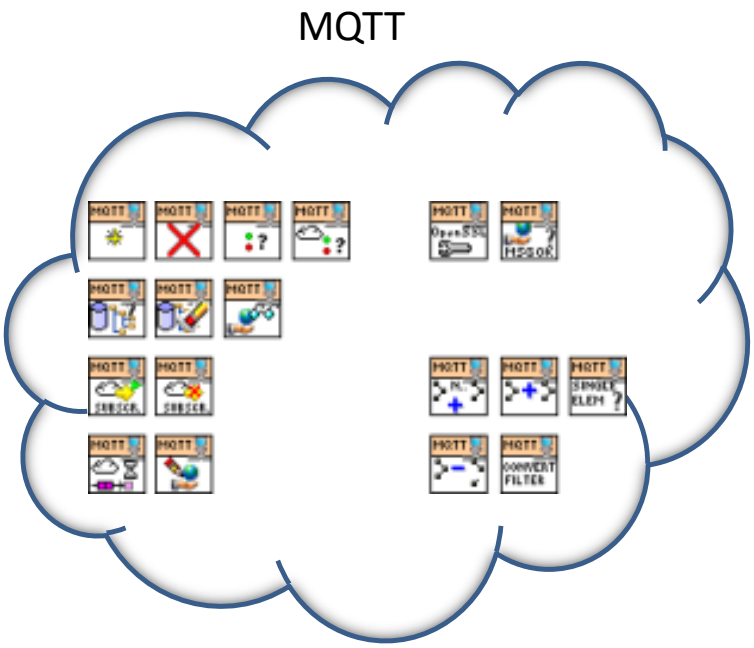
wireflow

AC0075-001, rev G

WireQueue MQTT User Manual



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Support information

Technical support and Product information

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WireFlow WireQueue LabVIEW driver (AC0075)

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Pre-requisites

Supported Platforms

Hardware

The LabVIEW API is running on Windows and LabVIEW RT targets with at least 128MB RAM.

Required software

The software runs on LabVIEW 2013 and higher, and requires the NI-HTTPS libraries with SSL support to be installed. All shared libraries shall be included in each build, if not, please see the chapter “Missing libraries” for detailed information on how to resolve missing shared libraries.

The software is installed with VI Package Manager version 2014 or higher.

RealTime targets

In order to run the software on the LabVIEW RT targets, please use MAX to make sure the NI HTTP with SSL support libraries are installed.

MQTT_API

The MQTT_API enables communication with a MQTT server either using standard TCP/IP or via TLS encrypted communication using OpenSSL. The driver starts a background process that listens on incoming topic updates from the MQTT server, and also handles the reconnections in the background. In the case of reconnect, the background process also handles re-subscription of topics

All received- and all published topics are saved to a local database (using Variant attributes), giving access to topics throughout the application. Each topic stored in the database is time-stamped, with the local time, when received or when published.

The background process also allows a third party implementation to filter and process topics before they are added to the local database.

General

The general API methods handle connections and configurations of the MQTT session, including the OpenSSL paths and certificates

MQTT_ConfigureOpenSSL.vi

Configure the TCP/TLS communication, in terms of the OpenSSL paths to be used.

If this VI is not run before the MQTT connection is initialized, the connection will use the default paths for OpenSSL.

NOTE: this VI must be placed before the MQTT connection is initialized

MQTT_ConfigureEvents.vi

This method configures and creates the Message events and/or message queues to be used in the system.

By default the system only uses the internal data storage to read subscribed Topics, this means that only the latest values can be read and that the application will be polling instead of event driven.

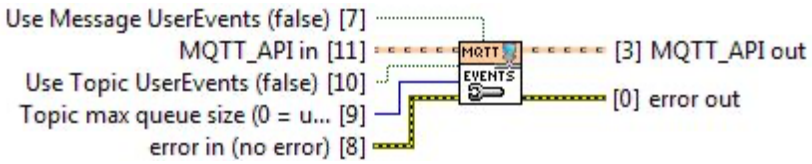
There are three types of event driven mechanisms that can be used in the system

- Topic UserEvents = Enable this to use UserEvents to receive and handle topics in an event structure.
- MQTT UserEvents = Enable this to use UserEvents to receive and handle MQTT messages (not PUBLISH) in an event structure, e.g. to perform actions at connection etc.

- Topic MsgQueue = Enable this to use a LabVIEW queue to receive topics with the MQTT_WaitForNext method

In order to use the UserEvents, first get UserEvent refs with the MQTT_GetMessageEventRefs method then register for the events and read them in an event structure.

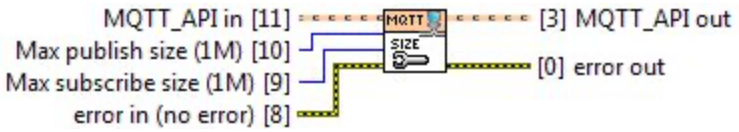
NOTE: this VI must be placed before the MQTT connection is initialized.



MQTT_ConfigureTopicSize.vi

This method configures the maximum size of publish and subscribe messages.
If a call to the publish method exceeds the Max publish size and error is generated.
If a message of size greater than Max subscribe size is received, it is silently dropped.

NOTE: this VI must be placed before the MQTT_Init.vi is called
NOTE2: If size is set to a negative number the default size will be used
NOTE3: the total receive buffer is set to 10 times the size of the Max subscribe size or 5M, whatever is greater



MQTT_Init.vi

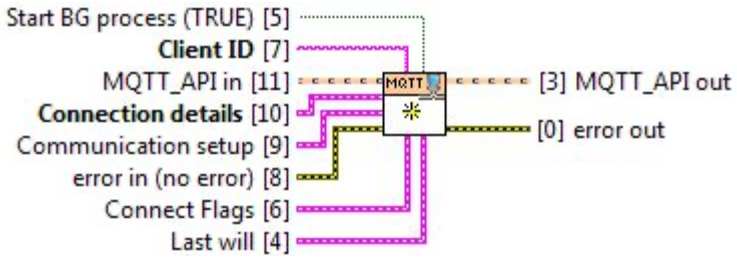
Initializes a MQTT session using the specified configuration parameters.

The CONNECT flags “User name”, “Password” and “Will flag” is automatically handled when the corresponding text fields are specified.

- Client ID = a unique identifier for the current application.
- Connection Details
  - server address = web address of the server
  - server port = port of the MQTT server
  - User name = account name for the connection
  - password = password for the connection
  - Keep Alive time = time from last message from the server until a PING message is sent. If no response is received within 2 * Keep alive time the connection is closed.
  - reconnect period = if communication is disconnected, the background process will automatically try to reconnect at this interval
- Communication setup

- Communication type = specifies if we should use TCP or TCP/TLS (recommended!)
- TLS level = specifies at which level the TLS certificate should be validated:
  - Full check (recommended)
  - allow valid certificate with wrong server name
  - allow any self signed certificate.
- TCP_NO-DELAY = If True the Nagle algorithm is disabled, and small packets are not buffered, but sent immediately.

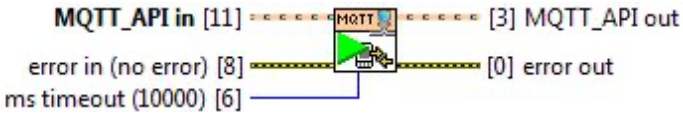
- Connect Flags = defines the MQTT connection flags, i.e. what parts is active in the connect message
  - Will Retain
  - Will QoS
  - Clean Session
- Last Will = defines a topic/value that will be set if the client is disconnected incorrectly, e.g. in the case of network failure.
  - topic
  - value
- Start BG process = indicates if the background process should be started, if set to FALSE, make sure to start the process using the MQTT_StartBackgroundProcess method



MQTT_StartBackgroundProcess.vi

Starts the MQTT background process unless started at the init session.

This can be used to create advanced applications that should act on received MQTT messages, e.g. CONNACK etc. See the WireQueue API **Error! Reference source not found.** method for an example



MQTT_Clear.vi

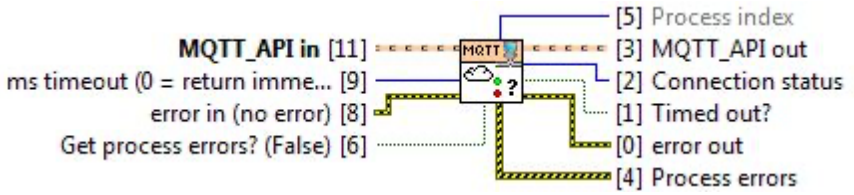
Clears the MQTT session, and disconnects from the server gracefully.

MQTT_GetStatus.vi

Returns the status of the background process, and optionally also returns the last 100 errors in the BG process.

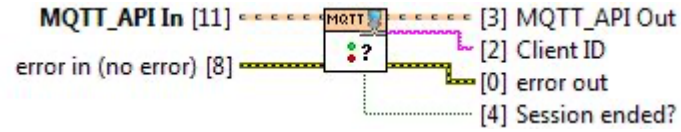
- Unknown = the BG process is in an unknown state (should only be reported at startup or exit)
- Idle = connection has been lost, waiting to reconnect
- Connecting = connect sequence has been initiated, waiting for server to respond
- Connected = the background process is sucessfully connected to the MQTT server.

NOTE. if ms timeout is set to a value greater than 0 the method will wait for an updated status message.



MQTT_GetSessionStatus.vi

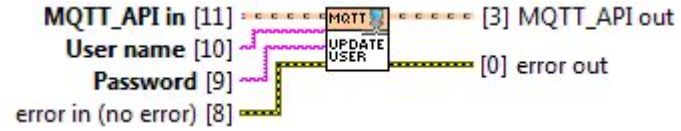
Returns the status of the current session, i.e. if the session is valid and the ClientID used to intialize.



MQTT_UpdateConnectionCredentials.vi

Updates the "User name" and "Password" used at MQTT Connect.

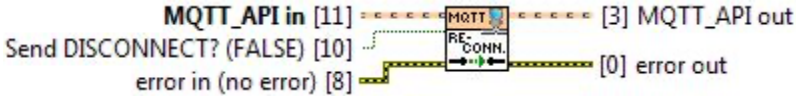
This can be used to update a time limited token so that the background process can correctly reconnect to the broker.



MQTT_ForceReconnect.vi

Forces a reconnection to the broker by closing the network connection to the broker.

Optionally sends a DISCONNECT message to the broker to signal that this is an intended shutdown.



Server override methods

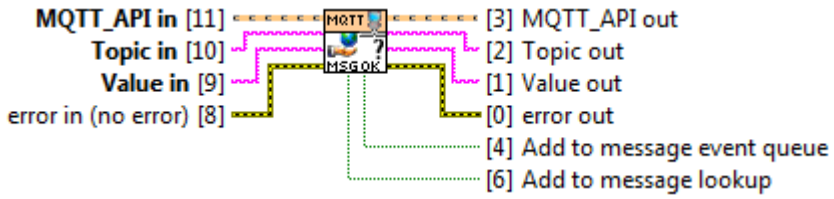
This group of methods can be overridden to implement low level filtering of topics as they arrive from the MQTT broker.

MQTT_CheckReceivedMessage.vi

Allows the implementation to filter on incoming messages before they are added to internal lookups or message queues, e.g. remove topics over a certain size.

- Topic in = name of the received topic
- Value in = value of the received topic
- Topic out = name of the topic to be used in the system
    - This can for example be the topic name stripped of a MAC
- Value out = value of the topic to be used in the system
    - Can for example be a decrypted string
- Add to message event queue
    - If TRUE the Topic/Value outputs will be added to the message queue
- Add to message lookup
    - If TRUE the Topic/Value outputs will be added to the message lookup

This VI can be overridden by a child class to expand filtering, stop use of message queue handling or lookup etc.



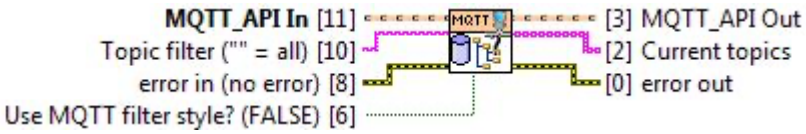
Local topic access

This group of API methods handles the topic access in the local database.

MQTT_ListTopics.vi

Return a list of all received or published topics in the local lookup that match a specific topic filter.

Filter is given in the LV match-pattern notation or in MQTT filter notation (experimental).

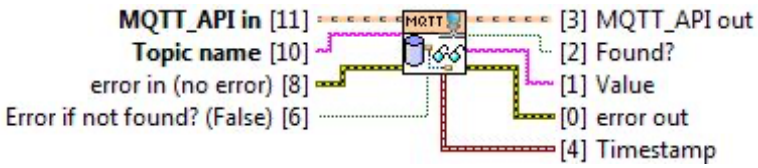


MQTT_ReadTopic.vi

Reads a local copy of a MQTT topic.

- Topic name = name of the topic to be read
- Error if not found= if TRUE and the topic is not found an error with code 6507 will be returned.
- Value = the value returned for the specified topic
- Found? = if False the specified topic was not found
- Timestamp = timestamp when the topic was received by the back ground process

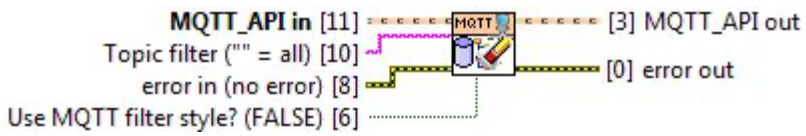
A Topic is built as a number of segments separated by '/', e.g. Device/Subsystem/TopicName



MQTT_ClearLocalTopics.vi

Remove the named topics from the local database, e.g. if a remote device has been removed.

If filter is empty string all topics are removed, otherwise filter is given in the LV matchpattern notation or in MQTT filter notation (experimental).



Server access methods

To use MQTT a central broker is needed, and this group of access methods deals with the communication between the broker and this client.

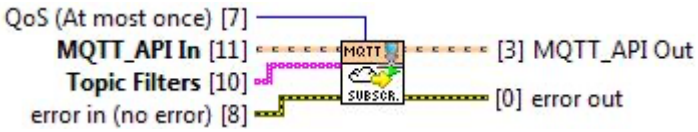
MQTT_Subscribe.vi

Start subscribing on a number of topics, using the specified QoS. To subscribe to topics with different QoS, call this VI multiple times with different settings.

- QoS = specifies the MQTT quality of service to be used with this subscription
- Topic Filters = Each element in the input array defines one subscription topic, with or without wildcards.

Note.

1. **Topics are case sensitive, e.g. Main/MyTopic and main/mytopic is two different topics**
2. **Use '+' as a single level wildcard, e.g. the filter Main/+/Status, matches any topic starting with Main and ending with Status**
3. **Use '#' to match any subtopic, e.g. the filter Main/Subsystem1/# matches all topics under the SubSystem Topic.**



MQTT_Unsubscribe.vi

Unsubscribes from the specified MQTT topic filters. The topic filter must exactly match the subscribed topics to be unsubscribed.

- Topic Filters = Each element in the input array defines one subscription topic, with or without wildcards.

Note.

1. **Topics are case sensitive, e.g. Main/MyTopic and main/mytopic is two different topics**
2. **Use '+' as a single level wildcard, e.g. the filter Main/+/Status, matches any topic starting with Main and ending with Status**
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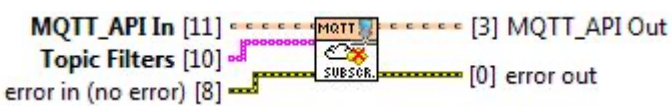


MQTT_Publish.vi

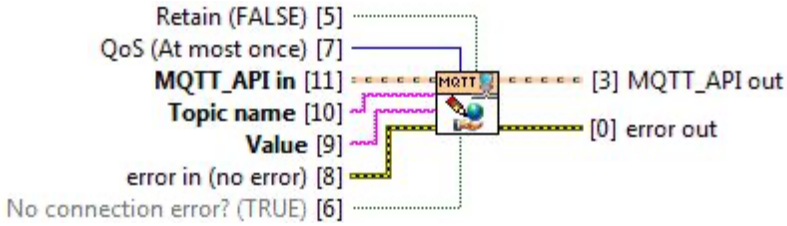
Publish a topic to the MQTT server with specified QoS and retain settings.

- QoS = The MQTT quality of service to be used with this publish topic
- Retain = If True the server will store a copy of the last message on the server
- Topic name = name of the topic to update
- Value = value of the topic

Note 1. To remove a retained message from the server, publish the topic with empty string value, and with Retain=True

Note 2. A Topic is built as a number of segments separated by '/', e.g.

Device/Subsystem/TopicName

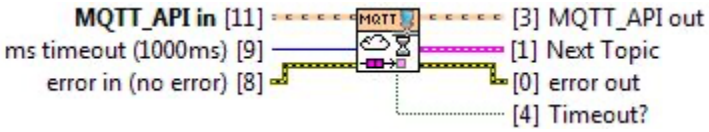


MQTT_WaitForNext.vi

Returns the next received topic from the MQTT server.

- Next Topic
  - Time Stamp = time when the background process received the message
  - Topic = name of the topic sent from the broker
  - Value = value of the topic
- Timeout? = True if no message was found in the queue

Note. The queue is limited in size (set by MQTT_ConfigureEvents) to prevent out of memory issues.



MQTT_GetMessageEventRefs

Returns UserEvent refs that can be used to create event driven applications.

- MQTT Event refs
  - Message events = All message types, except PUBLISH, are sent in this UserEvent together with their raw payload. E.g. CONNACK, PINGRESP etc.
  - Topic Events = All received PUBLISH messages will be decoded into Topic/Value pairs and sent into this User event

NOTE. To use these references one has to register for the events, and use an Event structure to receive the data. The events must also be activated in the MQTT_ConfigureEvents method.

Helper functions

ArrayBuildTopic.vi

Combines topic segments into one topic, i.e. if the base topic is <base>, and the topic elements are <subA>, <subB>and <subC> the resulting topic will be <base>/<subA>/<subB>/<subC>

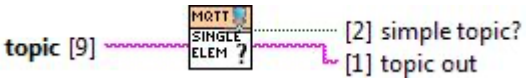
BuildTopic.vi

Adds the subtopic to the base topic to create the resulting topic.

actual topic = base topic/topic

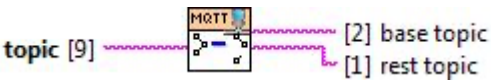
CheckSimpleTopic.vi

Checks if the topic is a single element topic, i.e. it only has one segment



StripTopic.vi

Strips the first element from the input topic, and returns the first element as base topic, and the rest as rest topic.



CreateMatchPatternFromTopicFilter.vi

Converts a MQTT topic filter into LabVIEW matchpattern format.

Use this to create LabVIEW matchpattern to find matching topics, e.g. the MQTT filter basetopic/+/subs/# translates to ^basetopic/[~\/]+/subs/.*$

Application notes and examples

Please visit https://www.wireflow.com and

https://www.wireflow.com/products/software/wf-wirequeue-mqtt-toolkit/

for additional How-To's and Application Notes.

Quick start

Install WireQueue using VIPM (VI Package manager is free and can be downloaded at http://jki.net/vipm)

Once VIPM is installed, install WireQueue by double-clicking the item in the list of packages (enter WireQueue in the filter box for fast find)

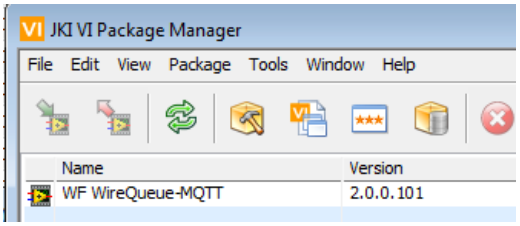


Figure 1. WireQueue in VI Package manager

After completion of installation of the WireQueue package go to Show Examples.

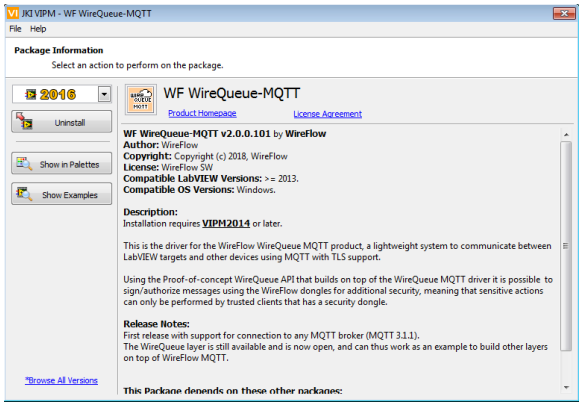


Figure 2. WireQueue information window in VIPM

Open the MQTT_BasicExample.vi example.

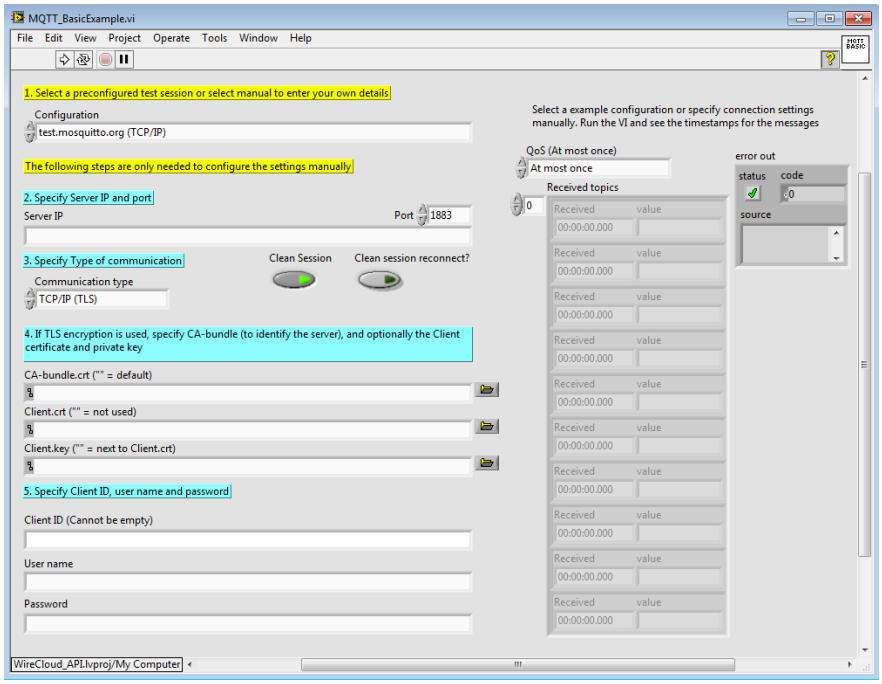


Figure 3. MQTT_BasicExample

This example connects to the test.mosquitto.org test broker, and can connect with TCP/IP, TCP/IP with TLS or TCP/IP with TLS and Client certificate authentication.

Select the type of communication and then run the example. The example subscribes to its own topics and post and read 10 topics.

Examples

The driver comes with a number of examples that can be found using the LabVIEW Example Finder, just search for WireQueue. You can also directly after installing the VIPM package show the included examples.

The examples cover basic MQTT messaging as well as WireQueue security messaging, logging as well as monitoring of all clients.

To monitor the data from a smart phone (iPhone or Android) please install WireQueue on the smartphone and login to the same server instance

The WireQueue examples are pre-configured to connect to a WireQueue demo server that is restarted periodically.

NOTE: To run the Security examples you need a WireFlow dongle.

Error codes

The software uses the following error codes

Error code	Description
6501	Server connection failed
6502	Invalid Alarm subsystem
6503	Invalid Error subsystem
6504	Only one WireQueue instance per LabVIEW context is allowed!
6505	Server connection was lost (no ping response)
6506	Operation not possible: No server connection
6507	Specified Topic was not found in local buffer
6508	Security message write failed: remote challenge is missing
6509	Local clock is probably not set
6510	Invalid topic filter when converting to LabVIEW matchpattern
6511	Invalid connection configurations
6512	Bad OpenSSL configuration
6513	Invalid configuration order
6514	Background process is already running
6515	Topic size exceeds maximum publish size
6550	SSL connection error
6551	SSL Connection has been closed
6552	SSL operation failed, more data to write or read
6553	SSL Connection is not completed
6554	SSL certificate lookup failed
6555	SSL system called failed
6556	SSL library error

Troubleshooting

This chapter lists the most common problems that a user might encounter

Connection fails

If there is an error at init the API will automatically clean up all connections and exit, but if the background process successfully connects once and then has to perform a reconnect a number of errors can occur. The connection can fail for a number of reasons, and the table below lists the actions by the software as well as the resolution that can be taken by the developer.

Fail reason	Software action	Resolution
Wrong IP address	Enters reconnection and waits for the IP to become available	Check the status, and verify that a correct IP address has been entered
Wrong IP port	See “Wrong IP address”	See “Wrong IP address”
Bad user name/password	Disconnects the session and closes all references and buffers with an error	Fix username and password
Not authorized	Disconnects the session and closes all references and buffers with an error	Ask an administrator to check that the specified ClientID is allowed access
Server unavailable	TCP connected ok on the port but there is no cloud server serving on that port The session is disconnected and closed with an error.	Verify the IP address/port and/or ask an administrator to verify that the service is up and running on that port.
SSL connection failed	Disconnects the session and closes all references and buffers with an error	Check that the OpenSSL config is correctly setup (see the “Missing libraries” section), either using default or specific configuration. Also check that the time is correctly set on the computer.

Missing libraries

The API runs out of the box with the OpenSSL libraries that are installed together with LabVIEW. In some cases it might be necessary to specify other versions, or other locations for the files. This is normally done with the MQTT_ConfigureOpenSSL.vi, but it can also be done by creating a single file named WireQueueSSL.cfg that should be placed in the \data folder of the application. The configuration specifies three OpenSSL files (two shared libraries and one certificate bundle):

```
[OpenSSL_Paths]

; this section defines the paths to the libraries used for Open SSL access.

; Each path can be given as an absolute path, or as a path relative to the
folder containing this file.

; NOTE: paths are platform dependent, and different OS's handle type case
differently


ssleay = "C:\Program Files (x86)\National
Instruments\Shared\nissl\NIlibeay32.dll"

libeay = "C:\Program Files (x86)\National
Instruments\Shared\nissl\NIssleay32.dll"

CA-bundle.crt = "C:\Program Files (x86)\National
Instruments\Shared\nicurl\ca-bundle.crt"
```

The paths can be given absolute or relative to the “data”-folder.

During development the config file can be put in a “data” folder next to the lvproj that contains the source code (if the code is opened outside of a project, the default OpenSSL configuration will be used.)