



iQunet-CloudLink

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1 iQunet-CloudLink architecture

As shown in Figure 1, iQunet-CloudLink is an optional database service (DBaaS) that synchronizes its mirror database with the database of your locally installed iQunet Edge Servers running condition monitoring with iQunet sensors.

Due to the additional frontends that become available, iQunet-CloudLink drastically increases the **interoperability** of the iQunet condition monitoring solution. iQunet-CloudLink is an optional service that is useful when running multiple Edge Server devices in for example different locations which makes integration complex.

iQunet-CloudLink only functions with iQunet Edge Server software versions 1.7.2 and higher. Contact your iQunet support team in case an Edge Server update is requested or request an update using our web form (<https://iqunet.com/resources/software/request-a-server-update/>).

Remark: iQunet-CloudLink is not a back-up service. Please contact your iQunet support team if a back-up service is requested.

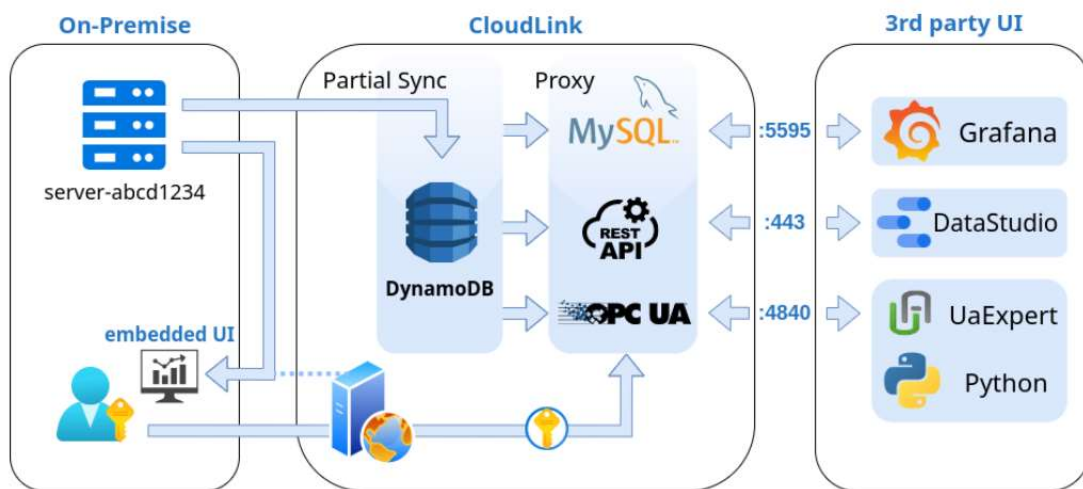


Figure 1: iQunet-CloudLink architecture

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2 Service description (DBaaS)

iQunet-CloudLink is available as Database-as-a-Service (DBaaS). For each iQunet Server that is synchronized to iQunet-CloudLink, a yearly subscription is invoiced. Please contact the commercial iQunet team to grant you access to the service.

Once the service subscription is ordered, iQunet-CloudLink access is granted. Your iQunet Edge Server device(s) will now be able to connect automatically to iQunet-CloudLink. This connection is activated in the Sensor Dashboard GUI of each Edge Server device (see Figure 2).

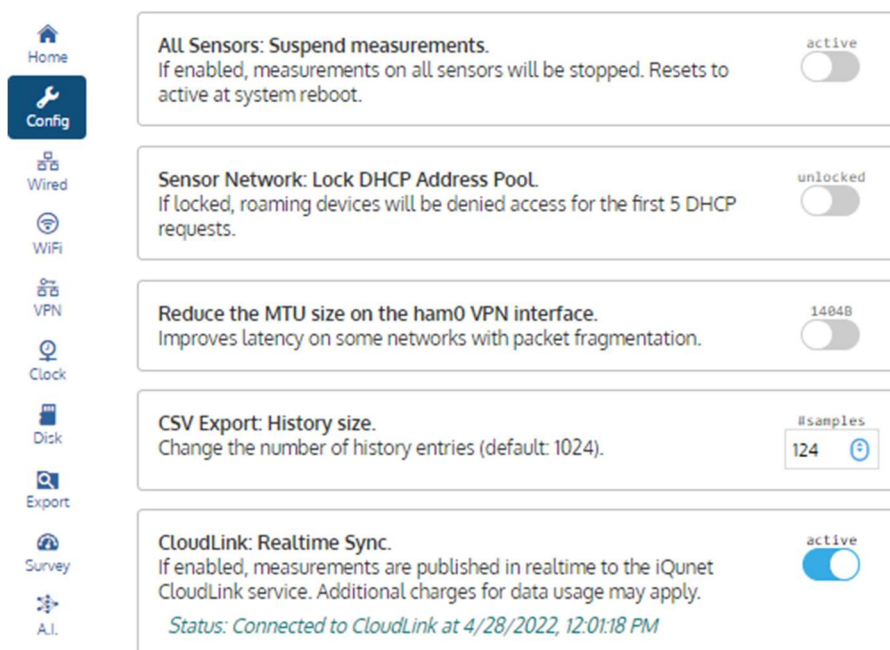


Figure 2: activating iQunet-CloudLink in the GUI of the iQunet Edge Server

2.1 Synchronization

iQunet-CloudLink synchronizes its mirror database with the database of the local iQunet Edge Server. The following data is synchronized:

- The full namespace with latest values and timestamps, and
- The quality metadata

of ALL nodes in the Edge Server.

After synchronization, the mirror database is guaranteed to reflect the exact namespaces and values from the Edge Server device, even when the device is rebooted, network connection is intermittent or iQunet-CloudLink is only activated later on (weeks or months after collecting the data in the Edge Server device).

Synchronization is started when a user connects to the MySQL or OPC UA frontend and is performed with quasi real-time updates.

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2.2 Historical data

The iQunet-CloudLink synchronization also includes the synchronization of historical data. Due to the amount of generated data, not all nodes are synchronized, however. Only historical data that is accessed regularly (e.g., once a week) via one of the iQunet-CloudLink frontends, is synchronized. Unused data is not synchronized.

Historical data synchronization is performed automatically, even when the iQunet-CloudLink service is only activated later on (weeks or months after collecting the data in the Edge Server device). After the synchronization of a historical node, the node history will reflect the exact same data as in the database of the Edge Server device without missing records. If the synchronization is incomplete or still running, the OPCUA status code will show the message “GoodMoreData” while reading the history.

2.3 Accessibility

iQunet-CloudLink data is also accessible when the iQunet Edge Servers are offline. This offline condition is reflected in the ServerStatus branch of the iQunet-CloudLink OPC UA server.

2.4 Cache

iQunet-CloudLink acts as a cache for Edge Server devices, so that end users:

- a. do not have to deal with offline devices,
- b. do not have to deal with the connection setup of end devices,
- c. have a single access point to request data of multiple iQunet Edge Servers,
- d. do not have to deal with firewall settings and restrictions at the location of the Edge Servers. For this, iQunet-CloudLink heavily relies on the use of TLS encrypted HTTP/TCP communication over common ports 80/443. This is to be able to traverse http-proxies at customer side. Proxies that intercept traffic with MITM TLS certificates are deliberately not supported.

2.5 Frontends

iQunet-CloudLink offers translation from OPC UA to MySQL, so that existing services such as Grafana can connect with minimal effort. Only a small, relevant subset of MySQL commands, required for accessing real-time and historical data, is supported (see section 3.4.3). Complex clients such as “phpMyAdmin” which heavily rely on MySQL aggregation commands are NOT supported.

Examples to connect to iQunet-CloudLink using MySQL commands (see section 3.4.4) and the standard python MySQL client are provided, as is the case for OPC UA (contact your iQunet support team).

2.6 DBaaS

iQunet-CloudLink runs in a fully managed synchronization database service that provides fast and predictable performance with seamless horizontal scalability. Due to operating and scaling a distributed database, customer data is safe, and traffic is managed. iQunet-CloudLink automatically spreads the data and traffic over enough cloud servers to handle throughput and storage requirements, while maintaining consistent and fast performance. Data is stored on solid-state disks (SSDs) and is automatically replicated across multiple availability zones in a region, providing high built-in data availability and data durability.

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2.7 Service level

The amount of data available for synchronization to iQunet-CloudLink is dependent on e.g., the number of user network interruptions, or the sensor measuring interval which can be set up to 24 hours. Therefore, the standard service level is SLA-S. This means, iQunet will do everything possible to ensure the iQunet-CloudLink services are online 100% of the time, however we do not make any specific guarantees. We aim for 100% availability, and in reality, the service is often available well above 95%.

In case a guaranteed service level with guaranteed availability is required, iQunet also provide SLA-B. Please contact the commercial team of iQunet in case SLA-B is required.

SLA	Service Window	KPI: Availability	KPI: Response time	KPI: Recovery time
S (Standard)	Office hours*	Best Effort	Best Effort	Best Effort
B (Best)	Office hours*	95,00 %	< 8 hours*	Best Effort

(*) office hours only (CET/CEST)

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3 iQunet-CloudLink frontend

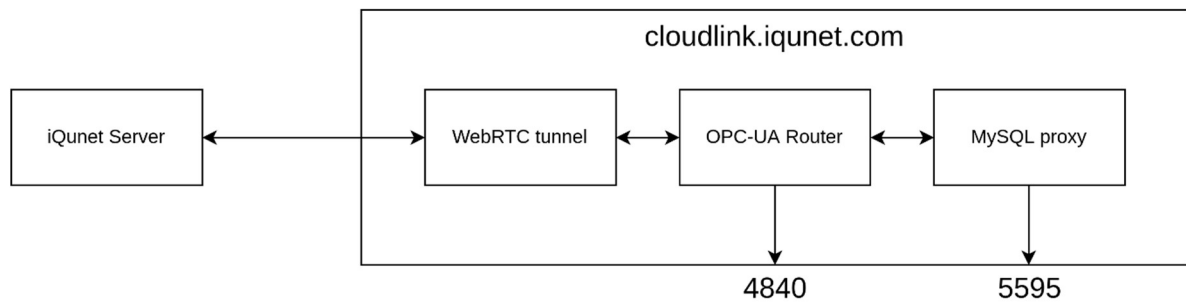


Figure 3: iQunet-CloudLink OPC UA and MySQL frontend

3.1 OPC UA and MySQL frontends

iQunet-CloudLink synchronizes the data of your local iQunet Edge Servers via a WebRTC tunnel (instead of the VPN tunnel to the embedded OPC UA server from an individual iQunet Edge Server). The synchronized data is now available from a single access point OPC UA server (cloudlink.iqunet.com). It is possible to request data of a single or of multiple iQunet Edge Servers.

iQunet-CloudLink also makes it possible to access the iQunet data, which is synchronized from the local iQunet Edge Servers, via a MySQL proxy instead of directly via OPC UA. The MySQL proxy thus acts as a translator (wrapper) from the OPC UA (Unified Architecture) Server to MySQL.

The access procedures to the OPC UA and MySQL frontends are described below.

3.2 Set up the iQunet Server for iQunet-CloudLink

Browse to <https://connect.iqunet.com/>.

Log in using your Gmail account or your email address.

Figure 4: log in using your Gmail account or your email address

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Go to the “Servers” tab at the top right of the page to set up iQunet-CloudLink access to your iQunet Server.



Figure 5: open the "Servers" tab

Click on “Add New Server”.

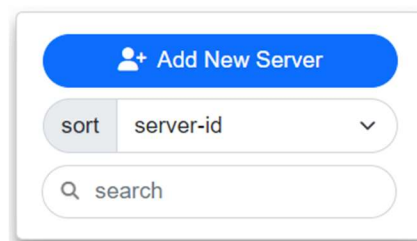


Figure 6: add a server card

Provide a name for the Server, enter the Server ID (server-xxxxxxx) and fill out an OPC UA username and password. Click “Submit”. The Server ID is provided by iQunet.

Configured credentials are valid for both OPC UA and MySQL.

Remark: it is not possible to use an OPC UA username that is already in use by yourself or by any other user connected to this Server.

 A form titled 'ADD NEW SERVER' with a close button (X) in the top right corner. It contains several input fields: 'Server Name' (with a green checkmark), 'Server ID' (with a green checkmark), 'OPC Username' (with a green checkmark), and 'OPC Password' (with a green checkmark and masked characters). Below these is a 'Comments' text area. At the bottom, there is a 'Created by:' field showing 'iqunetdemo@gmail.com' and two buttons: 'Cancel' and 'Submit'.

Figure 7: fill out the server details

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Remark: if you are not the first person to create a server card for this iQunet Server, your access must be granted by one of the users who already have access to this server.

Remark: blocked server accesses are shown in red.



Figure 8: blocked server access



Figure 9: allow user access to the server

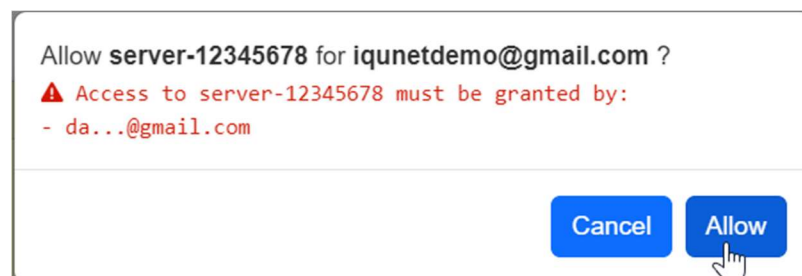


Figure 10: "access must be granted" message

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3.3 Connect to the OPC UA frontend

3.3.1 Connect using UA Expert

Open UA Expert and click on Server → Add.

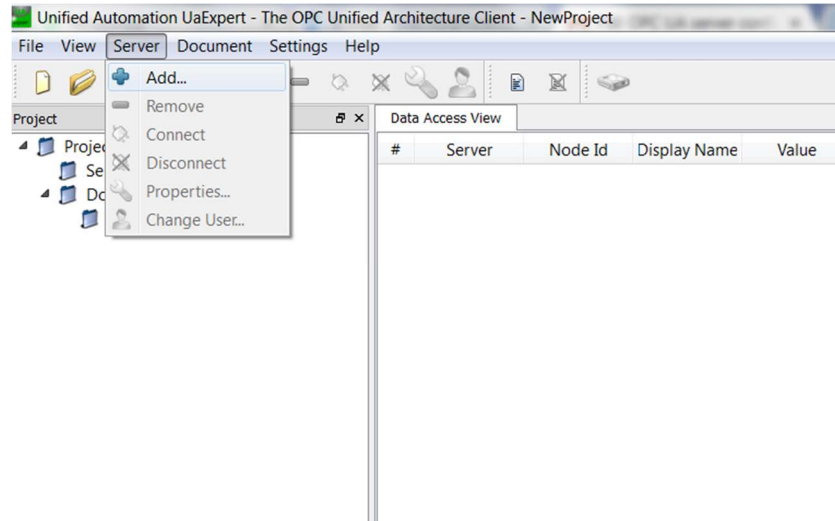


Figure 11: add a Server in UA Expert

Double click on "Double click to Add Server" and fill out "opc.tcp://cloudlink.iqunet.com:4840/server-abcd1234" where server-abcd1234 is your Server ID. Click OK.



Figure 12: add server to UA Expert

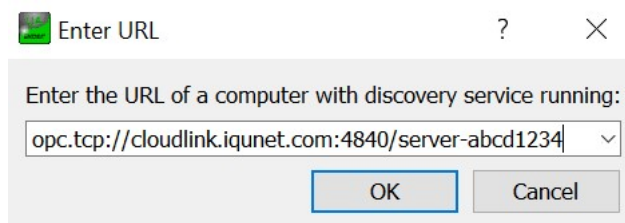


Figure 13: fill out the Server URL

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Select the added server in the server list. Double click on it twice and select the desired encryption method. Fill out the authentication details at the bottom (note: the “Store” checkbox must be checked to be able to fill out your password). Click OK to add the server to the project. If asked, accept the server’s certificate.

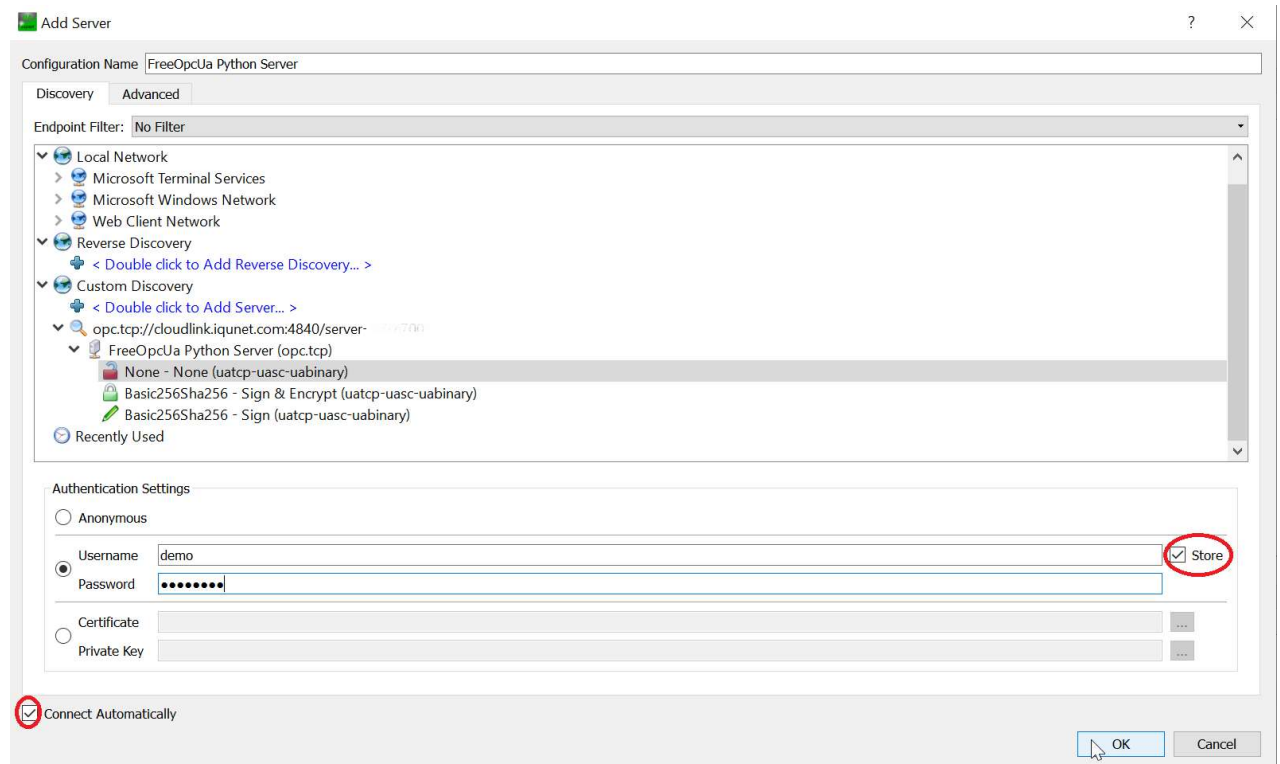


Figure 14: select the added server and fill out the authentication details

Right-click on the “FreeOpcUa Python Server” added to the project and click on “Connect” if the server is not connected automatically yet.

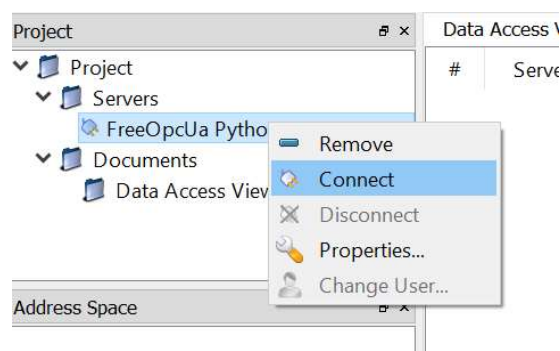


Figure 15: connect to the server

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All sensors connected to this server will appear in the Address Space.

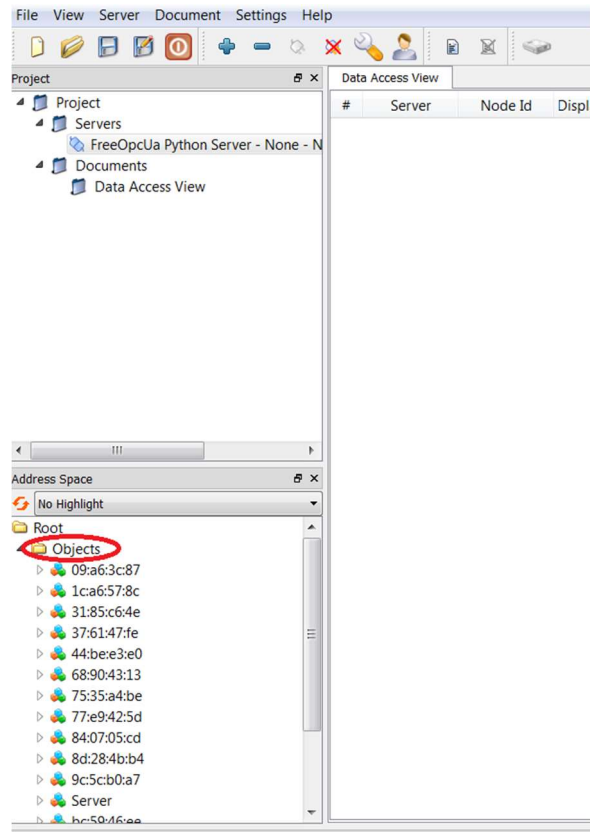


Figure 16: address space

Click on the macId of the sensor to see all possible attributes of the sensor.

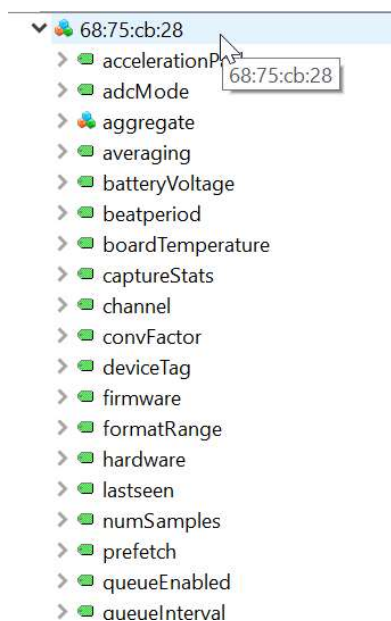


Figure 17: available sensor attributes

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In UA Expert you can see what the OPC UA router you connected to above is doing, and if there are synchronization errors or not. Check the “SyncStatus” node (*Root > Objects > Server > ServerStatus > SyncStatus*) for the synchronization status (see Figure 18):

Synchronization status (see Figure 19):

- idle (synchronization ok),
- syncing (synchronizing), or
- error.

The synchronization of the address space only starts at the first connection (via OPC UA or MySQL) i.e., when a user connects to the MySQL or OPC UA frontend. It is thus possible that the address space is still empty at the start and that a rebrowse of the “Objects” node (see Figure 20) is necessary after a few seconds or minutes (depending on the connection speed). The status of this synchronization is shown in the “SyncStatus” node.

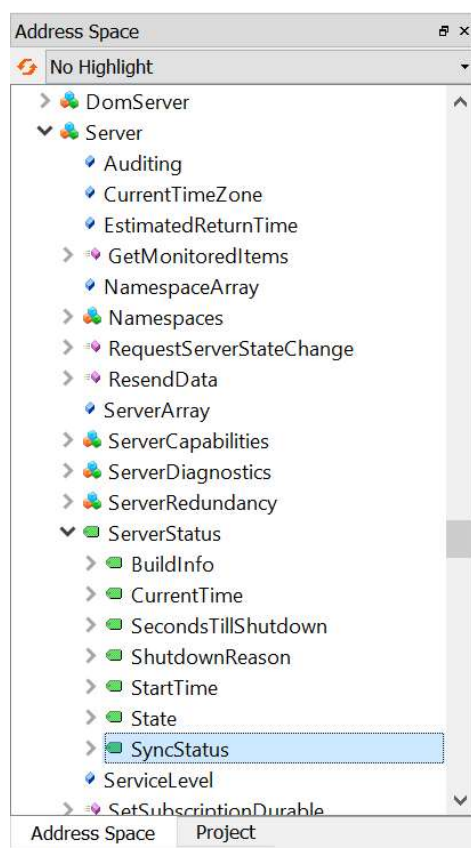


Figure 18: check the synchronization status

#	Server	Node Id	Display Name	Value	Datatype	Source Timestamp	...
1	FreeOpcUa P...	NS2 Numeri...	SyncStatus	idle	String	10:37:35.407 ...	10

Figure 19: check the synchronization status

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Figure 20: rebrowse of the address space

After synchronization, the “SyncStatus” will change back and forth from “syncing” to “idle” every few seconds to extract the most recent data.

Remark: the first time you request historical data, it is possible that you get the “BadWaitingForInitialData” error in UA Expert (see Figure 21). The synchronization of the address space is separated from the historical data. Historical data is only requested at the moment they are used. Synchronization is done from the oldest to the newest data values. It is thus possible that in consecutive queries the data that is shown is still updating and that the latest x values differ as the update progresses.

If the “BadWaitingForInitialData” error appears in UA Expert, just click once more on “Get Start Time” (see Figure 21).

Remark: in future versions it will be possible to check how far the historical synchronization has progressed. For the moment this can only be done by requesting the latest values and checking if these are the most recent ones. Contact iQunet support for the most recent software version available.

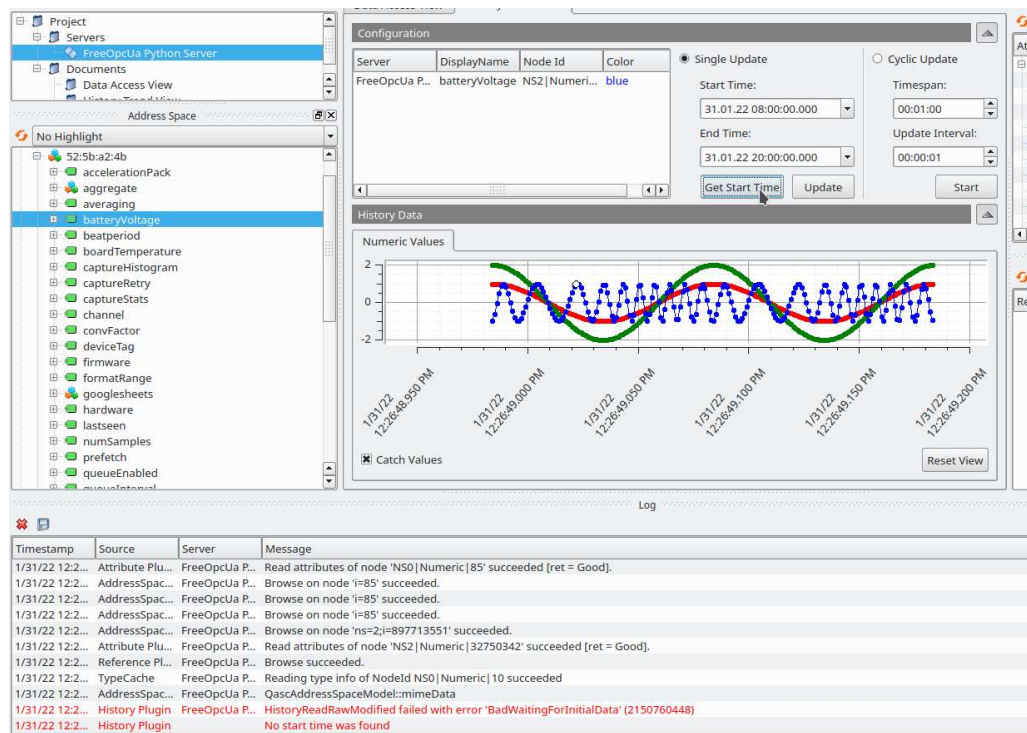


Figure 21: BadWaitingForInitialData error in UA Expert

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3.3.2 Other OPC UA connections

More information regarding communication using OPC UA can be found in the OPC UA instruction manual available in the resources section on the iQunet website:

<https://iqunet.com/resources/user-manuals/>.

3.4 Connect to the MySQL frontend

3.4.1 Install a MySQL client

Remark: only the MySQL client part is necessary, not the whole server environment.

3.4.2 Connect to iQunet-CloudLink

After installing MySQL, use the following query to make the connection to iQunet-CloudLink:

```
mysql -u<user> -p<password> -h cloudlink.iqunet.com -P 5595 --ssl-mode=REQUIRED
```

(For windows: `mysql.exe -u<user> -p<password> -h cloudlink.iqunet.com -P 5595 --ssl-mode=REQUIRED`)

Where:

- h stands for the hostname,
- P stands for the port,
- u stands for your username, and
- Password for your password.

```
@ ~$ mysql --user="demo" --password="demo123" -h cloudlink.iqunet.com -P 5595 --ssl-mode=REQUIRED
mysql: [Warning] Using a password on the command line interface can be insecure.
Welcome to the MySQL monitor.  Commands end with ; or \g.
Your MySQL connection id is 2756582832
Server version: 5.6.36-log iQunet MySQL Proxy

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affiliates. Other names may be trademarks of their respective
owners.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.
```

Figure 22: connection example

Remark: use the UA Expert OPC UA client to check which data is available on iQunet-CloudLink for a specific iQunet Edge Server (see section 3.3).

3.4.3 Supported SQL statements

After the iQunet Edge Server has been synchronized (to check via UA Expert), the next step is to extract data via MySQL.

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Remark: MySQL is a database and SQL is the query language that is used to extract the data. The proxy only supports a limited set of SQL commands (see the list of supported SQL statements at <https://connect.iqunet.com/queries>).

3.4.4 Examples

iQunet provides a Demo Server that is free to use. The iQunet-CloudLink service is activated for this Server.

Access to the Demo Server has the following limitations:

***Important note:**

This Demo iQunet Edge Server has been set up for software demonstration purposes only. Sensors registered in the demo environment are not connected to any equipment and do not collect any equipment data. Furthermore, iQunet might update this Server, change settings, remove, or add sensors, or change the iQunet server number any time without warning. Please contact iQunet in case you are not able to reach this iQunet Demo Server anymore and want to receive new access to another demo server.

To enter the **(temporary*)** demo environment, perform the following actions:

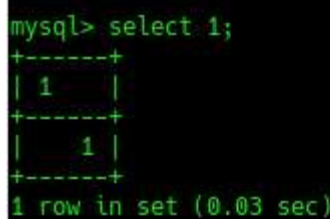
1. Enter “<https://connect.iqunet.com>” in your browser.
2. Authenticate yourself once using your Google account (left entry) – as an alternative create a new Google account for this demo.
3. Add a server card with name: “server-ef7cc700” (see section 3.2 for the instructions) and open the Sensor Dashboard by clicking on the Server ID on the created server card. You now made an access card to the Demo Server in your own environment.
4. You will now enter the Sensor Dashboard of a **local sensor system on an edge computer** (not a cloud system).
See <https://iqunet.com/resources/knowledge-base/how-can-i-connect-to-the-iqunet-server/> for more information. You connect via possibility 4.
 - a. Connected devices are:
 - i. Wireless Accelerometers, and
 - ii. Wireless Sensor Bridges with IEPE Piezoelectric Accelerometers and Current Clamps (the Clamps are clammed over a monophase 230V wire).
 - b. The user can open a parallel second session on mobile phone, tablet, second browser window,
 - c. For more information and the iQunet software manual, see the resources section on the iQunet website: <https://iqunet.com/resources/user-manuals/>. Select the software user manual for software versions 1.7.x or higher.
 - d. On this Demo Server, there is no AI monitoring installed.
 - e. The demo session is live, in the edge – not in the cloud.
 - f. The iQunet-CloudLink service is activated on this server. You can use the iQunet-CloudLink OPC UA and MySQL frontends for software testing purposes.

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3.4.4.1 SQL example 1

"SELECT 1;" <enter>

(<https://dev.mysql.com/doc/refman/8.0/en/select.html>)



```
mysql> select 1;
+-----+
| 1 |
+-----+
| 1 |
+-----+
1 row in set (0.03 sec)
```

Figure 23: SQL example 1 result

"SELECT 1;" means extract the number 1. You don't need to specify from which table. Some software programs use this statement to check if the connection with the MySQL Server is working.

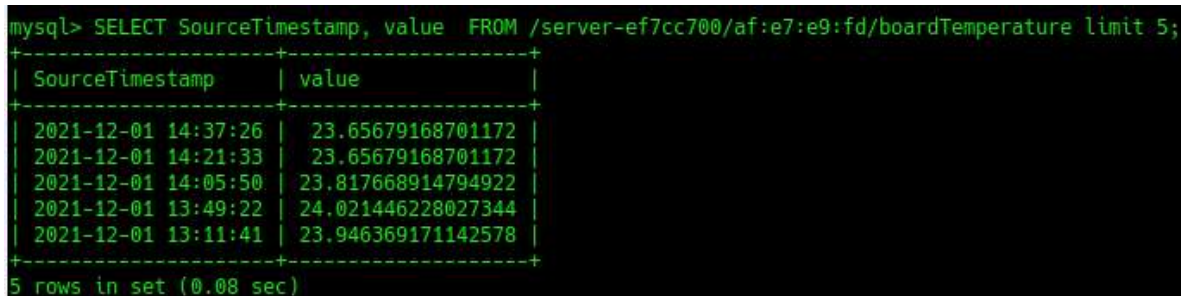
3.4.4.2 SQL example 2

"SELECT <column x> FROM <table> LIMIT 5;" <enter>

Get the latest 5 values from <column x> from <table>.

Remark: like in OPC UA the values are returned with the newest first and then backwards in time unless a specific starting point is given.

"SELECT SourceTimestamp, value FROM /server-ef7cc700/af:e7:e9:fd/boardTemperature limit 5;"



```
mysql> SELECT SourceTimestamp, value FROM /server-ef7cc700/af:e7:e9:fd/boardTemperature limit 5;
+-----+ +-----+
| SourceTimestamp | value |
+-----+ +-----+
| 2021-12-01 14:37:26 | 23.65679168701172 |
| 2021-12-01 14:21:33 | 23.65679168701172 |
| 2021-12-01 14:05:50 | 23.817668914794922 |
| 2021-12-01 13:49:22 | 24.021446228027344 |
| 2021-12-01 13:11:41 | 23.946369171142578 |
+-----+ +-----+
5 rows in set (0.08 sec)
```

Figure 24: SQL example 2 result

3.4.4.3 SQL example 3

Google Data Studio uses queries like the one below.

"SELECT sourceTimestamp, value FROM /server-ef7cc700/af:e7:e9:fd/boardTemperature WHERE sourceTimestamp >= STR_TO_DATE('2021-10-01', '%Y-%m-%d') AND sourceTimestamp <= STR_TO_DATE('2022-01-02', '%Y-%m-%d') LIMIT 5;"

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```
mysql> SELECT sourceTimestamp, value FROM /server-ef7cc700/af:e7:e9:fd/boardTemperature WHERE sourceTimestamp >= STR_TO_DATE('2021-10-01', '%Y-%m-%d') AND sourceTimestamp <= STR_TO_DATE('2022-01-02', '%Y-%m-%d') LIMIT 5;
```

sourceTimestamp	value
2021-10-05 20:45:06	24.364648818969727
2021-10-05 20:45:06	24.364648818969727
2021-10-05 22:48:35	23.013286590576172
2021-10-05 23:03:36	22.873859405517578
2021-10-05 23:18:58	22.777334213256836

```
5 rows in set (0.12 sec)

mysql>
```

Figure 25: SQL example 3 result

3.4.4.4 SQL example 4

The MySQL proxy also supports aliases:

“SELECT SourceTimestamp AS sts, value AS val FROM /server-ef7cc700/af:e7:e9:fd/boardTemperature limit 5;”

```
mysql> SELECT SourceTimestamp AS sts, value AS val FROM /server-ef7cc700/af:e7:e9:fd/boardTemperature limit 5;
```

sts	val
2021-12-01 14:37:26	23.65679168701172
2021-12-01 14:21:33	23.65679168701172
2021-12-01 14:05:50	23.817668914794922
2021-12-01 13:49:22	24.021446228027344
2021-12-01 13:11:41	23.946369171142578

```
5 rows in set (0.08 sec)

mysql>
```

Figure 26: SQL example 4 result (aliases)

3.4.5 Available columns

To check which columns you can select in SQL:

“SHOW COLUMNS FROM <table>;”

“SHOW COLUMNS FROM /server-ef7cc700/af:e7:e9:fd/boardTemperature;”

For the moment you can select:

- sourceTimestamp,
- serverTimestamp,
- and value.

OPC UA history lookups are per specification based on the SourceTimestamp so iQunet uses these timestamps.

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```
mysql> SHOW COLUMNS FROM /server-ef7cc700/af:e7:e9:fd/boardTemperature;
+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Field          | Type   | Collation | Null | Key | Default | Extra | Privileges | Comment |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| value          | float  | NULL      | NO   |     | 0.0      |       | select     |         |
| sourceTimestamp | datetime | NULL      | YES  |     | NULL     |       | select     |         |
| serverTimestamp | datetime | NULL      | YES  |     | NULL     |       | select     |         |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+
3 rows in set (0.08 sec)
```

Figure 27: available columns

3.4.6 Available tables

All table names are like the OPC UA paths:

/server-ef7cc700/af:e7:e9:fd/boardTemperature

/server-ef7cc700/af:e7:e9:fd/aggregate/x/rms/accelRmsX

```
mysql> SELECT SourceTimestamp AS sts, value AS val FROM /server-ef7cc700/af:e7:e9:fd/aggregate/x/rms/accelRmsX limit 5;
+-----+-----+
| sts          | val          |
+-----+-----+
| 2021-08-07 04:54:18 | 0.024094602093100548 |
| 2021-08-07 04:45:32 | 0.022789955139160156 |
| 2021-08-07 04:38:35 | 0.02268797717988491 |
| 2021-08-07 04:28:05 | 0.024566778913140297 |
| 2021-08-07 04:15:03 | 0.023597652092576027 |
+-----+-----+
5 rows in set (0.08 sec)
```

Figure 28: table name structure

You can check which tables are available for a specific sensor with the show tables query:

"SHOW TABLES FROM /server-ef7cc700/af:e7:e9:fd/;"

Remark: nodes deeper down in the tree are not shown. This will be implemented in future releases.

```
mysql> show tables from /server-ef7cc700/af:e7:e9:fd/;
+-----+
| Tables |
+-----+
| /server-ef7cc700/af:e7:e9:fd/lastseen |
| /server-ef7cc700/af:e7:e9:fd/firmware |
| /server-ef7cc700/af:e7:e9:fd/hardware |
| /server-ef7cc700/af:e7:e9:fd/convFactor |
| /server-ef7cc700/af:e7:e9:fd/ui |
| /server-ef7cc700/af:e7:e9:fd/vunits |
| /server-ef7cc700/af:e7:e9:fd/seriesHpf |
| /server-ef7cc700/af:e7:e9:fd/averaging |
| /server-ef7cc700/af:e7:e9:fd/channel |
| /server-ef7cc700/af:e7:e9:fd/sampleRate |
| /server-ef7cc700/af:e7:e9:fd/prefetch |
| /server-ef7cc700/af:e7:e9:fd/numSamples |
| /server-ef7cc700/af:e7:e9:fd/threshold |
| /server-ef7cc700/af:e7:e9:fd/formatRange |
+-----+
```

Figure 29: available tables

USER MANUAL

3.4.7 BadWaitingForInitialData error

Remark: the first time you request historical data, it is possible that you get the following error in MySQL (see Figure 30):

"ERROR 9990 (OPCUA): 0x80320000, "Waiting for the server to obtain values from the underlying data source."(BadWaitingForInitialData)"

```
mysql> SELECT SourceTimestamp AS sts, value AS val FROM /server-ef7cc700/af:e7:e9:fd/aggregate/x/rms/accelRmsX limit 5;
ERROR 9990 (OPCUA): 0x80320000, "Waiting for the server to obtain values from the underlying data source."(BadWaitingForInitialData)
```

Figure 30: BadWaitingForInitialData error

The synchronization of the address space is separated from the historical data. Historical data is only requested at the moment they are used. Synchronization is done from the oldest to the newest data values. It is thus possible that in consecutive queries the data that is shown is still updating and that the latest x values differ as the update progresses.

Remark: in future versions it will be possible to check how far the historical synchronization has progressed. For the moment this can only be done by requesting the latest values and checking if these are the most recent ones. Contact iQunet support for the most recent software version available.