libENI Documentation

Release latest

Aug 02, 2019

Contents

Official C++ implementation of libENI, which is part of the Lity project.

CHAPTER 1

Contents

1.1 Getting Started

1.1.1 Download the Prebuilt libENI

See libENI releases for the latest release.

- *libeni-dev*: for ENI operation developers
- *libeni*: for general ENI users.

Releases

Version	libeni-dev	libeni
v1.3.6	Ubuntu 16.04, CentOS 7	Ubuntu 16.04, CentOS 7
v1.2.x	Ubuntu 16.04, CentOS 7	Ubuntu 16.04, CentOS 7
v1.2.0	Ubuntu 16.04, CentOS 7	Ubuntu 16.04, CentOS 7

Prerequisites

libeni-dev	libeni
• Boost >= 1.58 • OpenSSL >= 1.0.2	• OpenSSL >= 1.0.2

See Prerequisites for platform specific prerequisites guide.

Install

```
tar zxvf libeni.tgz --strip-components 1 -C ${LIBENI_PATH}
```

Validate the Shared Libraries

```
cd ${LIBENI_PATH}/lib
sha512sum -c *.so.sha512
```

You should get a list of OKs if all libraries are good.

```
eni_crypto.so: OK
eni_reverse.so: OK
eni_scrypt.so: OK
```

Test Manually

See Testing Prebuilt ENI Operations for how to test the prebuilt shared libraries of ENI operations.

1.1.2 Build From Source

Prerequisites

- Boost >= 1.58
- CMake >= 3.1
- OpenSSL >= 1.0.2
- SkyPat >= 3.1.1 (see SkyPat releases)

Download Source Code

```
git clone https://github.com/CyberMiles/libeni.git ${LIBENI_PATH}
```

Build with CMake

```
cd ${LIBENI_PATH}
mkdir build
cd build
cmake ..
make
```

Run Tests

In your build directory, run `ctest`. The result looks like the below.

```
Test project ${LIBENI_PATH}/build
      Start  1: eni_reverse_checksum_test
 1/13 Test  #1: eni_reverse_checksum_test ........   Passed    0.00 sec
      Start  2: eni_crypto_checksum_test
 2/13 Test  #2: eni_crypto_checksum_test .........   Passed    0.00 sec
      Start  3: crypto_unittests
 3/13 Test  #3: crypto_unittests .................   Passed    0.01 sec
      Start  4: eni_scrypt_checksum_test
 4/13 Test  #4: eni_scrypt_checksum_test .........   Passed    0.00 sec
      Start  5: scrypt_unittests
 5/13 Test  #5: scrypt_unittests .................   Passed    0.01 sec
      Start  6: t0000-smoke
 6/13 Test  #6: t0000-smoke ......................   Passed    0.00 sec
      Start  7: t0005-tools-eni-scrypt
 7/13 Test  #7: t0005-tools-eni-scrypt ...........   Passed    0.01 sec
      Start  8: t0004-tools-eni-crypto
 8/13 Test  #8: t0004-tools-eni-crypto ...........   Passed    0.02 sec
      Start  9: t0001-testlib
 9/13 Test  #9: t0001-testlib ....................   Passed    0.01 sec
      Start 10: t0002-examples-eni-reverse
10/13 Test #10: t0002-examples-eni-reverse .......   Passed    0.01 sec
      Start 11: consensus_tests
11/13 Test #11: consensus_tests ..................   Passed    0.07 sec
      Start 12: malformed_consensus_tests
12/13 Test #12: malformed_consensus_tests ........   Passed    0.03 sec
      Start 13: unittests
13/13 Test #13: unittests ........................   Passed    1.37 sec

100% tests passed, 0 tests failed out of 13

Label Time Summary:
auto           =   0.06 sec (8 tests)
checksum       =   0.00 sec (3 tests)
regression     =   0.13 sec (6 tests)
unittest       =   1.40 sec (3 tests)

Total Test time (real) =   1.57 sec
```

See *Testing/Temporary/LastTest.log* for the detailed output of all tests.

1.2 Developer Guide

In this tutorial, we will guide you through how to create new ENI operations with libENI in C++.

1.2.1 Prerequisites

In order to build your ENI operations, you need to install *libeni-dev* first.

See *Getting Started* for more information.

1.2.2 Contents

Implement an ENI Operation

Here, we use *examples/eni/reverse* as an example. In this example, we will create an ENI operation called *reverse* that takes a string, and returns the reversed string.

The below code piece shows how developers use this ENI operation when writing a contract in Solidity.

```
string memory reversed;
reversed = eni("reverse", "The string to be reversed.");
```

Subclass `EniBase`

In order to implement an ENI operation, you need to `#include <eni.h>`, create a subclass of `eni::EniBase`, and implement the following functions.

0. A constructor that takes a string as its parameter. Remember to pass the string to the constructor of the superclass, `eni::EniBase`, which will convert the raw string into a `json::Array` containing the arguments for your ENI operation.
1. A destructor.
2. Three pure virtual functions, which should be implement privately.
   - `parse` to parse the arguments.
   - `gas` to calculate gas consumption from the arguments.
   - `run` to execute your ENI operation with the arguments.

```
#include <eni.h>
class Reverse : public eni::EniBase {
public:
  Reverse(const std::string& pArgStr)
    : eni::EniBase(pArgStr) { ... }

  ~Reverse() { ... }

private:
  bool parse(const json::Array& pArgs) override { ... }

  eni::Gas gas() const override { ... }

  bool run(json::Array& pRetVal) override { ... }
};
```

Parse Arguments

The `parse` function takes a `json::Array` containing the arguments given to your ENI operation. To ensure the other two functions `gas` and `run` process the arguments in the same way, please validate, preprocess, and store the arguments into member variables in the `parse` function.

The `parse` function should return `true` when all arguments are good, and return `false` otherwise. (i.e. when the given arguments are not correct, e.g., lacking arguments, or wrong type).

In this example, the `json::Array` constructed by `eni::EniBase` contains only the argument string for ENI operation *reverse*.

```
["The string to be reversed."]
```

Here we just take the first argument and convert it to a string.

```
class Reverse : public eni::EniBase {
  ...
private:
  bool parse(const json::Array& pArgs) override {
    m_Str = pArgs[0].toString();
    return true;
  }

  std::string m_Str;
};
```

Check the documentation to see more detail about how arguments are converted into a `json::Array`.

Estimate Gas Consumption

Before your ENI operation is run, you need to estimate how much gas it will cost. Override the pure virtual function `gas`, and return your estimated gas cost.

In this example, we use the string length as its gas consumption.

```
class Reverse : public eni::EniBase {
  ...
private:
  eni::Gas gas() const override {
    return m_Str.length();
  }
};
```

Return `0` when error occurs (e.g., gas is incalculable).

Execute the Operation

Override the pure virtual function `run`, and push the result of your ENI operation back into the `json::Array`.

```
class Reverse : public eni::EniBase {
  ...
private:
  bool run(json::Array& pRetVal) override {
    std::string ret(m_Str.rbegin(), m_Str.rend());
    pRetVal.emplace_back(ret);
    return true;
  }
};
```

Return `true` only when your ENI operation is successfully executed.

Export the ENI Operation with C Interface

Your ENI operation will be called via its C interface, so be sure to export the C interface with `ENI_C_INTERFACE(OP, CLASS)`, where *OP* is your ENI operation name (i.e., *reverse* in this example), and

CLASS is the name of implemented class (i.e., `Reverse` in this example).

```
ENI_C_INTERFACE(reverse, Reverse)
```

Related Guides

Next: *Build ENI Operations Into a Shared Library*.

Build ENI Operations Into a Shared Library

Please add these flags `-std=c++11 -fPIC` when compiling your ENI operation into a shared library. See GCC Option Summary for explanation to these flags.

Specify the path to libENI headers with `-I${LIBENI_PATH}/include`.

You might also want to link to libENI by specifying the path `-L${LIBENI_PATH}/lib`, and the library name `-leni`.

Here is an example Makefile for *examples/eni/reverse*. Please be aware that the flags and commands might differ if you're using different compilers.

```
CPPFLAGS=-I${LIBENI_PATH}/include
CXXFLAGS=-std=c++11 -fPIC
LDFLAGS=-L${LIBENI_PATH}/lib
LDADD=-leni

all:
      g++ ${CPPFLAGS} ${CXXFLAGS} ${LDFLAGS} -shared -oeni_reverse.so eni_reverse.cpp
↪${LDADD}
```

Related Guides

Next: *Test Your ENI Operations*. Previous: *Implement an ENI Operation*.

Test Your ENI Operations

Test From `EniBase` Interface

Your ENI operations will only be accessed from the two public member functions of `eni::EniBase`.

- `Gas getGas()` should return the gas cost of your ENI operation.
- `char* start()` should run your ENI operation and return the results in JSON format.

You may test your subclass through these two public functions.

```
eni::EniBase* functor = new Reverse("[\"Hello World\"]");
ASSERT_NE(functor, nullptr);
EXPECT_EQ(functor->getGas(), 12);
char* ret = functor->start();
EXPECT_EQ(::strcmp(ret, "[\"!dlroW olleH\"]"), 0);
free(ret);
delete functor;
```

Test From Shared Library Interface

Setup Environment

Make sure libENI can be found in your environment. See Getting Started for how to install libENI.

You might want to try the following settings if libENI is installed but not found in your environment.

```
PATH=${PATH}:${LIBENI_PATH}/bin
LD_LIBRARY_PATH=${LD_LIBRARY_PATH}:${LIBENI_PATH}/lib
```

Tools for Testing

Related Guides

Previous: *Build ENI Operations Into a Shared Library*.

1.3 Documentation

1.3.1 Types

ENI Types

These types are provided to be coherent with primitive types of Lity (Solidity).

ENI Integers

All integer types in ENI is implemented using boost::multiprecision::number. Some of them are aliases for types predefined in boost::multiprecision::cpp_int.

Integer Type	Size (bits)	Signed	Note
`eni::s256`	256	✓	Alias for `boost::multiprecision::int256_t`.
`eni::Int`	256	✓	Alias for `eni::s256`.
`eni::u256`	256		Alias for `boost::multiprecision::uint256_t`.
`eni::u160`	160		Size of an Ethereum address.
`eni::u128`	128		Alias for `boost::multiprecision::uint128_t`.
`eni::u64`	64		
`eni::UInt`	256		Alias for `eni::u256`.

Operations on ENI Integers

See the documentation for boost::multiprecision::number for supported operations.

Suggested Use of ENI Integers

This section does not exist yet. *(´-ι_-‘)*

ENI Boolean

`eni::Bool` is an alias for C++ `bool`.

ENI Address

`eni::Address` is an alias for `eni::u160` (20 bytes, size of an Ethereum address).

Convert ENI Types to C++ String

`eni::to_string` uses boost::lexical_cast internally to convert ENI types to `std::string`.

All ENI integers, `eni::Bool`, `eni::Address` are supported.

```
std::string to_string(eni::TypeName);
```

Usage

```
eni::Int int32max(2147483647);
std::string s = eni::to_string(int32max); // "2147483647"

eni::Bool bTrue(true);
std::string t = eni::to_string(bTrue);    // "true"
```

Abstract Data Types

See `eni::Vector` and `eni::StringMap`.

This section does not exist yet. *(´-ι_-`)*

JSON Types

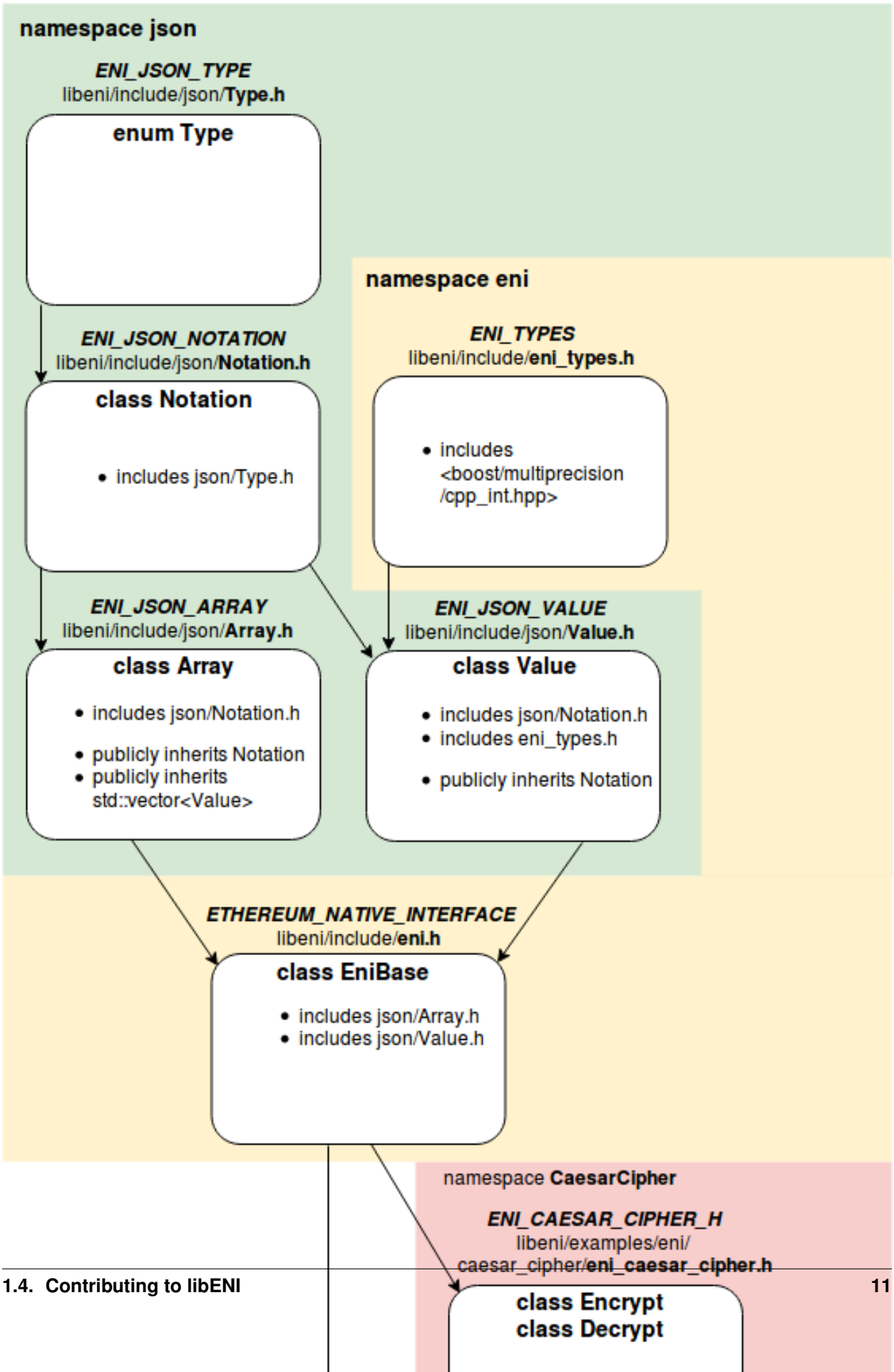
This section does not exist yet. *(´-ι_-`)*

1.4 Contributing to libENI

See *Getting Started* for how to build libENI.

1.4.1 Overview of libENI Code

The following image illustrates the libENI code hierarchy and the use of namespaces.


namespace json
ENI_JSON_TYPE
libeni/include/json/Type.h
enum Type
namespace eni
ENI_JSON_NOTATION
libeni/include/json/Notation.h
class Notation
includes json/Type.h
ENI_TYPES
libeni/include/eni_types.h
includes <boost/multiprecision /cpp_int.hpp>
ENI_JSON_ARRAY
libeni/include/json/Array.h
class Array
includes json/Notation.h
publicly inherits Notation
publicly inherits std::vector<Value>
ENI_JSON_VALUE
libeni/include/json/Value.h
class Value
includes json/Notation.h
includes eni_types.h
publicly inherits Notation
ETHEREUM_NATIVE_INTERFACE
libeni/include/eni.h
class EniBase
includes json/Array.h
includes json/Value.h
namespace CaesarCipher
ENI_CAESAR_CIPHER_H
libeni/examples/eni/caesar_cipher/eni_caesar_cipher.h
class Encrypt
class Decrypt

Directory Structure

Path	Description
docs/	Documentations.
examples/	Examples of how to use libENI.
include/	Header files for libENI.
lib/	Implementations for libENI.
test/	All tests for libENI and its examples.
tools/	Tools and modules for libENI.

1.4.2 Report an Issue

Please provide the following information as much as possible.

- The version (commit-ish) your using.
- Your platform, environment setup, etc.
- Steps to reproduce the issue.
- Your expected result of the issue.
- Current result of the issue.

1.4.3 Create a Pull Request

- Fork from the *master* branch.
- Avoid to create merge commits when you update from *master* by using `git rebase` or `git pull --rebase` (instead of `git merge`).
- Add test cases for your pull request if you're proposing new features or major bug fixes.
- Build and test locally before submit your pull request. See *Getting Started* for how to test libENI.

Please try to follow the existing coding style of libENI (although it is neither well-styled nor documented at this moment), which is basically based on LLVM coding standards.