DIFS flow check

with nfd

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정아름

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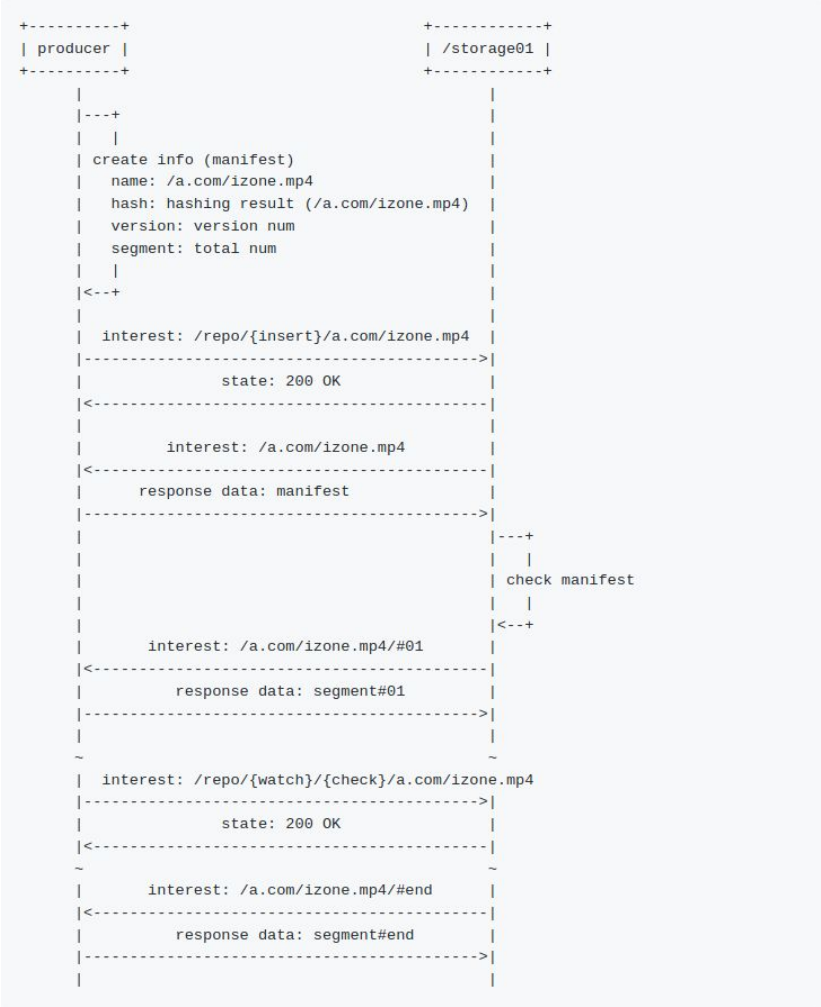
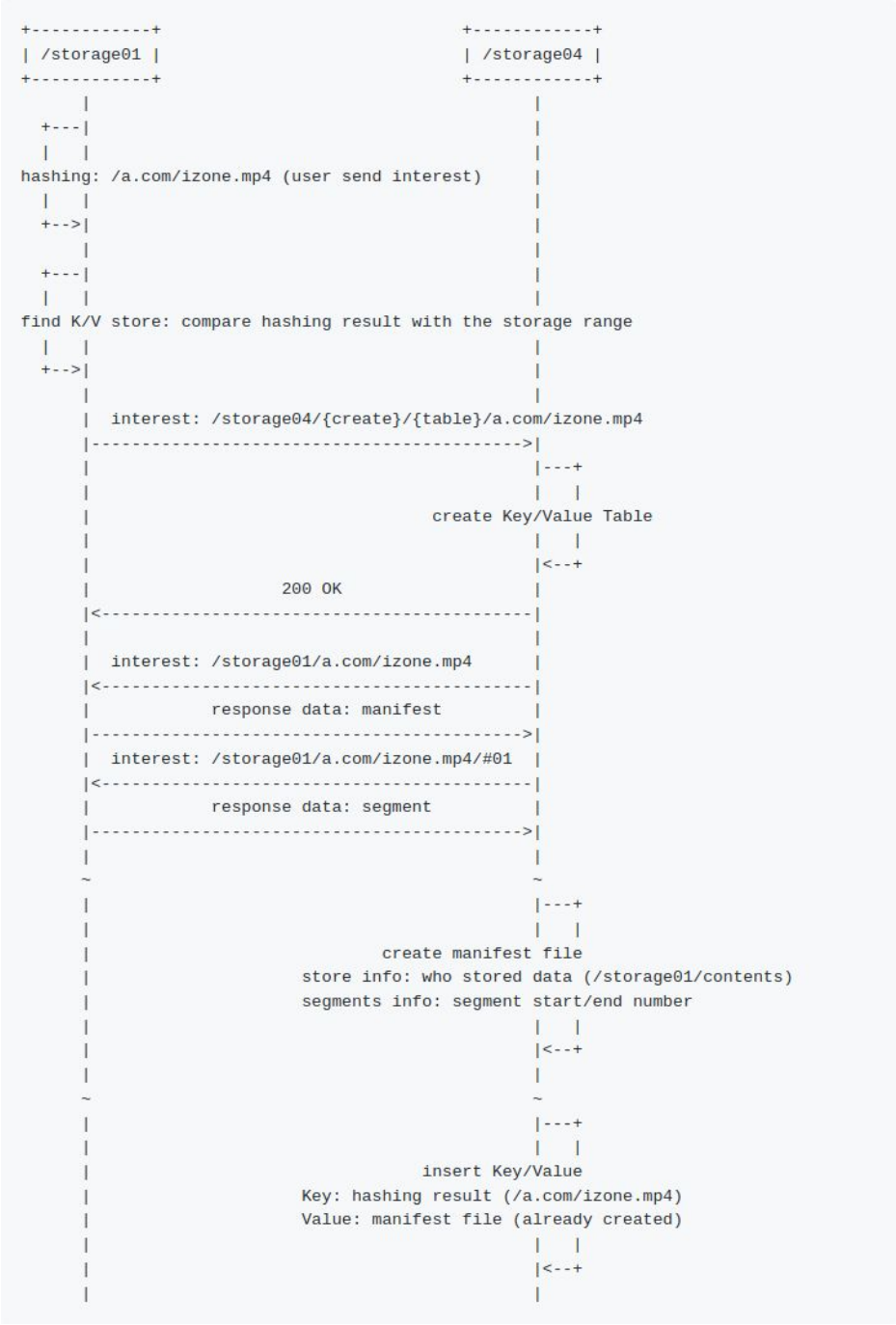
1. DIFS

1.1. Flow check





1.1.1 NFD routing

```
kjwon15@malformed:~/workspace/tmp-repo <(b'd606ecf')+?> % nfdc route list
prefix=/get nexthop=284 origin=app cost=0 flags=child-inherit expires=never
prefix=/example/repo nexthop=284 origin=app cost=0 flags=child-inherit expires=never
prefix=/example/repo/0 nexthop=284 origin=app cost=0 flags=child-inherit expires=never
prefix=/example/repo/0/data nexthop=284 origin=app cost=0 flags=child-inherit expires=never
prefix=/localhost/nfd nexthop=267 origin=app cost=0 flags=child-inherit expires=never
```

(repo-0만 가동하였을 때)

```
kjwon15@malformed:~/workspace/tmp-repo <(b'd606ecf')+?> % nfdc route list
prefix=/get nexthop=284 origin=app cost=0 flags=child-inherit expires=never
prefix=/get nexthop=286 origin=app cost=0 flags=child-inherit expires=never
prefix=/get nexthop=287 origin=app cost=0 flags=child-inherit expires=never
prefix=/example/repo nexthop=284 origin=app cost=0 flags=child-inherit expires=never
prefix=/example/repo nexthop=286 origin=app cost=0 flags=child-inherit expires=never
prefix=/example/repo nexthop=287 origin=app cost=0 flags=child-inherit expires=never
prefix=/example/repo/0 nexthop=284 origin=app cost=0 flags=child-inherit expires=never
prefix=/example/repo/0/data nexthop=284 origin=app cost=0 flags=child-inherit expires=never
prefix=/example/repo/1 nexthop=286 origin=app cost=0 flags=child-inherit expires=never
prefix=/example/repo/1/data nexthop=286 origin=app cost=0 flags=child-inherit expires=never
prefix=/example/repo/2 nexthop=287 origin=app cost=0 flags=child-inherit expires=never
prefix=/example/repo/2/data nexthop=287 origin=app cost=0 flags=child-inherit expires=never
prefix=/localhost/nfd nexthop=267 origin=app cost=0 flags=child-inherit expires=never
```

(repo-0..2를 모두 가동하였을 때)

prefix	
/get	GET 요청(cli to repo)
/example/repo	PUT 요청
/example/repo/0	GET 요청(manifest, data)
/example/repo/0/data	GET(data)

1.1.2. FS tree

1.1.2.1. 처음 실행

```
.
├── 0
│   ├── data
│   └── manifest
├── 1
│   ├── data
│   └── manifest
└── 2
    ├── data
    └── manifest

9 directories, 0 files
```

1.1.2.2. 파일 put 이후

```
.
```

```
├── 0
│   ├── data
│   └── manifest
├── 1
│   ├── data
│   │   └── 64
│   │       └── ae7feac04e895299c352b42b2e98219ecc4456
│   └── manifest
└── 2
    ├── data
    └── manifest
        └── bf60b7671423e439c9858fd6b417a935bb82871f

10 directories, 2 files
```

1.1.3. Manifest

```
{
  "info": {
    "name": "/data/1/%FD%00%00%01q%9A%CA%F5%0C",
    "hash": "f1cf19a772d9d4790c7a7d7a0b46509ccb96593c",
    "startBlockId": "0",
    "endBlockId": "0"
  },
  "storages": [
    {
      "storage_name": "/example/repo/0",
      "segment": {
        "start": "0",
        "end": "0"
      }
    }
  ]
}
```

1.2. InterestFilter

1.2.1. read

prefix	
/example/repo/0/data	실제 데이터
/get	매니페스트 요청 (cli to repo)

1.2.2. write

prefix	
/example/repo/insert	데이터 삽입
/example/repo/insert check	
/example/repo/0/info	매니페스트 전달(insert)

1.2.3. manifest

prefix	
/example/repo/0/create	매니페스트 생성
/example/repo/0/find	매니페스트 조회

1.3. Code walkthrough

1.3.1. ndn part

1.3.1.1. registerPrefix

```
m_face.registerPrefix(clusterPrefix, nullptr,
  [] (const Name& clusterPrefix, const std::string& reason) {
    std::cerr << "Cluster prefix " << clusterPrefix << "
registration error: " << reason << std::endl;
```

특정 prefix를 가진 인터레스트를 받을 수 있도록 NFD의 라우트 목록에 추가한다. 이를 통해 추가적으로 NFD 라우트를 추가하지 않고도 하나의 route를 이용해 모든 데이터를 처리할 수 있다.

1.3.1.2. setInterestFilter

```
getFace().setInterestFilter(
  Name(prefix).append("create"),
  bind(&ManifestHandle::onCreateInterest, this, _1, _2));

getFace().setInterestFilter(
  Name(prefix).append("find"),
  bind(&ManifestHandle::onFindInterest, this, _1, _2));
```

특정 prefix를 가진 인터레스트를 받을 수 있도록 핸들러를 등록한다. 해당 prefix가 registerPrefix를 통해 등록 된 prefix를 가지지 않는다면 스스로 route를 등록하게 된다.

1.3.1.3. interest handler

```
void
ReadHandle::onInterest(const Name& prefix, const Interest&
interest);
```

필터로 지정한 인터레스트를 받아서 처리 할 핸들러를 구현한다.

1.3.1.4. expressInterest

```
getFace().expressInterest(
  findInterest,
  bind(&ReadHandle::onFindCommandResponse, this, _1, _2,
processId),
  bind(&ReadHandle::onFindCommandTimeout, this, _1, processId), //
Nack
  bind(&ReadHandle::onFindCommandTimeout, this, _1, processId));
```

생성한 interest를 핸들러를 지정해 face를 통해 내보낸다. processId를 통해 어떤 작업인지 식별할 수 있게 되어 있다.

1.3.1.5. reply handler

```
void
WriteHandle::onSegmentData(const Interest& interest, const Data&
data, ProcessId processId);
```

1.3.2. storage part

1.3.2.1. insertData

```
int64_t
FsStorage::insert(const Data& data)
{
  return writeData(data, DIRNAME_DATA);
}

int64_t
FsStorage::writeData(const Data& data, const char* dataType)
{
  auto name = data.getName();
  auto id = hash(name.toUri());

  Index::Entry entry(data, 0);

  boost::filesystem::path fsPath = getPath(data.getName(),
dataType);
  boost::filesystem::create_directories(fsPath.parent_path());

  std::ofstream outFileData(fsPath.string(), std::ios::binary);
  outFileData.write(
      reinterpret_cast<const char*>(data.wireEncode().wire()),
      data.wireEncode().size());

  return (int64_t)id;
```

```
}
```

기존 repo-ng와 호환성을 위해 int64_t 형식의 해시를 리턴하고 fs 스토리지에 정해진 형식대로 파일 형태로 데이터를 저장한다.

1.3.2.2. insertManifest

```
std::string
FsStorage::insertManifest(const Manifest& manifest)
{
  boost::filesystem::path fsPath = m_path / DIRNAME_MANIFEST /
manifest.getHash();

  auto json = manifest.toJson();

  std::ofstream outFile(fsPath.string());
  outFile.write(
      json.c_str(),
      json.size());

  return manifest.getHash();
}
```

기존 repo-ng와의 호환성이 필요 없기 때문에 sha1 형식의 std::string을 리턴하고 fs 스토리지에 정해진 형식대로 매니페스트를 저장한다.

1.3.2.3. deleteData/erase

```
bool
FsStorage::erase(const Name& name)
{
  auto fsPath = getPath(name, DIRNAME_DATA);

  boost::filesystem::file_status fsPathStatus =
boost::filesystem::status(fsPath);
  if (!boost::filesystem::is_directory(fsPathStatus)) {
      std::cerr << name.toUri() << " is not exists" << std::endl;
```

```
    return false;
  }

  boost::filesystem::remove_all(fsPath);
  return true;
}
```

id 대신 Name을 통해 경로를 얻어와 데이터가 들어있는 디렉터리를 삭제한다. 상위 디렉터리가 비어도 삭제하지는 않는다.

1.3.2.4. readData

```
std::shared_ptr<Data>
FsStorage::read(const Name& name)
{
  auto fsPath = getPath(name.toUri(), DIRNAME_DATA);
  auto data = make_shared<Data>();

  boost::filesystem::ifstream inFileData(fsPath,
std::ifstream::binary);
  inFileData.seekg(0, inFileData.end);
  int length = inFileData.tellg();
  inFileData.seekg(0, inFileData.beg);

  char * buffer = new char [length];
  inFileData.read(buffer, length);

  data->wireDecode(Block(reinterpret_cast<const uint8_t*>(buffer),
length));

  return data;
}
```

데이터를 읽어들여 wireDecode를 통해 Data 형식으로 디코딩 해 반환한다.

1.3.2.5. readManifest

```
Manifest
FsStorage::readManifest(const std::string hash)
```

```
{
  boost::filesystem::path fsPath = m_path / DIRNAME_MANIFEST /
hash;
  boost::filesystem::ifstream inFileData(fsPath);

  std::string json(
      (std::istreambuf_iterator<char>(inFileData)),
      std::istreambuf_iterator<char>());

  return Manifest::fromJson(json);
}
```

json형식을 읽어들여 그대로 디코딩 후 반환한다.

2. repo-ng

2.1. nfd routing

prefix	
/example/data	get
/example/repo/0	insert

2.2. Code walkthrough

2.2.1. storage part

2.2.1.1. insertData

```
bool
RepoStorage::insertData(const Data& data)
{
   bool isExist = m_index.hasData(data);
   if (isExist)
      BOOST_THROW_EXCEPTION(Error("The Entry Has Already In the
Skiplist. Cannot be Inserted!"));
   int64_t id = m_storage.insert(data);
   if (id == -1)
      return false;
   bool didInsert = m_index.insert(data, id);
   if (didInsert)
      afterDataInsertion(data.getName());
   return didInsert;
}
```

인덱스에 있는 지 확인 후 데이터를 저장하고 인덱스에 추가한다.

2.2.1.2. deleteData

```
ssize_t
```

```
RepoStorage::deleteData(const Name& name)
{
  bool hasError = false;
  std::pair<int64_t,ndn::Name> idName = m_index.find(name);
  if (idName.first == 0)
      return false;
  int64_t count = 0;
  while (idName.first != 0) {
      bool resultDb = m_storage.erase(idName.first);
      bool resultIndex = m_index.erase(idName.second); //full name
      if (resultDb && resultIndex) {
      afterDataDeletion(idName.second);
      count++;
      }
      else {
      hasError = true;
      }
      idName = m_index.find(name);
  }
  if (hasError)
      return -1;
  else
      return count;
}
```

인덱스를 검사해서 해당 prefix로 시작하는 모든 데이터를 지운 뒤 지워진 갯수를 반환한다.

2.2.1.3. readData

```
shared_ptr<Data>
RepoStorage::readData(const Interest& interest) const
{
  std::pair<int64_t,ndn::Name> idName = m_index.find(interest);
  if (idName.first != 0) {
      shared_ptr<Data> data = m_storage.read(idName.first);
      if (data) {
      return data;
      }
```

```
  }
  return shared_ptr<Data>();
}
```

2.2.2. sqlite part

2.2.2.1. fullEnumerate

```
void
SqliteStorage::fullEnumerate(const std::function<void(const
Storage::ItemMeta)>& f)
{
  sqlite3_stmt* m_stmt = 0;
  int rc = SQLITE_DONE;
  string sql = string("SELECT id, name, keylocatorHash FROM
NDN_REPO;");
  rc = sqlite3_prepare_v2(m_db, sql.c_str(), -1, &m_stmt, 0);
  if (rc != SQLITE_OK)
      BOOST_THROW_EXCEPTION(Error("Initiation Read Entries from
Database Prepare error"));
  int entryNumber = 0;
  while (true) {
      rc = sqlite3_step(m_stmt);
      if (rc == SQLITE_ROW) {

      ItemMeta item;
      item.fullName.wireDecode(Block(reinterpret_cast<const
uint8_t*>(sqlite3_column_blob(m_stmt, 1)),
                                     sqlite3_column_bytes(m_stmt,
1)));
      item.id = sqlite3_column_int(m_stmt, 0);
      item.keyLocatorHash = make_shared<const
ndn::Buffer>(sqlite3_column_blob(m_stmt, 3),

sqlite3_column_bytes(m_stmt, 3));

      try {
```

```
      f(item);
      }
      catch (...) {
      sqlite3_finalize(m_stmt);
      throw;
      }
      entryNumber++;
      }
      else if (rc == SQLITE_DONE) {
      sqlite3_finalize(m_stmt);
      break;
      }
      else {
      std::cerr << "Initiation Read Entries rc:" << rc <<
std::endl;
      sqlite3_finalize(m_stmt);
      BOOST_THROW_EXCEPTION(Error("Initiation Read Entries
error"));
      }
  }
  m_size = entryNumber;
}
```

모든 아이템을 읽어와서 인덱스에 등록한다.

2.2.2.2. insert

```
int64_t
SqliteStorage::insert(const Data& data)
{
  Name name = data.getName();

  Index::Entry entry(data, 0); //the id is not used
  int64_t id = -1;
  if (name.empty()) {
      std::cerr << "name is empty" << std::endl;
      return -1;
  }
```

```
  int rc = 0;

  sqlite3_stmt* insertStmt = 0;

  string insertSql = string("INSERT INTO NDN_REPO (id, name, data,
keylocatorHash) "
                            "VALUES (?, ?, ?, ?)");

  if (sqlite3_prepare_v2(m_db, insertSql.c_str(), -1, &insertStmt,
0) != SQLITE_OK) {
      sqlite3_finalize(insertStmt);
      std::cerr << "insert sql not prepared" << std::endl;
  }
  //Insert
  auto result = sqlite3_bind_null(insertStmt, 1);
  if (result == SQLITE_OK) {
      result = sqlite3_bind_blob(insertStmt, 2,
                            entry.getName().wireEncode().wire(),
                            entry.getName().wireEncode().size(),
SQLITE_STATIC);
  }
  if (result == SQLITE_OK) {
      result = sqlite3_bind_blob(insertStmt, 3,
                            data.wireEncode().wire(),
                            data.wireEncode().size(),
SQLITE_STATIC);
  }
  if (result == SQLITE_OK) {
      BOOST_ASSERT(entry.getKeyLocatorHash()->size() ==
ndn::util::Sha256::DIGEST_SIZE);
      result = sqlite3_bind_blob(insertStmt, 4,
                            entry.getKeyLocatorHash()->data(),
                            entry.getKeyLocatorHash()->size(),
SQLITE_STATIC);
  }

  if (result == SQLITE_OK) {
      rc = sqlite3_step(insertStmt);
      if (rc == SQLITE_CONSTRAINT) {
      std::cerr << "Insert failed" << std::endl;
      sqlite3_finalize(insertStmt);
```

```
      BOOST_THROW_EXCEPTION(Error("Insert failed"));
      }
      sqlite3_reset(insertStmt);
      m_size++;
      id = sqlite3_last_insert_rowid(m_db);
  }
  else {
      BOOST_THROW_EXCEPTION(Error("Some error with insert"));
  }

  sqlite3_finalize(insertStmt);
  return id;
}
```

3개의 blob을 바인드 한 후 insert 한 후 id를 리턴한다.

2.2.2.3. erase

```
bool
SqliteStorage::erase(const int64_t id)
{
  sqlite3_stmt* deleteStmt = 0;

  string deleteSql = string("DELETE from NDN_REPO where id = ?;");

  if (sqlite3_prepare_v2(m_db, deleteSql.c_str(), -1, &deleteStmt,
0) != SQLITE_OK) {
      sqlite3_finalize(deleteStmt);
      std::cerr << "delete statement prepared failed" << std::endl;
      BOOST_THROW_EXCEPTION(Error("delete statement prepared
failed"));
  }

  if (sqlite3_bind_int64(deleteStmt, 1, id) == SQLITE_OK) {
      int rc = sqlite3_step(deleteStmt);
      if (rc != SQLITE_DONE && rc != SQLITE_ROW) {
      std::cerr << " node delete error rc:" << rc << std::endl;
      sqlite3_finalize(deleteStmt);
      BOOST_THROW_EXCEPTION(Error(" node delete error"));
```

```
      }
      if (sqlite3_changes(m_db) != 1)
      return false;
      m_size--;
  }
  else {
      std::cerr << "delete bind error" << std::endl;
      sqlite3_finalize(deleteStmt);
      BOOST_THROW_EXCEPTION(Error("delete bind error"));
  }
  sqlite3_finalize(deleteStmt);
  return true;
}
```

id를 받아서 해당 row를 삭제한다.

2.2.2.4. read

```
shared_ptr<Data>
SqliteStorage::read(const int64_t id)
{
  sqlite3_stmt* queryStmt = 0;
  string sql = string("SELECT * FROM NDN_REPO WHERE id = ? ;");
  int rc = sqlite3_prepare_v2(m_db, sql.c_str(), -1, &queryStmt,
0);
  if (rc == SQLITE_OK) {
      if (sqlite3_bind_int64(queryStmt, 1, id) == SQLITE_OK) {
      rc = sqlite3_step(queryStmt);
      if (rc == SQLITE_ROW) {
      auto data = make_shared<Data>();
      data->wireDecode(Block(reinterpret_cast<const
uint8_t*>(sqlite3_column_blob(queryStmt, 2)),
                             sqlite3_column_bytes(queryStmt, 2)));
      sqlite3_finalize(queryStmt);
      return data;
      }
      else if (rc == SQLITE_DONE) {
      return nullptr;
      }
```

```
      else {
      std::cerr << "Database query failure rc:" << rc << std::endl;
      sqlite3_finalize(queryStmt);
      BOOST_THROW_EXCEPTION(Error("Database query failure"));
      }
      }
      else {
      std::cerr << "select bind error" << std::endl;
      sqlite3_finalize(queryStmt);
      BOOST_THROW_EXCEPTION(Error("select bind error"));
      }
      sqlite3_finalize(queryStmt);
  }
  else {
      sqlite3_finalize(queryStmt);
      std::cerr << "select statement prepared failed" << std::endl;
      BOOST_THROW_EXCEPTION(Error("select statement prepared
failed"));
  }
  return nullptr;
}
```

id를 받아서 쿼리를 날린 후 data를 디코딩 해서 반환한다.

2.2.2.5. size

```
int64_t
SqliteStorage::size()
{
  sqlite3_stmt* queryStmt = 0;
  string sql("SELECT count(*) FROM NDN_REPO ");
  int rc = sqlite3_prepare_v2(m_db, sql.c_str(), -1, &queryStmt,
0);
  if (rc != SQLITE_OK)
      {
      std::cerr << "Database query failure rc:" << rc << std::endl;
      sqlite3_finalize(queryStmt);
      BOOST_THROW_EXCEPTION(Error("Database query failure"));
      }
```

```
  rc = sqlite3_step(queryStmt);
  if (rc != SQLITE_ROW)
      {
      std::cerr << "Database query failure rc:" << rc << std::endl;
      sqlite3_finalize(queryStmt);
      BOOST_THROW_EXCEPTION(Error("Database query failure"));
      }

  int64_t nDatas = sqlite3_column_int64(queryStmt, 0);
  if (m_size != nDatas) {
      std::cerr << "The size of database is not correct! " <<
std::endl;
  }
  return nDatas;
}
```

select count(*) 쿼리를 날려 행의 갯수를 반환한다.