blockDevice.put(1, &blockInfo, mtfs::blockType::DATA_BLOCK, true
        ));
279 }
280
281 TEST_F(BlockDeviceFixture, getMetas) {
282   mtfs::blockInfo_t blockInfo = mtfs::blockInfo_t(), receiveInfo = mtfs::
        blockInfo_t();
283 //  memset(&blockInfo, 0, sizeof(mtfs::blockInfo_t));
284 //  memset(&receiveInfo, 0, sizeof(mtfs::blockInfo_t));
285
286   mtfs::ident_t ident1(1, 1, 1);
287   mtfs::ident_t ident2(2, 2, 2);
288
289   blockInfo.referenceId.push_back(ident1);
290   blockInfo.referenceId.push_back(ident2);
291   blockInfo.lastAccess = (uint64_t) time(nullptr);
292
293   ASSERT_EQ(0, blockDevice.put(2, &blockInfo, mtfs::blockType::INODE, true));
294   ASSERT_EQ(0, blockDevice.get(2, &receiveInfo, mtfs::blockType::INODE, true));
295   ASSERT_EQ(blockInfo, receiveInfo);
296
297   receiveInfo = mtfs::blockInfo_t();
298   ASSERT_EQ(0, blockDevice.put(2, &blockInfo, mtfs::blockType::DIR_BLOCK, true)
        );
299   ASSERT_EQ(0, blockDevice.get(2, &receiveInfo, mtfs::blockType::DIR_BLOCK,
        true));
300   ASSERT_EQ(blockInfo, receiveInfo);
301
302   receiveInfo = mtfs::blockInfo_t();
303   ASSERT_EQ(0, blockDevice.put(2, &blockInfo, mtfs::blockType::DATA_BLOCK, true
        ));
304   ASSERT_EQ(0, blockDevice.get(2, &receiveInfo, mtfs::blockType::DATA_BLOCK,
        true));
305   ASSERT_EQ(blockInfo, receiveInfo);
306 }
307
308 TEST_F(BlockDeviceFixture, putDirBlock) {
309   mtfs::ident_t id1, id2;
310   id2.poolId = id1.poolId = 1;
311   id1.volumeId = 1;
312   id1.id = 2;
313   id2.volumeId = 2;
314   id2.id = 42;
315
316   vector<mtfs::ident_t> ids;
317   ids.push_back(id1);
318   ids.push_back(id2);
319
320   mtfs::dirBlock_t block = mtfs::dirBlock_t();
321   block.entries.clear();
322   block.entries.insert(make_pair("baz", ids));
323   block.entries.insert(make_pair("test", ids));
324
325   uint64_t dId = 0;
326
327   ASSERT_EQ(0, blockDevice.add(&dId, mtfs::blockType::DIR_BLOCK));
328   EXPECT_LE(0, dId);
329   ASSERT_EQ(0, blockDevice.put(dId, &block, mtfs::blockType::DIR_BLOCK, false))
        ;
```

```
330
331   mtfs::dirBlock_t readBlock;
332   ASSERT_EQ(0, blockDevice.get(dId, &readBlock, mtfs::blockType::DIR_BLOCK,
        false));
333   ASSERT_EQ(block.entries.size(), readBlock.entries.size());
334   for (auto &&item: block.entries) {
335     ASSERT_NE(readBlock.entries.end(), readBlock.entries.find(item.first));
336     int i = 0;
337     for (auto &&ident: item.second) {
338       ASSERT_EQ(ident, readBlock.entries[item.first][i]);
339       i++;
340     }
341   }
342
343   ASSERT_EQ(0, blockDevice.del(dId, mtfs::blockType::DIR_BLOCK));
344 }
345
346 int main(int argc, char **argv) {
347   ::testing::InitGoogleTest(&argc, argv);
348   return RUN_ALL_TESTS();
349 }
```

Listing 3.36 – "blockDeviceTests.cpp"

3.9.2 S3

```
1  /**
2   * \file s3Tests.cpp
3   * \brief
4   * \author David Wittwer
5   * \version 0.0.1
6   * \copyright GNU Publis License V3
7   *
8   * This file is part of MTFS.
9
10    MTFS is free software: you can redistribute it and/or modify
11    it under the terms of the GNU General Public License as published by
12    the Free Software Foundation, either version 3 of the License, or
13    (at your option) any later version.
14
15    Foobar is distributed in the hope that it will be useful,
16    but WITHOUT ANY WARRANTY; without even the implied warranty of
17    MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
18    GNU General Public License for more details.
19
20    You should have received a copy of the GNU General Public License
21    along with Foobar.  If not, see <http://www.gnu.org/licenses/>.
22  */
23
24 #include <gtest/gtest.h>
25 #include <S3/S3.h>
26 #include <mtfs/Mtfs.h>
27 //#include <mtfs/structs.h>
28
29 #define BLOCK_SIZE 4096
30
31 using namespace std;
32 using namespace pluginSystem;
```

```
33
34 #define HOME "/home/david/Cours/4eme/Travail_bachelor/Home/Plugins/"
35
36 TEST(S3, attachDetach) {
37 #ifndef DEBUG
38   if (setuid(0) != 0)
39   cout << "fail setuid" << endl;
40 #endif
41
42   S3 device;
43   map<string, string> params;
44   params.insert(make_pair("home", HOME));
45   params.insert(make_pair("blockSize", to_string(BLOCK_SIZE)));
46   params.emplace("region", "eu-central-1");
47   params.emplace("bucket", "mtfs");
48   ASSERT_TRUE(device.attach(params));
49   ASSERT_TRUE(device.detach());
50 }
51
52 class S3Fixture : public ::testing::Test {
53 public:
54   S3Fixture() {
55     rootIdent.poolId = 0;
56     rootIdent.volumeId = 0;
57     rootIdent.id = 0;
58   }
59
60   virtual void SetUp() {
61     map<string, string> params;
62     params.emplace("home", HOME);
63     params.emplace("blockSize", to_string(BLOCK_SIZE));
64     params.emplace("region", "eu-central-1");
65     params.emplace("bucket", "mtfs");
66     s3.attach(params);
67   }
68
69   virtual void TearDown() {
70     s3.detach();
71   }
72
73   ~S3Fixture() {
74   }
75
76   S3 s3;
77   mtfs::ident_t rootIdent;
78
79 };
80
81 TEST_F(S3Fixture, addInode) {
82   uint64_t inode = 0;
83   ASSERT_EQ(0, s3.add(&inode, mtfs::blockType::INODE));
84   ASSERT_NE(0, inode);
85
86   uint64_t inode2 = 0;
87   ASSERT_EQ(0, s3.add(&inode2, mtfs::blockType::INODE));
88   ASSERT_NE(0, inode2);
89   ASSERT_GT(inode2, inode);
90
91   uint64_t inode3 = 0;
```

```
92    ASSERT_EQ(0, s3.add(&inode3, mtfs::blockType::INODE));
93  }
94
95  TEST_F(S3Fixture, delInode) {
96    uint64_t inode;
97    s3.add(&inode, mtfs::blockType::INODE);
98    ASSERT_EQ(0, s3.del(inode, mtfs::blockType::INODE));
99
100   uint64_t inode2;
101   s3.add(&inode2, mtfs::blockType::INODE);
102   s3.add(&inode2, mtfs::blockType::INODE);
103   s3.add(&inode2, mtfs::blockType::INODE);
104   s3.del(inode, mtfs::blockType::INODE);
105 }
106
107 TEST_F(S3Fixture, writeInode) {
108   uint64_t inodeId = 0;
109   s3.add(&inodeId, mtfs::blockType::INODE);
110
111   mtfs::ident_t oIdent;
112   oIdent.id = 42;
113   oIdent.volumeId = 1;
114   oIdent.poolId = 1;
115
116   mtfs::inode_t ino;
117   ino.accesRight = 0666;
118   ino.uid = 0;
119   ino.gid = 0;
120   ino.size = 1024;
121   ino.linkCount = 1;
122   ino.atime = (unsigned long &&) time(nullptr);
123
124   for (int i = 0; i < 4; ++i) {
125     vector<mtfs::ident_t> blocks;
126
127     for (uint j = 0; j < 3; ++j) {
128       mtfs::ident_t ident = mtfs::ident_t(1, j, i * 3 + j);
129
130       blocks.push_back(ident);
131     }
132     ino.dataBlocks.push_back(blocks);
133   }
134
135   ASSERT_EQ(0, s3.put(inodeId, &ino, mtfs::blockType::INODE, false));
136 }
137
138 TEST_F(S3Fixture, readInode) {
139   mtfs::inode_t original, inode;
140   memset(&original, 0, sizeof(mtfs::inode_t));
141   memset(&inode, 0, sizeof(mtfs::inode_t));
142
143   original.accesRight = 0644;
144   original.uid = 1;
145   original.gid = 1;
146   original.size = 1024;
147   original.linkCount = 1;
148   original.atime = (unsigned long &&) time(nullptr);
149
150   for (int i = 0; i < 4; ++i) {
```

```
151     vector<mtfs::ident_t> blocks;
152
153     for (uint j = 0; j < 3; ++j) {
154       mtfs::ident_t ident = mtfs::ident_t(1, j, i * 3 + j);
155
156       blocks.push_back(ident);
157     }
158     original.dataBlocks.push_back(blocks);
159   }
160
161   uint64_t inodeId;
162   s3.add(&inodeId, mtfs::blockType::INODE);
163   s3.put(inodeId, &original, mtfs::blockType::INODE, false);
164   ASSERT_EQ(0, s3.get(inodeId, &inode, mtfs::blockType::INODE, false));
165
166 //  cout << original.accesRight << " " << inode.accesRight << endl;
167   ASSERT_EQ(original, inode);
168   original.size = 2048;
169   s3.put(inodeId, &original, mtfs::blockType::INODE, false);
170   ASSERT_EQ(0, s3.get(inodeId, &inode, mtfs::blockType::INODE, false));
171 }
172
173 TEST_F(S3Fixture, addBlock) {
174   uint64_t block = 0;
175   ASSERT_EQ(0, s3.add(&block, mtfs::blockType::DATA_BLOCK));
176 //  EXPECT_NE(0, block);
177
178   uint64_t block2 = 0;
179   ASSERT_EQ(0, s3.add(&block2, mtfs::blockType::DATA_BLOCK));
180   ASSERT_NE(0, block2);
181   ASSERT_GT(block2, block);
182
183   uint64_t block3 = 0;
184   ASSERT_EQ(0, s3.add(&block3, mtfs::blockType::DATA_BLOCK));
185 }
186
187 TEST_F(S3Fixture, delBlock) {
188   uint64_t block;
189   s3.add(&block, mtfs::blockType::DATA_BLOCK);
190   ASSERT_EQ(0, s3.del(block, mtfs::blockType::DATA_BLOCK));
191
192   uint64_t block2;
193   s3.add(&block2, mtfs::blockType::DATA_BLOCK);
194   s3.add(&block2, mtfs::blockType::DATA_BLOCK);
195   s3.add(&block2, mtfs::blockType::DATA_BLOCK);
196   s3.del(block, mtfs::blockType::DATA_BLOCK);
197 }
198
199 TEST_F(S3Fixture, writeBlock) {
200   uint8_t block[BLOCK_SIZE];
201   memset(block, 0, BLOCK_SIZE);
202   for (uint8_t i = 0; i < 50; ++i) {
203     block[i] = 'a';
204   }
205
206   uint64_t blockId = 0;
207   s3.add(&blockId, mtfs::blockType::DATA_BLOCK);
208   ASSERT_EQ(0, s3.put(blockId, &block, mtfs::blockType::DATA_BLOCK, false));
209 }
```

```
210
211 TEST_F(S3Fixture, readBlock) {
212   uint8_t block[BLOCK_SIZE];
213   memset(block, 0, BLOCK_SIZE);
214
215   uint8_t readBlock[BLOCK_SIZE];
216   memset(readBlock, 0, BLOCK_SIZE);
217
218   for (int i = 0; i < 500; ++i) {
219     block[i] = (uint8_t) to_string(i)[0];
220   }
221
222   uint64_t blockId = 0;
223   s3.add(&blockId, mtfs::blockType::DATA_BLOCK);
224   s3.put(blockId, &block, mtfs::blockType::DATA_BLOCK, false);
225
226   ASSERT_EQ(0, s3.get(blockId, &readBlock, mtfs::blockType::DATA_BLOCK, false))
      ;
227   ASSERT_TRUE(0 == memcmp(block, readBlock, BLOCK_SIZE));
228 }
229
230 TEST_F(S3Fixture, rootInode) {
231   mtfs::inode_t inode;
232   inode.accesRight = 0444;
233   inode.uid = 1000;
234   inode.gid = 1000;
235   inode.size = 1024;
236   inode.linkCount = 2;
237   inode.atime = (uint64_t) time(nullptr);
238   inode.dataBlocks.clear();
239
240   mtfs::inode_t readInode;
241
242   ASSERT_EQ(0, s3.put(0, &inode, mtfs::blockType::INODE, false));
243   ASSERT_EQ(0, s3.get(0, &readInode, mtfs::blockType::INODE, false));
244   ASSERT_EQ(inode, readInode);
245 }
246
247 TEST_F(S3Fixture, superblock) {
248   mtfs::superblock_t superblock;
249   superblock.iCacheSz = superblock.dCacheSz = superblock.bCacheSz = superblock.
      blockSz = 4096;
250   superblock.migration = superblock.redundancy = 1;
251   superblock.pools.clear();
252   for (int i = 0; i < 5; ++i) {
253     mtfs::pool_t pool;
254     pool.migration = 0;
255     pool.rule = nullptr;
256     pool.volumes.clear();
257     superblock.pools[i] = pool;
258   }
259
260
261   ASSERT_TRUE(s3.putSuperblock(superblock));
262 }
263
264 TEST_F(S3Fixture, putMetas) {
265   mtfs::blockInfo_t blockInfo;
266
```

```
267   mtfs::ident_t ident1(1, 1, 1);
268   mtfs::ident_t ident2(2, 2, 2);
269
270   blockInfo.referenceId.push_back(ident1);
271   blockInfo.referenceId.push_back(ident2);
272   blockInfo.lastAccess = (uint64_t) time(nullptr);
273
274   ASSERT_EQ(0, s3.put(1, &blockInfo, mtfs::blockType::INODE, true));
275   ASSERT_EQ(0, s3.put(1, &blockInfo, mtfs::blockType::DIR_BLOCK, true));
276   ASSERT_EQ(0, s3.put(1, &blockInfo, mtfs::blockType::DATA_BLOCK, true));
277 }
278
279 //TEST_F(S3Fixture, getMetas) {
280 //   mtfs::blockInfo_t blockInfo = mtfs::blockInfo_t(), receiveInfo = mtfs::
      blockInfo_t();
281 ////   memset(&blockInfo, 0, sizeof(mtfs::blockInfo_t));
282 ////   memset(&receiveInfo, 0, sizeof(mtfs::blockInfo_t));
283 //
284 //   mtfs::ident_t ident1(1, 1, 1);
285 //   mtfs::ident_t ident2(2, 2, 2);
286 //
287 //   blockInfo.referenceId.push_back(ident1);
288 //   blockInfo.referenceId.push_back(ident2);
289 //   blockInfo.lastAccess = (uint64_t) time(nullptr);
290 //
291 //   ASSERT_EQ(0, s3.put(2, &blockInfo, mtfs::blockType::INODE, true));
292 //   ASSERT_EQ(0, s3.get(2, &receiveInfo, mtfs::blockType::INODE, true));
293 //   ASSERT_EQ(blockInfo, receiveInfo);
294 //
295 //   receiveInfo = mtfs::blockInfo_t();
296 //   ASSERT_EQ(0, s3.put(2, &blockInfo, mtfs::blockType::DIR_BLOCK, true));
297 //   ASSERT_EQ(0, s3.get(2, &receiveInfo, mtfs::blockType::DIR_BLOCK, true));
298 //   ASSERT_EQ(blockInfo, receiveInfo);
299 //
300 //   receiveInfo = mtfs::blockInfo_t();
301 //   ASSERT_EQ(0, s3.put(2, &blockInfo, mtfs::blockType::DATA_BLOCK, true));
302 //   ASSERT_EQ(0, s3.get(2, &receiveInfo, mtfs::blockType::DATA_BLOCK, true));
303 //   ASSERT_EQ(blockInfo, receiveInfo);
304 //}
305
306 TEST_F(S3Fixture, putDirBlock) {
307   mtfs::ident_t id1, id2;
308   id2.poolId = id1.poolId = 1;
309   id1.volumeId = 1;
310   id1.id = 2;
311   id2.volumeId = 2;
312   id2.id = 42;
313
314   vector<mtfs::ident_t> ids;
315   ids.push_back(id1);
316   ids.push_back(id2);
317
318   mtfs::dirBlock_t block = mtfs::dirBlock_t();
319   block.entries.clear();
320   block.entries.insert(make_pair("baz", ids));
321   block.entries.insert(make_pair("test", ids));
322
323   uint64_t dId = 0;
324
```

```
325   ASSERT_EQ(0, s3.add(&dId, mtfs::blockType::DIR_BLOCK));
326   EXPECT_LE(0, dId);
327   ASSERT_EQ(0, s3.put(dId, &block, mtfs::blockType::DIR_BLOCK, false));
328
329   mtfs::dirBlock_t readBlock;
330   ASSERT_EQ(0, s3.get(dId, &readBlock, mtfs::blockType::DIR_BLOCK, false));
331   ASSERT_EQ(block.entries.size(), readBlock.entries.size());
332   for (auto &&item: block.entries) {
333     ASSERT_NE(readBlock.entries.end(), readBlock.entries.find(item.first));
334     int i = 0;
335     for (auto &&ident: item.second) {
336       ASSERT_EQ(ident, readBlock.entries[item.first][i]);
337       i++;
338     }
339   }
340
341   ASSERT_EQ(0, s3.del(dId, mtfs::blockType::DIR_BLOCK));
342 }
343
344 int main(int argc, char **argv) {
345   ::testing::InitGoogleTest(&argc, argv);
346   return RUN_ALL_TESTS();
347 }
```

Listing 3.37 – "s3Tests.cpp"

Chapitre 4

CMakeLists

4.1 CMakeLists général

```
cmake_minimum_required(VERSION 3.5)
project(mtFS)

set(CMAKE_CXX_STANDARD 14)

include_directories(library)
include_directories(mtFS/include)

add_subdirectory(mtFS)
add_subdirectory(mtFS_Tests)
add_subdirectory(Plugin)
```

Listing 4.1 – "CMakeLists.txt"

4.2 CMakeLists mtfs

```
if (NOT DEFINED MTFS_HOME_DIR)
  set(MTFS_HOME_DIR /home/mtfs)
endif ()
add_definitions(-DMTFS_HOME_DIR="${MTFS_HOME_DIR}")
add_definitions(-DMTFS_PLUGIN_HOME="${MTFS_HOME_DIR}/Plugins/")
add_definitions(-DMTFS_CONFIG_DIR="${MTFS_HOME_DIR}/Configs/")
add_definitions(-DMTFS_INSTALL_DIR="${MTFS_HOME_DIR}/Systems/")

set(FS_HEAD
    include/mtfs/Cache.h
    include/mtfs/Acces.h
    include/mtfs/Mtfs.h
    include/mtfs/Pool.h
    include/mtfs/PoolManager.h
    include/mtfs/Rule.h
    include/mtfs/structs.h
    include/mtfs/TimeRule.h
    include/mtfs/UserRightRule.h
    include/mtfs/Volume.h
    include/mtfs/Migrator.h)

set(FS_SRC
    src/mtfs/Cache.cpp
```

```
24      src/mtfs/Mtfs.cpp
25      src/mtfs/Pool.cpp
26      src/mtfs/PoolManager.cpp
27      src/mtfs/Rule.cpp
28      src/mtfs/TimeRule.cpp
29      src/mtfs/UserRightRule.cpp
30      src/mtfs/Volume.cpp
31      src/mtfs/Migrator.cpp)
32
33  set(MTFUSE_HEAD
34      include/wrapper/FuseBase.h
35      include/wrapper/FuseCallback.h
36      include/wrapper/MtfsFuse.h
37      )
38
39  set(MTFUSE_SRC
40      src/wrapper/FuseBase.cpp
41      src/wrapper/FuseCallback.cpp
42      src/wrapper/MtfsFuse.cpp
43      )
44
45  set(CONF_HEAD
46      include/pluginSystem/PluginManager.h
47      include/pluginSystem/Plugin.h
48      src/utils/Semaphore.cpp include/utils/Semaphore.h src/mtfs/Migrator.cpp
        include/mtfs/Migrator.h)
49
50  set(CONF_SRC
51      src/pluginSystem/PluginManager.cpp
52      )
53
54  set(UTILS
55      include/utils/Fs.h
56      src/utils/Fs.cpp
57      src/utils/Semaphore.cpp
58      include/utils/Semaphore.h
59      src/utils/Logger.cpp
60      include/utils/Logger.h
61      )
62
63  set(CMAKE_PREFIX_PATH /opt/aws-build)
64  find_package(aws-sdk-cpp)
65  add_definitions(-DUSE_IMPORT_EXPORT)
66
67  add_executable(mtfsCreate src/mtfsCreate.cpp
68      ${FS_SRC} ${CONF_SRC} ${UTILS})
69
70  target_link_libraries(mtfsCreate fuse3 dl boost_system boost_filesystem
        boost_thread pthread)
71
72
73  #add_definitions(-DDEBUG)
74
75  add_executable(mtfsMount src/mtfsMount.cpp
76      ${CONF_HEAD} ${CONF_SRC}
77      ${FS_HEAD} ${FS_SRC}
78      ${MTFUSE_HEAD} ${MTFUSE_SRC}
79      ${UTILS}
80      )
```

```
81
82 target_link_libraries(mtfsMount fuse3 dl boost_system boost_filesystem
       boost_thread pthread)
```

Listing 4.2 – "mtFS/CMakeLists.txt"

4.3 CMakeLists plugin

```
1  add_subdirectory(BlockDevice)
2  add_subdirectory(S3)
3
4  set(PLUGIN_H ../mtFS/include/pluginSystem/Plugin.h)
5
6  #set(BLOCK_SRCS BlockDevice/BlockDevice.h BlockDevice/BlockDevice.cpp ${
       PLUGIN_H})
7  #add_executable(Block ${BLOCK_SRCS})
8  #
9  #set(S3_SRCS S3/S3.h S3/S3.cpp ${PLUGIN_H})
10 #add_executable(S3exe ${S3_SRCS})
11 #target_link_libraries(S3exe aws-cpp-sdk-s3)
```

Listing 4.3 – "Plugin/CMakeLists.txt"

4.3.1 CMakeLists block

```
1  project(blockDevice)
2
3  set(CMAKE_BUILD_TYPE Release)
4
5  add_library(block SHARED BlockDevice.cpp ../../mtFS/src/utils/Logger.cpp)
```

Listing 4.4 – "Plugin/BlockDevice/CMakeLists.txt"

4.3.2 CMakeLists S3

```
1  project(S3)
2
3  set(CMAKE_BUILD_TYPE Release)
4
5  add_library(s3 SHARED S3.cpp ../../mtFS/src/utils/Logger.cpp)
6  target_link_libraries(s3 aws-cpp-sdk-s3)
```

Listing 4.5 – "Plugin/S3/CMakeLists.txt"

4.4 CMakeLists Tests

```
1  project(mtFS_Tests)
2
3  add_subdirectory(PluginTests)
4  add_subdirectory(PerformanceTests)
```

Listing 4.6 – "mtFS_Tests/CMakeLists.txt"

4.4.1 CMakeLists Performance tests

```
add_executable(perfTests main.cpp)

target_link_libraries(perfTests boost_system boost_filesystem boost_thread)
```

Listing 4.7 – "mtFS_Tests/PerformanceTests/CMakeLists.txt"

4.4.2 CMakeLists PluginTests

```
include_directories(${gtest_SOURCE_DIR}/include ${gtest_SOURCE_DIR})
include_directories(../../mtFS/include ../../Plugin/)

set(BLOCK_SRCS ../../Plugin/BlockDevice/BlockDevice.h ../../Plugin/BlockDevice/
    BlockDevice.cpp)

add_definitions(-DDEBUG)
add_executable(blockTests blockDeviceTests.cpp ${BLOCK_SRCS} ../../mtFS/src/
    utils/Logger.cpp)

target_link_libraries(blockTests gtest gtest_main boost_system)

set(CMAKE_PREFIX_PATH /opt/aws-build)

find_package(aws-sdk-cpp)
add_definitions(-DUSE_IMPORT_EXPORT)
set(S3_SRCS ../../Plugin/S3/S3.h ../../Plugin/S3/S3.cpp ../../mtFS/src/utils/
    Logger.cpp)
add_executable(s3Tests s3Tests.cpp ${S3_SRCS})

target_link_libraries(s3Tests gtest gtest_main boost_system aws-cpp-sdk-s3)
```

Listing 4.8 – "mtFS_Tests/PluginTests/CMakeLists.txt"

Bibliographie

[1] CMake. Compilateur c/c++. https://cmake.org/download/, 2017. [En ligne ; Page disponible le 16-août-2017].