MQTT Client provider

(Publisher)

Version 1.3.1

User's guide

August 30 2021

[Remarks]

[Revision history]

Version	Date	Content
1.0.0	2016-12-15	First edition.
1.1.0	2017-07-19	"Type option" was added to the AddVariable command.
1.2.0	2018-05-29	Added exclusive control to initialization and termination of Mosquitto library. Supports SSL communication.
1.2.1	2018-07-31	"AddController" was corrected.
1.2.2	2019-07-24	CodePage support for topics and messages.
1.3.0	2020-05-21	Change client authentication for secure communication arbitrarily.
1.3.0	2020-08-31	Added cause and solution for error code 0x8010000F.
1.3.1	2021-08-30	Internal code optimization.

[Hardware]

Model	Version	Notes

Content

1. Introduction

This document is a user's guide of a CAO provider that works as a MQTT client to publish messages for MTQQ Broker.

CAO provider described in this document is called PUBLISHER provider (CaoProvMQTT_PUBLISHER.dll).

Chapter2 describes the overview of PUBLISHER provider, and details about variables.

PUBLISHER provider uses an open source Mosquitto library to use MQTT protocol for communication.

For details about MQTT protocol and Mosquitto library, refer to the following URL.

The operation of MQTT Client as SUBSCRIBER is implemented in the SUBSCRIBER provider (CaoProvMQTT_SUBSCRIBER.dll) that is another MQTT Client provider.

For details about SUBSCRIBER provider, refer to SUBSCRIBER provider user's guide.

In order to use this provider, "Visual C++ Redistributable for Visual Studio 2015" is required.

[Reference site links]

http://mqtt.org/

http://mosquitto.org/

2. Outline of this provider

2.1. Outline

PUBLISHER provider is a CAO provider that publishes messages to MQTT Broker with Mosquitto library. The file format is DLL (Dynamic Link Library) and it is dynamically uploaded from the CAO engine. To use PUBLISHER provider, you need to install ORiN2SDK, or, complete registration manually with the procedure shown below.

Table 2-1 PUBLISHER provider

File name	CaoProvMQTT_PUBLISHER.dll
ProgID	CaoProv.MQTT_PUBLISHER
Registration	regsvr32 CaoProvMQTT_PUBLISHER.dll
De-registration	regsvr32 /u CaoProvMQTT_PUBLISHER.dll

2.2. Method and Properties

2.2.1. CaoWorkspace::AddController method

PUBLISHER provider establishes communication by referring to the connection parameters for communication with MQTT Broker when AddController is executed. (It functions as a MQTT Client.)

Syntax AddController(<bstrCtrlName:BSTR>,<bstrProvName:BSTR>,
<bstrPCName:BSTR>,<bstrOption:BSTR>))

bstrCtrlName : [in] Controller name
bstrProvName : [in] Provider name. Fixed to " CaoProv.MQTT_PUBLISHER"
bstrPcName : [in] Computer name where the provider runs.
bstrOption : [in] Option string

The following shows a list of option string items.

Table 2-2 Option strings of CaoWorkspace::AddController

Option [1]	Description
Conn=<host>[:<port>[:<keepalive>]]]	Required. Connection parameter. (Refer to 2.2.1.1)
ID[=<ID string>]	ID string of a Client (When omitting this, it generates a unique ID based on GUIDE instead.)
User[=<User name>[:<Password>]]	User/Password authorization setting (This entry remains empty if it is omitted.)
MqttProtocol[=<version>]	MQTT protocol version used for communication. (Refer to 2.2.1.2)
Will[=<topic>:<payload>[:<qos>[:<retain>]]]	Will settings (Refer to 2.2.1.3)
ConnTimeout[=<Timeout period >]	Timeout period for connection (millisecond) (Default : 500)
Timeout[=<Timeout period >]	Timeout period at the request sending (millisecond) (Default : 500)
CA[=<CA certificate file name >][2]	Specify a certificate file name of CA (certificate

[1] Items enclosed with square brackets ("[]") are omittable. Underlined part shows the default value when the option is not specified.
[2] Secure communication is performed when the CA option is specified. To perform client authentication, specify Certificate, PrivateKey, PKPassword.

	authority). (Default: null)
Certificate[=<Certificate file name >][2]	Specify a certificate file name. (Default: null)
PrivateKey[=<Private key file name >][2]	Specify a private key file name. (Default: null)
PKPassword[=<Password>][2]	Specify a password of private key
Insecure[=<True/False>]	Specify whether to skip the server's certificate and server consistency check when connecting secure communications. True: Skip the check. False: Do not skip check (default)

2.2.1.1. Conn option

The following shows connection parameter strings for Conn option.

"Conn=<host>[:<port>[:<keepalive>]]]"

<host>	:	Connection destination host name or IP address Example : "localhost", "192.168.0.1"
<port>	:	Connection port number 1883, 8883, … any number (Default: 1883)
<keepalive>	:	Keep arrive value that is set to MQTT Broker. (sec) (Default: 60)

2.2.1.2. MqttProtocol option

The following shows connection parameter strings for MqttProtocol option.

"MqttProtocol[=<version>]"

<version>	:	MQTT protocol version used for communication. Either V3.1 or V3.1.1 is available. v31, v311 (Default: v311)

2.2.1.3. Will option

The following shows connection parameter strings for Will option.

Will[=<topic>:<payload>[:<qos>[:<retain>]]]

<topic>	:	Topic
<payload>	:	Text message in Will.
<qos>	:	QoS. 0, 1, 2. (Default : 0)
<retain>	:	Retain. True, False. (Default: False)

2.2.2. CaoController::AddVariable method

AddVariable method of CaoController class is a method to create variable objects that enables each provider to publish.

To execute Publish, use the variable name as a topic. (Refer to 2.2.2.1)

Syntax AddVariable(<bstrVariableName:VT_BSTR>[,<bstrOption:VT_BSTR>])

<bstrVariableName> : [in] Variable Name

<bstrOption> : [in] Option character string

The following shows a list of option character string items.

Table 2-3 Option strings of CaoController::AddVariable

Option [3]	Description
QoS[=<0/1/2>]	QoS at Publish. 0,1,2
Retain[=<True/False>]	Retain at Publish. True, False
Type[=<0/1>]	Data type at Publish. 0 (VT_BSTR), 1 (VT_UI1|VT_ARRAYY)
CodePage[=<Code page>]	Code page of the message to publish. 0 or higher (Refer to 2.2.2.2)

[3] Items enclosed with square brackets ("[]") are omittable. Underlined part shows the default value when the option is not specified..

2.2.2.1. Specifying a topic with a variable name

PUBLISHER provider uses a variable name as a topic.

A topic has a format of layer using "/" (slash) as a delimiter. It also can be specified with wildcards, such as "#" (sharp) or "+" (plus). (You can combine such wildcards to use.)

/ : Delimiter of layer structure

: All topics in this layer and lower layers will be the target.

+ : Treat this layer as a wildcard

Example) Office/# All topics in "Office" and the lower layer will be the target.

Match : Office/Tokyo

Match : Office/Osaka

Match : Office/Nagoya/4F

Do not match : House/Tokyo/1F

Example) Office/+/3F If the first and the third layer matches, any topic is allowed in the second layer.

Match : Office/Tokyo/3F

Match : Office/Osaka/3F

Do not match : Office/Nagoya/4F

Do not match : Office/Tokyo/1F

2.2.2.2. Code page specification

Specify code page or constant.

2.2.2.2.1. Code page

Example)

932	:	Japanese(Shift JIS)
1200	:	Unicode
65001	:	Unicode(UTF-8)

2.2.2.2.2. Constant

0	:	The system default Windows ANSI code page.
1	:	The current system OEM code page.
2	:	The current system Macintosh code page.
3	:	The Windows ANSI code page for the current thread.
42	:	Symbol code page.

2.2.3. CaoVariable:put_Value property

Execute Publish with a variable name as a topic, and a string specified by Value (VT_BSTR) as a Payload.

2.2.4. CaoVariable:get_Value property

Return a value (VT_BSTR) that has executed Publish the last.

2.2.5. CaoController::OnMessage event

The following cause triggers an OnMessage event of CaoController class.

Table 2-4 Message type

Message type		Trigger
1	Disconnection detected	This message occurs when a client disconnects from MQTT Broker by any causes.

2.2.5.1. Disconnection detected

Data type obtained by the disconnection detection message is as follows.

Number : Message type (1)

Value : Response code of the cause of disconnection (VT_I4)

DateTime : Time stamp

Destination : Null

Source : Connection destination host name or IP address

Description : Text description of the response code

2.3. Variable list

2.3.1. CaoController class

Table 2-5 CaoController class User variable list

Variable name	Data type	Description	Attribute	
			get	put
Arbitrary (used as a topic)	VT_BSTR	Execute "Publish" by "put_Value".	✓	✓

Table 2-6 CaoController class System variable list

Variable name	Data type	Description	Attribute	
			get	put
@VERSION	VT_BSTR	Provider version information	✓	—
@MQTT_LIB_VERSION	VT_BSTR	Mosquitto library Version information	✓	—

2.4. Error code

In PUBLISHER provider, the following original error codes are defined.

For about ORiN2 common errors, refer to the error code section of ORiN2 Programming guide.

Table 2-7 Specific error code list

Error name	Error number	Description
E_MOSQ_CONN_PENDING	0x80100001	Error code of Mosquitto library MOSQ_ERR_CONN_PENDING occurred.
E_MOSQ_NOMEM	0x80100002	Error code of Mosquitto library MOSQ_ERR_NOMEM occurred.
E_MOSQ_PROTOCOL	0x80100003	Error code of Mosquitto library MOSQ_ERR_PROTOCOL occurred.
E_MOSQ_INVAL	0x80100004	Error code of Mosquitto library MOSQ_ERR_INVAL occurred.
E_MOSQ_NO_CONN	0x80100005	Error code of Mosquitto library MOSQ_ERR_NO_CONN occurred.
E_MOSQ_CONN_REFUSED	0x80100006	Error code of Mosquitto library MOSQ_ERR_CONN_REFUSED occurred.
E_MOSQ_NOT_FOUND	0x80100007	Error code of Mosquitto library MOSQ_ERR_NOT_FOUND occurred.
E_MOSQ_CONN_LOST	0x80100008	Error code of Mosquitto library MOSQ_ERR_CONN_LOST occurred.
E_MOSQ_TLS	0x80100009	Error code of Mosquitto library MOSQ_ERR_TLS occurred.
E_MOSQ_PAYLOAD_SIZE	0x8010000A	Error code of Mosquitto library MOSQ_ERR_PAYLOAD_SIZE occurred.
E_MOSQ_NOT_SUPPORTED	0x8010000B	Error code of Mosquitto library MOSQ_ERR_NOT_SUPPORTED occurred.
E_MOSQ_AUTH	0x8010000C	Error code of Mosquitto library MOSQ_ERR_AUTH occurred.
E_MOSQ_ACL_DENIED	0x8010000D	Error code of Mosquitto library MOSQ_ERR_ACL_DENIED occurred.
E_MOSQ_UNKNOWN	0x8010000E	Error code of Mosquitto library MOSQ_ERR_UNKNOWN occurred.

E_MOSQ_ERRNO	0x8010000F	Error code of Mosquitto library MOSQ_ERR_ERRNO occurred. The MQTT Broker of the connection destination may not be running. Start MQTT Broker and reconnect.
E_MOSQ_EAI	0x80100010	Error code of Mosquitto library MOSQ_ERR_EAI occurred.
E_MOSQ_PROXY	0x80100011	Error code of Mosquitto library MOSQ_ERR_PROXY occurred.

Appendix A. Terms of MQTT protocol

This chapter describes terms used in the MQTT protocol.

- **Broker**

  A server of the MQTT protocol communication.

  A Broker receives a topic message from a Publisher and then provides it to an interested Subscriber.

- **Subscriber**

  A Client on the MQTT protocol communication (message receiving side).

  A Subscriber registers at a Broker to subscribe a desired topic, and then receive messages.

- **Publisher**

  A Client on the MQTT protocol communication (message sending side).

  A Publisher sends messages to a Broker with specifying a topic. There is no need of thinking about Subscriber.

- **QoS**

  QoS defines how difficult the Broker/Client tries to assure that a message is received.

  QoS0 : The Broker/Client delivers the message at most once.

  QoS1 : The Broker/Client delivers the message at least once.

  QoS2 : The Broker/Client delivers the message exactly once.

- **Will**

  When a Client connects to a Broker, the Client can inform the Broker that it has a Will.

  If the Client disconnects from Broker unexpectedly, a topic and a message specified by Will are sent to a Subscriber which connects to the Broker.

- **Retain**

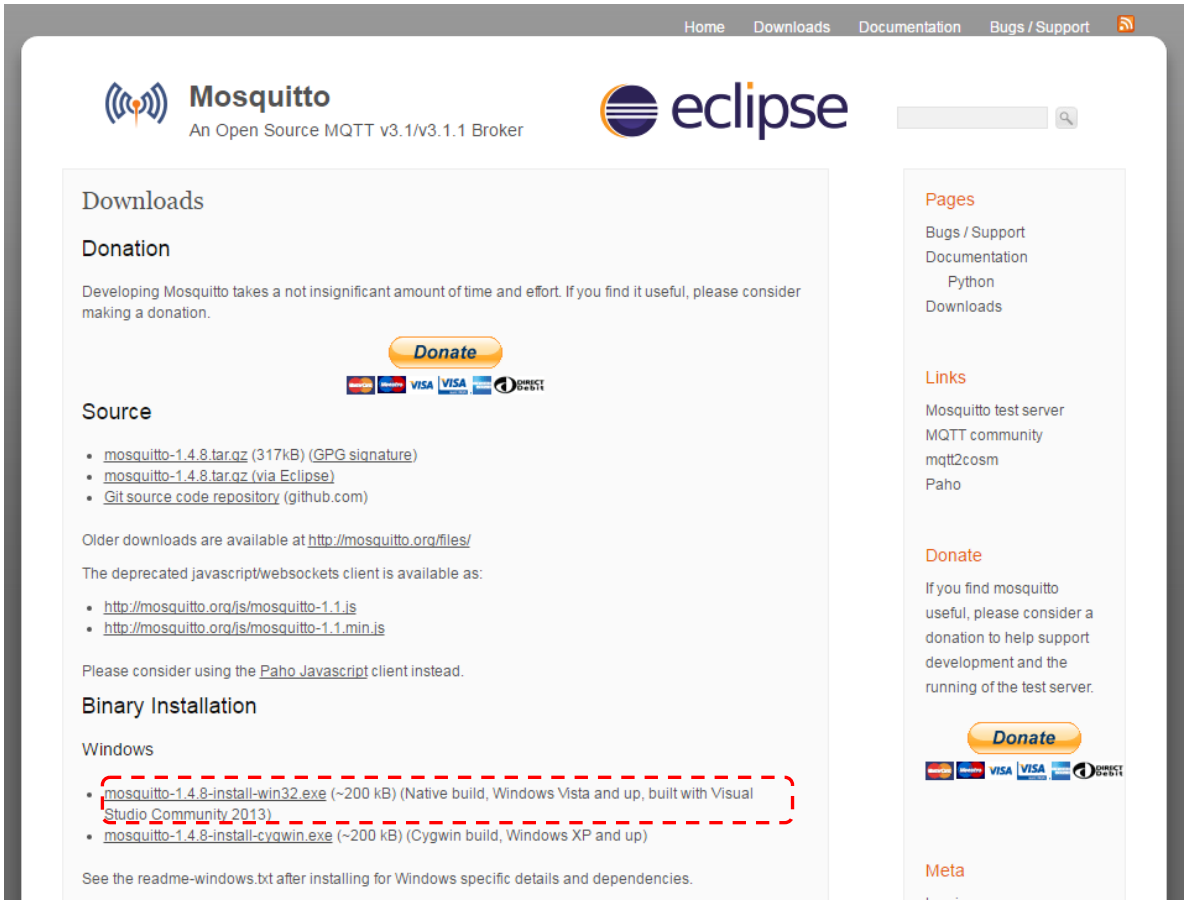
  "Retain" is a function that Broker retains the latest message in each topic after publishing it. If a new subscription is made that matches the topic of the retained message, the message is sent to the subscriber.

Appendix B. Implementation of MQTT Broker

This chapter explains how to implement MQTT Broker with Mosquitto that is an open source message broker.

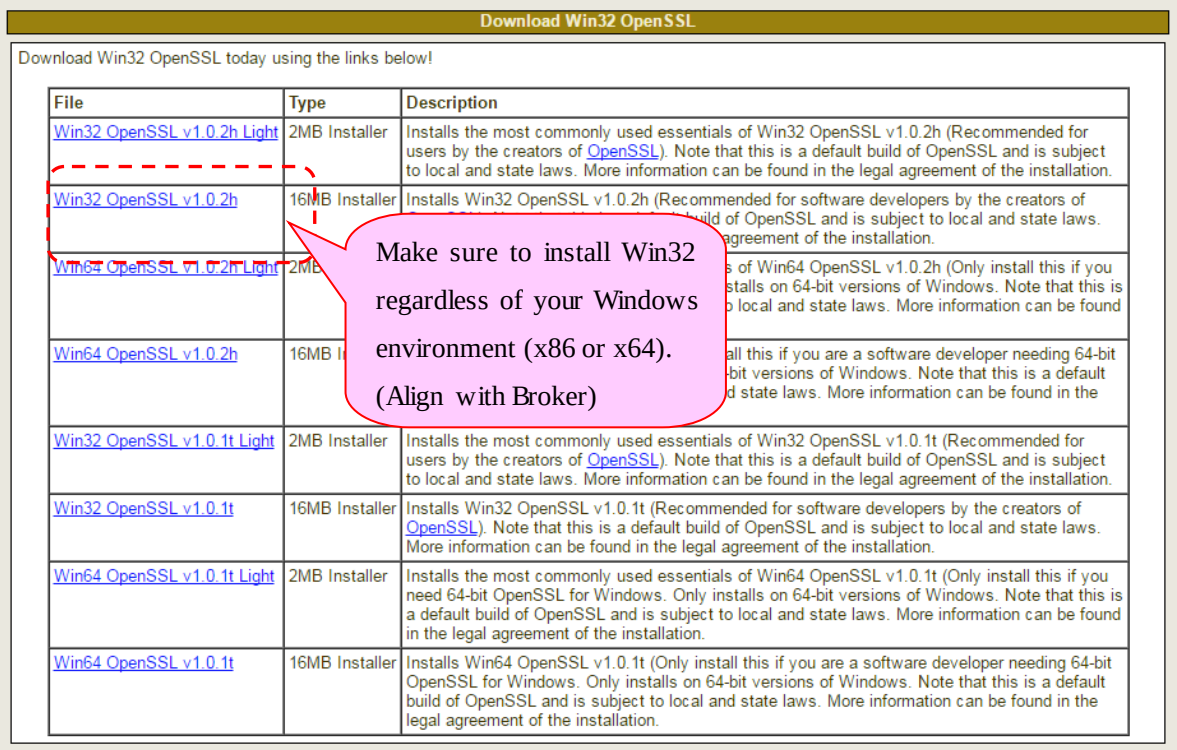
[For Windows]

1. Download an installer from http://mosquitto.org/download/ .

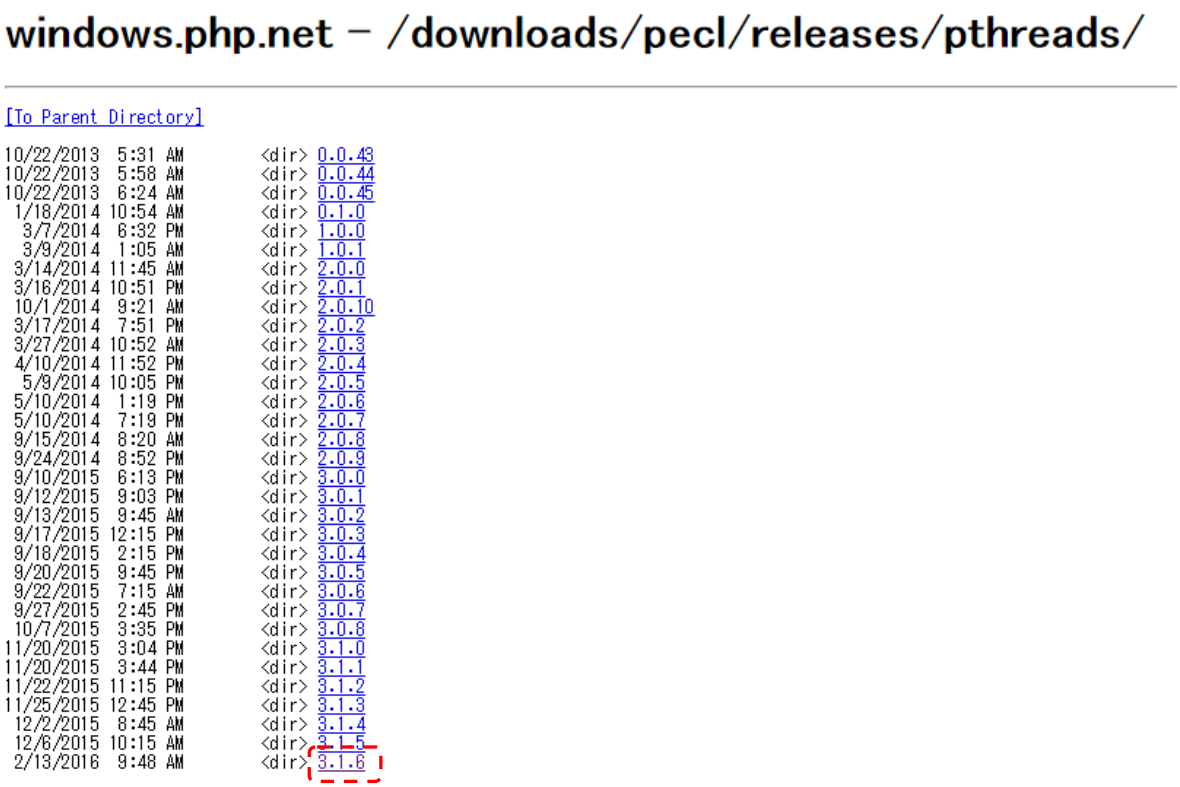


2. Execute the downloaded installer.
3. You will find a message that asks you to install OpenSSL (libeay32.dll, ssleay32.dll) and pthreads (pthreadVC2.dll) manually though, ignore this message in this step and go next. (Details are explained later.
4. Leave the components as default settings.
5. Change the install destination to "C:¥mosquitt" from "C:¥Program Files (x86)¥mosquitto", which is the default setting. (This is because the default path includes spaces that makes difficult to later settings.)
6. Complete the installation.

7. Download the Win32 installer (the latest version) of OpenSSL that have been compiled from http://slproweb.com/products/Win32OpenSSL.html. (Leave as a default.)



8. Download an compressed file (the latest version) of pthreads from http://windows.php.net/downloads/pecl/releases/pthreads/ and then expand it to any directory.



9. Add the path to OpenSSL and pthreads.
10. Restart your computer.

Now you can use Mosquitto Broker. In default setting, Mosquitto Broker starts as a service at the startup of your computer. You need to close a running service if you start an option by specifying with a command line or read a conf file which setting has been modified.

[For Linux (Ubuntu)]

1. Start Terminal, and then execute the following commands.
2. Update a package list.

```
$ sudo apt-get update
```

3. Implement a Broker.

```
$ sudo apt-get install mosquitto
```

4. Implement a Client.

```
$ sudo apt-get install mosquitto-clients
```

If any dependent packages such as OpenSSL are not installed, you need to install it separately.

If mosquitto does not appear in the package list, add a repository with the following command.

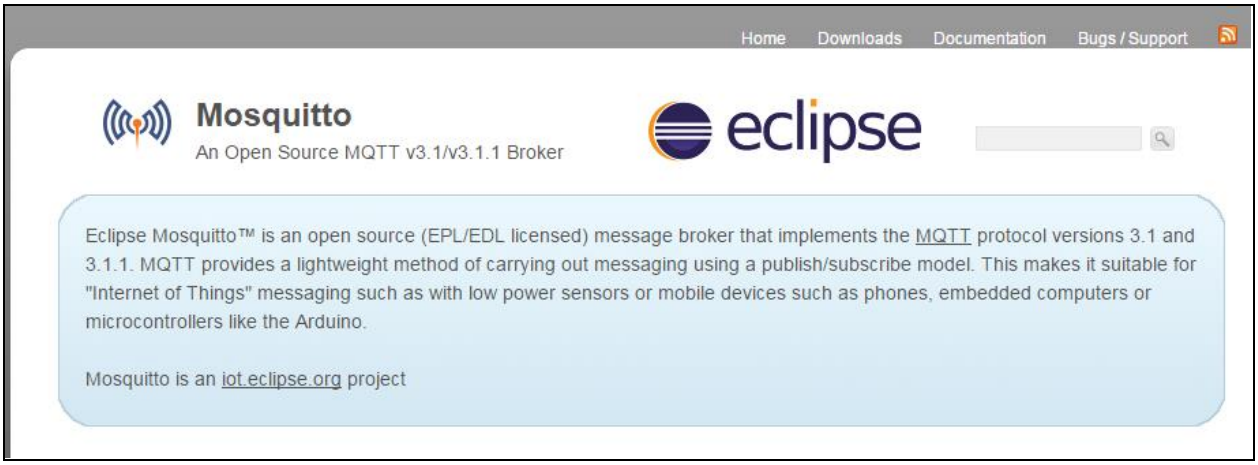
```
$ sudo add-apt-repository ppa:mosquitto-dev/mosquitto-ppa
```

Once the Mosquitto package has been implemented, Broker becomes a service-state.

Just like the Windows environment, you need to close a running service if you start an option by specifying with a command line or read a conf file which setting has been modified.

Appendix C. Mosquitto

URL: https://mosquitto.org/



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Appendix D. Pthread_win32

URL: http://sources.redhat.com/pthreads-win32

Open Source
POSIX Threads for Win32

Current release: 2.9.1 (2012-05-27)
See the ANNOUNCEMENT and NEWS for details.

Pthreads-w32 release 1.11.0 (2005-06-04) was the last series 1.x.x version!
(Version 1.11.0 is a back-port of the 2.7.0 functionality and bug fixes. See the NEWS file inside the package for more information.)

What is this project about?

The POSIX 1003.1-2001 standard defines an application programming interface (API) for writing multithreaded applications. This interface is known more commonly as *pthreads*. A good number of modern operating systems include a threading library of some kind: Solaris (UI) threads, Win32 threads, DCE threads, DECthreads, or any of the draft revisions of the pthreads standard. The trend is that most of these systems are slowly adopting the pthreads standard API, with application developers following suit to reduce porting woes.

Win32 does not, and is unlikely to ever, support pthreads natively. This project seeks to provide a freely available and high-quality solution to this problem.

Various individuals have been working on independent implementations of this well-documented and standardised threading API, but most of them never see the light of day. The tendency is for people to only implement what they personally need, and that usually does not help others. This project attempts to consolidate these implementations into one implementation of pthreads for Win32.

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The file tests/rwlock7.c is derived from code written by Dave Butenhof for his book 'Programming With POSIX(R) Threads'. The original code was obtained by free download from his website http://home.earthlink.net/~anneart/family/Threads/source.html and did not contain a copyright or author notice. It is assumed to be freely distributable.

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Why pthreads-win32 did not use the GNU General Public License
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The goal of the pthreads-win32 project has been to provide a quality and complete implementation of the POSIX threads API for Microsoft Windows within the limits imposed by virtue of it being a stand-alone library and not

linked directly to other POSIX compliant libraries. For example, some functions and features, such as those based on POSIX signals, are missing.

Pthreads-win32 is a library, available in several different versions depending on supported compilers, and may be used as a dynamically linked module or a statically linked set of binary modules. It is not an application on it's own.

It was fully intended that pthreads-win32 be usable with commercial software not covered by either the GPL or the LGPL licenses. Pthreads-win32 has many contributors to it's code base, many of whom have done so because they have used the library in commercial or proprietry software projects.

Releasing pthreads-win32 under the LGPL ensures that the library can be used widely, while at the same time ensures that bug fixes and improvements to the pthreads-win32 code itself is returned to benefit all current and future users of the library.

Although pthreads-win32 makes it possible for applications that use POSIX threads to be ported to Win32 platforms, the broader goal of the project is to encourage the use of open standards, and in particular, to make it just a little easier for developers writing Win32 applications to consider widening the potential market for their products.