

The GNU Taler merchant backend operator tutorial

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This manual is for the GNU Taler merchant backend (version 0.3.0, 2 June 2017),
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1 Introduction

1.1 About GNU Taler

GNU Taler is an open protocol for an electronic payment system with a free software reference implementation. GNU Taler offers secure, fast and easy payment processing using well understood cryptographic techniques. GNU Taler allows customers to remain anonymous, while ensuring that merchants can be held accountable by governments. Hence, GNU Taler is compatible with anti-money-laundering (AML) and know-your-customer (KYC) regulation, as well as data protection regulation (such as GDPR).

GNU Taler is not yet production-ready, after following this manual you will have a backend that can process payments in “KUDOS”, but not regular currencies. This is not so much because of limitations in the backend, but because we are not aware of a Taler exchange operator offering regular currencies today.

1.2 About this manual

This tutorial targets system administrators who want to install a GNU Taler merchant *backend*.

We expect some moderate familiarity with the compilation and installation of free software packages. An understanding of cryptography is not required.

This first chapter of the tutorial will give a brief overview of the overall Taler architecture, describing the environment in which the Taler backend operates. The second chapter then explains how to install the software, including key dependencies. The third chapter will explain how to configure the backend, including in particular the configuration of the bank account details of the merchant.

The last chapter gives some additional information about advanced topics which will be useful for system administrators but are not necessary for operating a basic backend.

1.3 Architecture overview

Taler is a pure payment system, not a new crypto-currency. As such, it operates in a traditional banking context. In particular, this means that in order to receive funds via Taler, the merchant must have a regular bank account, and payments can be executed in ordinary currencies such as USD or EUR. For testing purposes, Taler uses a special currency “KUDOS” and includes its own special bank.

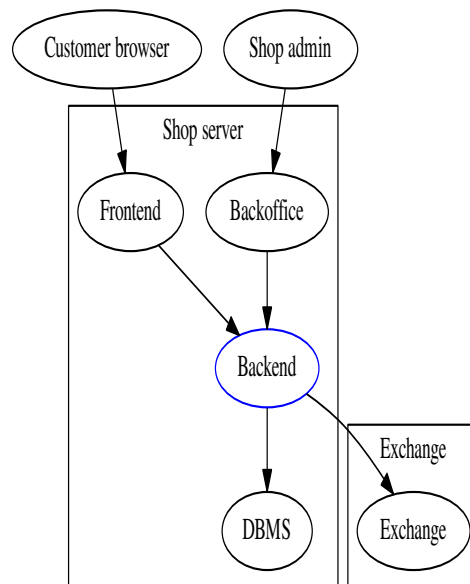
The Taler software stack for a merchant consists of four main components:

- A frontend which interacts with the customer’s browser. The frontend enables the customer to build a shopping cart and place an order. Upon payment, it triggers the respective business logic to satisfy the order. This component is not included with Taler, but rather assumed to exist at the merchant. This manual describes how to integrate Taler with Web shop frontends.
- A back office application that enables the shop operators to view customer orders, match them to financial transfers, and possibly approve refunds if an order cannot be satisfied. This component is again not included with Taler, but rather assumed to

exist at the merchant. This manual will describe how to integrate such a component to handle payments managed by Taler.

- A Taler-specific payment backend which makes it easy for the frontend to process financial transactions with Taler. The next two chapters will describe how to install and configure this backend.
- A DBMS which stores the transaction history for the Taler backend. For now, the GNU Taler reference implementation only supports Postgres, but the code could be easily extended to support another DBMS.

The following image illustrates the various interactions of these key components:



Basically, the backend provides the cryptographic protocol support, stores Taler-specific financial information in a DBMS and communicates with the GNU Taler exchange over the Internet. The frontend accesses the backend via a RESTful API. As a result, the frontend never has to directly communicate with the exchange, and also does not deal with sensitive data. In particular, the merchant's signing keys and bank account information is encapsulated within the Taler backend.

2 Installation

This chapter describes how to install the GNU Taler merchant backend.

2.1 Installing Taler using Docker

This section provides instructions for the merchant backend installation using ‘Docker’.

For security reasons, we run Docker against a VirtualBox instance, so the `docker` command should connect to a `docker-machine` instance that uses the VirtualBox driver.

Therefore, the needed tools are: “docker“, “docker-machine“, and “docker-compose“. Please refer to Docker’s official¹ documentation in order to get those components installed, as that is not in this manual’s scope.

Before starting to build the merchant’s image, make sure a “docker-machine“ instance is up and running.

Because all of the Docker source file are kept in our “deployment“ repository, we start by checking out the `git://taler.net/deployment` codebase:

```
$ git clone git://taler.net/deployment
```

Now we actually build the merchant’s image. From the same directory as above:

```
$ cd deployment/docker/merchant/  
$ docker-compose build
```

If everything worked as expected, the merchant is ready to be launched. From the same directory as the previous step:

```
# Recall: the docker-machine should be up and running.  
$ docker-compose up
```

You should see some live logging from all the involved containers. At this stage of development, you should also ignore some (harmless) error message from postgresql about already existing roles and databases.

To test if everything worked as expected, it suffices to issue a simple request to the merchant, as:

```
$ curl http://$(docker-machine ip)/  
# A greeting message should be returned by the merchant.
```

2.2 Generic instructions

This section provides generic instructions for the merchant backend installation independent of any particular operating system. Operating system specific instructions are provided in the following sections. You should follow the operating system specific instructions if those are available, and only consult the generic instructions if no system-specific instructions are provided for your specific operating system.

2.2.1 Installation of dependencies

The following packages need to be installed before we can compile the backend:

- `autoconf` \geq 2.69
- `automake` \geq 1.14

¹ <https://docs.docker.com/>

- libtool \geq 2.4
- autopoint \geq 0.19
- libltdl \geq 2.4
- libunistring \geq 0.9.3
- libcurl \geq 7.26 (or libgnurl \geq 7.26)
- GNU libmicrohttpd \geq 0.9.39
- GNU libgcrypt \geq 1.6
- libjansson \geq 2.7
- Postgres \geq 9.4, including libpq
- libgnunetutil (from Git)
- GNU Taler exchange (from Git)

Except for the last two, these are available in most GNU/Linux distributions and should just be installed using the respective package manager.

The following sections will provide detailed instructions for installing the libgnunetutil and GNU Taler exchange dependencies.

2.2.2 Installing libgnunetutil

Before you install libgnunetutil, you must download and install the dependencies mentioned in the previous section, otherwise the build may succeed but fail to export some of the tooling required by Taler.

To download and install libgnunetutil, proceed as follows:

```
$ git clone https://gnunet.org/git/gnunet/
$ cd gnunet/
$ ./bootstrap
$ ./configure [--prefix=GNUNETPFX]
$ # Each dependency can be fetched from non standard locations via
$ # the '--with-<LIBNAME>' option. See './configure --help'.
$ make
# make install
```

If you did not specify a prefix, GNUnet will install to `/usr/local`, which requires you to run the last step as `root`.

2.2.3 Installing the GNU Taler exchange

After installing GNUnet, you can download and install the exchange as follows:

```
$ git clone git://taler.net/exchange
$ cd exchange
$ ./bootstrap
$ ./configure [--prefix=EXCHANGEPPFX] \
              [--with-gnunet=GNUNETPFX]
$ # Each dependency can be fetched from non standard locations via
$ # the '--with-<LIBNAME>' option. See './configure --help'.
$ make
# make install
```


If you did not specify a prefix, the exchange will install to `/usr/local`, which requires you to run the last step as root. Note that you have to specify `--with-gnunet=/usr/local` if you installed GNUnet to `/usr/local` in the previous step.

2.2.4 Installing the GNU Taler merchant backend

The following steps assume all dependencies are installed.

Use the following commands to download and install the merchant backend:

```
$ git clone git://taler.net/merchant
$ cd merchant
$ ./bootstrap
$ ./configure [--prefix=PREFIX] \
               [--with-gnunet=GNUNETPREFIX] \
               [--with-exchange=EXCHANGEPREFIX]
$ # Each dependency can be fetched from non standard locations via
$ # the '--with-<LIBNAME>' option. See './configure --help'.
$ make
$ make install
```

Note that you have to specify `--with-exchange=/usr/local` and/or `--with-exchange=/usr/local` if you installed the exchange and/or GNUnet to `/usr/local` in the previous steps.

2.3 Installing Taler on Debian GNU/Linux

Debian wheezy is too old and lacks most of the packages required.

On Debian jessie, only GNU libmicrohttpd needs to be compiled from source. To install dependencies on Debian jesse, run the following commands:

```
# apt-get install \
  autoconf \
  automake \
  autopoint \
  libtool \
  libltdl-dev \
  libunistring-dev \
  libcurl4-gnutls-dev \
  libgcrypt20-dev \
  libjansson-dev \
  libpq-dev \
  postgresql-9.4
# wget https://ftp.gnu.org/gnu/libmicrohttpd/libmicrohttpd-latest.tar.gz
# wget https://ftp.gnu.org/gnu/libmicrohttpd/libmicrohttpd-latest.tar.gz.sig
# gpg -v libmicrohttpd-latest.tar.gz # Should show signed by 939E6BE1E29FC3CC
# tar xf libmicrohttpd-latest.tar.gz
# cd libmicrohttpd-0*
# ./configure
# make install
```

For more recent versions of Debian, you should instead run:

```
# apt-get install \  
  autoconf \  
  automake \  
  autopoint \  
  libtool \  
  libltdl-dev \  
  libunistring-dev \  
  libcurl4-gnutls-dev \  
  libgcrypt20-dev \  
  libjansson-dev \  
  libpq-dev \  
  postgresql-9.5 \  
  libmicrohttpd-dev
```

For the rest of the installation, follow the generic installation instructions starting with the installation of libgnunetutil. Note that if you used the Debian wheezy instructions above, you need to pass `--with-microhttpd=/usr/local/` to all `configure` invocations.

3 How to configure the merchant's backend

The installation already provides reasonable defaults for most of the configuration options. However, some must be provided, in particular the database account and bank account that the backend should use. By default, the file `$HOME/.config/taler.conf` is where the Web shop administrator specifies configuration values that augment or override the defaults. The format of the configuration file is the well-known INI file format. You can edit the file by hand, or use the `taler-config` commands given as examples. For more information on `taler-config`, see [Section 5.2 \[Using taler-config\]](#), page 14.

3.1 Backend options

The following table describes the options that commonly need to be modified. Here, the notation `[$section]/$option` denotes the option `$option` under the section `[$section]` in the configuration file.

Service address

The following option sets the transport layer address used by the merchant backend:

```
[merchant]/serve = TCP | UNIX
```

If given,

- TCP, then we need to set the TCP port in `[merchant]/port`
- UNIX, then we need to set the unix domain socket path and mode in `[merchant]/unixpath` and `[merchant]/unixpath_mode`. The latter takes the usual permission mask given as a number, e.g. 660 for user/group read-write access.

The frontend can then connect to the backend over HTTP using the specified address. If frontend and backend run within the same operating system, the use of a UNIX domain socket is recommended to avoid accidentally exposing the backend to the network.

To run the Taler backend on TCP port 8888, use:

```
$ taler-config -s merchant -o serve -V TCP
$ taler-config -s merchant -o port -V 8888
```

Currency Which currency the Web shop deals in, i.e. “EUR” or “USD”, is specified using the option

```
[taler]/currency
```

For testing purposes, the currency MUST match “KUDOS” so that tests will work with the Taler demonstration exchange at <https://exchange.demo.taler.net/>:

```
$ taler-config -s taler -o currency -V KUDOS
```

Database In principle is possible for the backend to support different DBMSs. The option

```
[merchant]/db
```

specifies which DBMS is to be used. However, currently only the value "postgres" is supported. This is also the default.

In addition to selecting the DBMS software, the backend requires DBMS-specific options to access the database.

For postgres, you need to provide:

```
[merchantdb-postgres]/config
```

This option specifies a postgres access path using the format `postgres:///DBNAME`, where `DBNAME` is the name of the Postgres database you want to use. Suppose `$USER` is the name of the user who will run the backend process. Then, you need to first run

```
$ sudo -u postgres createuser -d $USER
```

as the Postgres database administrator (usually `postgres`) to grant `$USER` the ability to create new databases. Next, you should as `$USER` run:

```
$ createdb $DBNAME
```

to create the backend’s database. Here, `DBNAME` must match the database name given in the configuration file.

To configure the Taler backend to use this database, run:

```
$ taler-config -s merchantdb-postgres -o CONFIG \
-V postgres:///DBNAME
```

Exchange To add an exchange to the list of trusted payment service providers, you create a section with a name that starts with “merchant-exchange-”. In that section, the following options need to be configured:

- The “uri” option specifies the exchange’s base URL. For example, to use the Taler demonstrator use:

```
$ taler-config -s merchant-exchange-demo -o URI \
-V https://exchange.demo.taler.net/
```

- The “master_key” option specifies the exchange’s master public key in base32 encoding. For the Taler demonstrator, use:

```
$ taler-config -s merchant-exchange-demo -o master_key \
-V CQQZ9DY3MZ1ARMN5K1VKDETSO4Y2QCKMMCFHZSWJWWVN82BTTH00
```

Note that multiple exchanges can be added to the system by using different tokens in place of `demo` in the example above. Note that all of the exchanges must use the same currency. If you need to support multiple currencies, you need to configure a backend per currency.

Wireformat

In order to receive payments, the merchant backend needs to communicate bank account details to the exchange. The banking system used is specified using the following global option:

```
[merchant]/wireformat
```

The value `test` can be used to interact with the Taler demonstrator at <https://bank.demo.taler.net/>:

```
$ taler-config -s merchant -o wireformat -V test
```

Other wireformats will be supported in the future to interact with actual banks.

Instances The backend allows the user to run multiple instances of shops with distinct business entities against a single backend. Each instance uses its own bank account and key for signing contracts. It is mandatory to configure a "default" instance. The specific configuration format depends slightly on the banking system selected via the `wireformat` option.

- For the `test` wire format, a sample specification looks as follows:

```
{
  "type": "test",
  "bank_uri": "https://bank.demo.taler.net/",
  "account_number": 5,
  "salt": "RANDOMSALT"
}
```

These bank details are included in the contract in their hashed form. Hence, the random `salt` is necessary to make it difficult for customers to invert the hash by brute-force.

You should substitute the account number with your actual account number. In order to get an account number, register at our demonstration bank at <https://bank.demo.taler.net/> using your browser.

The option `test_response_file` in the section `merchant-instance-wireformat-default` specifies the path to this file. Assuming this JSON specification is stored in a file `$TEST.json`, then run:

```
$ taler-config -s merchant-instance-wireformat-default \
  -o test_response_file -V $TEST.json
```

Note that additional instances can be specified using different tokens in the section name instead of `default`.

3.2 Sample backend configuration

The following is an example for a complete backend configuration:

```
[merchant]
wireformat = TEST
serve = TCP
port = 8888
currency = EUR
database = postgres

[merchant-instance-default]
KEYFILE = $DATADIR/key.priv

[merchant-instance-wireformat-default]
TEST_RESPONSE_FILE = $DATADIR/test.json

[merchantedb-postgres]
config = postgres:///donations

[merchant-demoexchange]
uri = https://exchange.demo.taler.net/
master_key = CQQZ9DY3MZ1ARMN5K1VKDETS04Y2QCKMMCFHWSWJWVWN82BTTH00
```

Given the above configuration, the backend will use a database named `donations` within Postgres.

The backend will deposit the coins it receives to the exchange at <https://exchange.demo.taler.net/>, which has the master key `"CQQZ9DY3MZ1ARMN5K1VKDETS04Y2QCKMMCFH2SWJWWVN82BTTH00"`.

Please note that `doc/config.sh` will walk you through all configuration steps, showing how to invoke `taler-config` for each of them.

3.3 Launching the backend

Assuming you have configured everything correctly, you can launch the merchant backend using:

```
$ taler-merchant-httpd
```

When launched for the first time, this command will print a message about generating your private key. If everything worked as expected, the command

```
$ curl http://localhost:8888/
```

should return the message

```
Hello, I'm a merchant's Taler backend. This HTTP server is not for humans.
```

Please note that your backend is right now likely globally reachable. Production systems should be configured to bind to a UNIX domain socket or properly restrict access to the port.

4 Testing

The tool `taler-merchant-generate-payments` can be used to test the merchant backend installation. It implements all the payment's steps in a programmatically way, relying on the backend you give it as input. Note that this tool gets installed along all the merchant backend's binaries.

This tool gets configured by a config file, that must have the following layout:

```
[payments-generator]

# The exchange used during the test: make sure the merchant backend
# being tested accpets this exchange.
# If the sysadmin wants, she can also install a local exchange
# and test against it.
exchange = https://exchange.demo.taler.net/

# This value must indicate some URL where the backend
# to be tested is listening; it doesn't have to be the
# "official" one, though.
merchant = http://localbackend/

# This value is used when the tool tries to withdraw coins,
# and must match the bank used by the exchange. If the test is
# done against the exchange at https://exchange.demo.taler.net/,
# then this value can be "https://bank.demo.taler.net/".
bank = https://bank.demo.taler.net/

# The merchant instance in charge of serving the payment.
# Make sure this instance has a bank account at the same bank
# indicated by the 'bank' option above.
instance = default

# The currency used during the test. Must match the one used
# by merchant backend and exchange.
currency = KUDOS
```

Run the test in the following way:

```
$ taler-merchant-generate-payments [-c config] [-e EURI] [-m MURI]
```

the argument `config` given to `-c` points to the configuration file and is optional - `~/config/taler.conf` will be checked by default. By default, the tool forks two processes: one for the merchant backend, and one for the exchange. The option `-e` (`-m`) avoids any exchange (merchant backend) fork, and just runs the generator against the exchange (merchant backend) running at EURI (MURI).

Please NOTE that the generator contains *hardcoded* values, as for deposit fees of the coins it uses. In order to work against the used exchange, those values MUST match the ones used by the exchange.

The following example shows how the generator "sets" a deposit fee of EUR:0.01 for the 5 EURO coin.

```
// from <merchant_repository>/src/sample/generate_payments.c
{ .oc = OC_PAY,
  .label = "deposit-simple",
  .expected_response_code = MHD_HTTP_OK,
  .details.pay.contract_ref = "create-proposal-1",
  .details.pay.coin_ref = "withdraw-coin-1",
  .details.pay.amount_with_fee = concat_amount (currency, "5"),
  .details.pay.amount_without_fee = concat_amount (currency, "4.99") },
```

The logic calculates the deposit fee according to the subtraction: `amount_with_fee - amount_without_fee`.

The following example shows a 5 EURO coin configuration - needed by the used exchange - which is compatible with the hardcoded example above.

```
[coin_eur_5]
value = EUR:5
duration_overlap = 5 minutes
duration_withdraw = 7 days
duration_spend = 2 years
duration_legal = 3 years
fee_withdraw = EUR:0.00
fee_deposit = EUR:0.01 # important bit
fee_refresh = EUR:0.00
fee_refund = EUR:0.00
rsa_keysize = 1024
```

If the command terminates with no errors, then the merchant backend is correctly installed.

After this operation is done, the merchant database will have some dummy data in it, so it may be convenient to clean all the tables; to this purpose, issue the following command:

```
$ taler-merchant-dbinit -r
```


5 Advanced topics

5.1 Configuration in Taler

In Taler realm, any component obeys to the same pattern to get configuration values. According to this pattern, once the component has been installed, the installation deploys default values in `/${prefix}/share/taler/config.d/`, in `.conf` files. In order to override these defaults, the user can write a custom `.conf` file and either pass it to the component at execution time, or name it `taler.conf` and place it under `$HOME/.config/`.

A config file is a text file containing *sections*, and each section contains its *values*. The right format follows:

```
[section1]
value1 = string
value2 = 23

[section2]
value21 = string
value22 = /path22
```

Throughout any configuration file, it is possible to use `$`-prefixed variables, like `$VAR`, especially when they represent filesystem paths. It is also possible to provide defaults values for those variables that are unset, by using the following syntax: `${VAR:-default}`. However, there are two ways a user can set `$`-prefixable variables:

by defining them under a `[paths]` section, see example below,

```
[paths]
TALER_DEPLOYMENT_SHARED = ${HOME}/shared-data
..
[section-x]
path-x = ${TALER_DEPLOYMENT_SHARED}/x
```

or by setting them in the environment:

```
$ export VAR=/x
```

The configuration loader will give precedence to variables set under `[path]`, though.

The utility `taler-config`, which gets installed along with the exchange, serves to get and set configuration values without directly editing the `.conf`. The option `-f` is particularly useful to resolve pathnames, when they use several levels of `$`-expanded variables. See `taler-config --help`.

Note that, in this stage of development, the file `$HOME/.config/taler.conf` can contain sections for *all* the component. For example, both an exchange and a bank can read values from it.

The repository `git://taler.net/deployment` contains examples of configuration file used in our demos. See under `deployment/config`.

Note: Expectably, some components will not work just by using default values, as their work is often interdependent. For example, a merchant needs to know an exchange URL, or a database name.

5.2 Using `taler-config`

The tool `taler-config` can be used to extract or manipulate configuration values; however, the configuration use the well-known INI file format and can also be edited by hand.

Run

```
$ taler-config -s $SECTION
```

to list all of the configuration values in section `$SECTION`.

Run

```
$ taler-config -s $section -o $option
```

to extract the respective configuration value for option `$option` in section `$section`.

Finally, to change a setting, run

```
$ taler-config -s $section -o $option -V $value
```

to set the respective configuration value to `$value`. Note that you have to manually restart the Taler backend after you change the configuration to make the new configuration go into effect.

Some default options will use `$`-variables, such as `$DATADIR` within their value. To expand the `$DATADIR` or other `$`-variables in the configuration, pass the `-f` option to `taler-config`. For example, compare:

```
$ taler-config -s merchant-instance-wireformat-default \
  -o test_response_file
$ taler-config -f -s merchant-instance-wireformat-default \
  -o test_response_file
```

While the configuration file is typically located at `$HOME/.config/taler.conf`, an alternative location can be specified to `taler-merchant-httpd` and `taler-config` using the `-c` option.

5.3 Merchant key management

The option “KEYFILE” in the section “merchant-instance-default” specifies the path to the instance’s private key. You do not need to create a key manually, the backend will generate it automatically if it is missing. While generally unnecessary, it is possible to display the corresponding public key using the `gnunet-ecc` command-line tool:

```
$ gnunet-ecc -p \
  $(taler-config -f -s merchant-instance-default \
    -o keyfile)
```

5.4 Using the SEPA wire transfer method

The following is a sample configuration for the SEPA wire transfer method:¹.

```
{
  "type": "SEPA",
  "IBAN": "XY00 1111 2222 3333 4444 5555 6666",
```

¹ Supporting SEPA is still work in progress; the backend will accept this configuration, but the exchange will not work with SEPA today.

```
"name": "Taler charity program",  
"BIC": "XXXXAB99",  
"salt": "RANDOMSALT"  
}
```

We will now assume that this information is stored in file `${DATADIR}/sepa.json`. Then, to configure the backend for SEPA payments in EUR, the following configuration options need to be set:

```
$ taler-config -s merchant -o currency -V EUR  
$ taler-config -s merchant -o wireformat -V sepa  
$ taler-config -s merchant-instance-wireformat-default \  
    -o sepa_response_file -V ${DATADIR}/sepa.json
```

Please note that you will also have to configure an exchange and/or auditors that support SEPA. However, we cannot explain how to do this yet as such entities do not yet exist. Once such entities do exist, we expect future versions of the Taler backend to ship with pre-configured exchanges and auditors for common denominations.

GNU-LGPL

Version 2.1, February 1999

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51 Franklin Street, Fifth Floor, Boston, MA 02110-1301, USA

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[This is the first released version of the Lesser GPL. It also counts as the successor of the GNU Library Public License, version 2, hence the version number 2.1.]

Preamble

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Although the Lesser General Public License is *Less* protective of the users' freedom, it does ensure that the user of a program that is linked with the Library has the freedom and the wherewithal to run that program using a modified version of the Library.

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(For example, a function in a library to compute square roots has a purpose that is entirely well-defined independent of the application. Therefore, Subsection 2d requires that any application-supplied function or table used by this function must be optional: if the application does not supply it, the square root function must still compute square roots.)

These requirements apply to the modified work as a whole. If identifiable sections of that work are not derived from the Library, and can be reasonably considered independent and separate works in themselves, then this License, and its terms, do not apply

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This option is useful when you wish to copy part of the code of the Library into a program that is not a library.

4. You may copy and distribute the Library (or a portion or derivative of it, under Section 2) in object code or executable form under the terms of Sections 1 and 2 above provided that you accompany it with the complete corresponding machine-readable source code, which must be distributed under the terms of Sections 1 and 2 above on a medium customarily used for software interchange.

If distribution of object code is made by offering access to copy from a designated place, then offering equivalent access to copy the source code from the same place satisfies the requirement to distribute the source code, even though third parties are not compelled to copy the source along with the object code.

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However, linking a “work that uses the Library” with the Library creates an executable that is a derivative of the Library (because it contains portions of the Library), rather than a “work that uses the library”. The executable is therefore covered by this License. Section 6 states terms for distribution of such executables.

When a “work that uses the Library” uses material from a header file that is part of the Library, the object code for the work may be a derivative work of the Library even though the source code is not. Whether this is true is especially significant if the work can be linked without the Library, or if the work is itself a library. The threshold for this to be true is not precisely defined by law.

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Otherwise, if the work is a derivative of the Library, you may distribute the object code for the work under the terms of Section 6. Any executables containing that work also fall under Section 6, whether or not they are linked directly with the Library itself.

6. As an exception to the Sections above, you may also combine or link a “work that uses the Library” with the Library to produce a work containing portions of the Library, and distribute that work under terms of your choice, provided that the terms permit modification of the work for the customer’s own use and reverse engineering for debugging such modifications.

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- b. Use a suitable shared library mechanism for linking with the Library. A suitable mechanism is one that (1) uses at run time a copy of the library already present on the user’s computer system, rather than copying library functions into the executable, and (2) will operate properly with a modified version of the library, if the user installs one, as long as the modified version is interface-compatible with the version that the work was made with.
- c. Accompany the work with a written offer, valid for at least three years, to give the same user the materials specified in Subsection 6a, above, for a charge no more than the cost of performing this distribution.
- d. If distribution of the work is made by offering access to copy from a designated place, offer equivalent access to copy the above specified materials from the same place.
- e. Verify that the user has already received a copy of these materials or that you have already sent this user a copy.

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Version 3, 19 November 2007

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for a price no more than your reasonable cost of physically performing this conveying of source, or (2) access to copy the Corresponding Source from a network server at no charge.

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