



AQUA-LIS v3.02

Communication Protocol

Nº Document: AQUALISv3.02

Version	Date	Author	Changes
3.00	6/2018	Joan Viladomat	=> Creation of WSDL and current description document
3.01	10/2018	Joan Viladomat	<p>=> System behavior in sorting and aliquoting examples in different configuration and scenarios where “no tests” are answered.</p> <p>=> Explicit that it is a WebService and the LIS must be the server</p> <p>=> change of the address of the wsdl in the NGNY github repository</p>
3.02	12/2018	Joan Viladomat Victor Barbero	<p>=> Added explanation about the virtual tests in point 4.2.2.</p> <p>=> Changed timeout 15s to 30s in point 4.</p> <p>=> Added explanation about superior response time to 3s in point 4.</p> <p>=> Added fields to the Get Tests RESPONSE</p> <pre><SecondaryVolume>SEC_VOLUME</SecondaryVolume></pre> <pre><SecondaryDestination>SEC_DESTINATION</SecondaryDestination></pre> <pre><SecondaryName>SEC_NAME</SecondaryName></pre>

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1. AQUA System installations

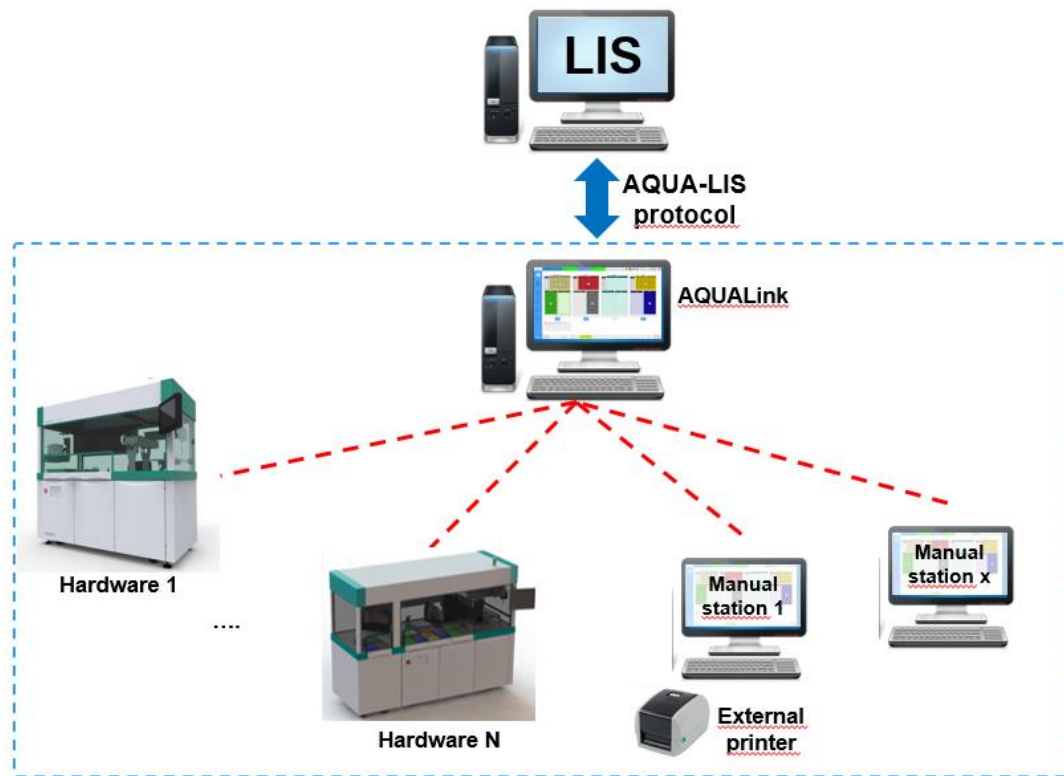
AQUA Systems can be installed and configured depending the needs of every laboratory. It can vary from a single AQUA installation, where only one AQUA Hardware machine deals with the samples arriving at the lab, up to a Multiple AQUA Systems installation, where there is an internal network managed by AQUALink.

In all scenarios, the interface with the LIS is centralized in one single AQUALink computer.

1.1. Single AQUA system installations



1.2. Multiple AQUA system installations



2. Communication configuration

AQUALink is the software that manages the information and communications between AQUA systems (1 or more) and the Laboratory Information System (LIS).

This document describes the communication protocol between AQUALink and the LIS.

- The **LIS is the server**. It will deploy an HTTP SOAP XML **Web service over TCP/IP**
- **AQUALink is the client**. It will send HTTP SOAP XML requests and will wait for the response from the server.
- The LIS should be able to **handle multiple concurrents requests from the client**.

The following WSDL (Web Service Description Language) document describes this web service. It specifies the location of the service and the methods.

https://github.com/ngny/AQUALink-sample/blob/master/aqualis_30_wSDL.xml

2.1. IP Addresses

In a specific AQUA System installation, AQUALink computer has to be given an IP reachable from the LIS computer.

2.2. LIS Port

The LIS must be listening for requests at a specific communications port.

2.3. AQUALink Mode

AQUALink communication can be configured as:

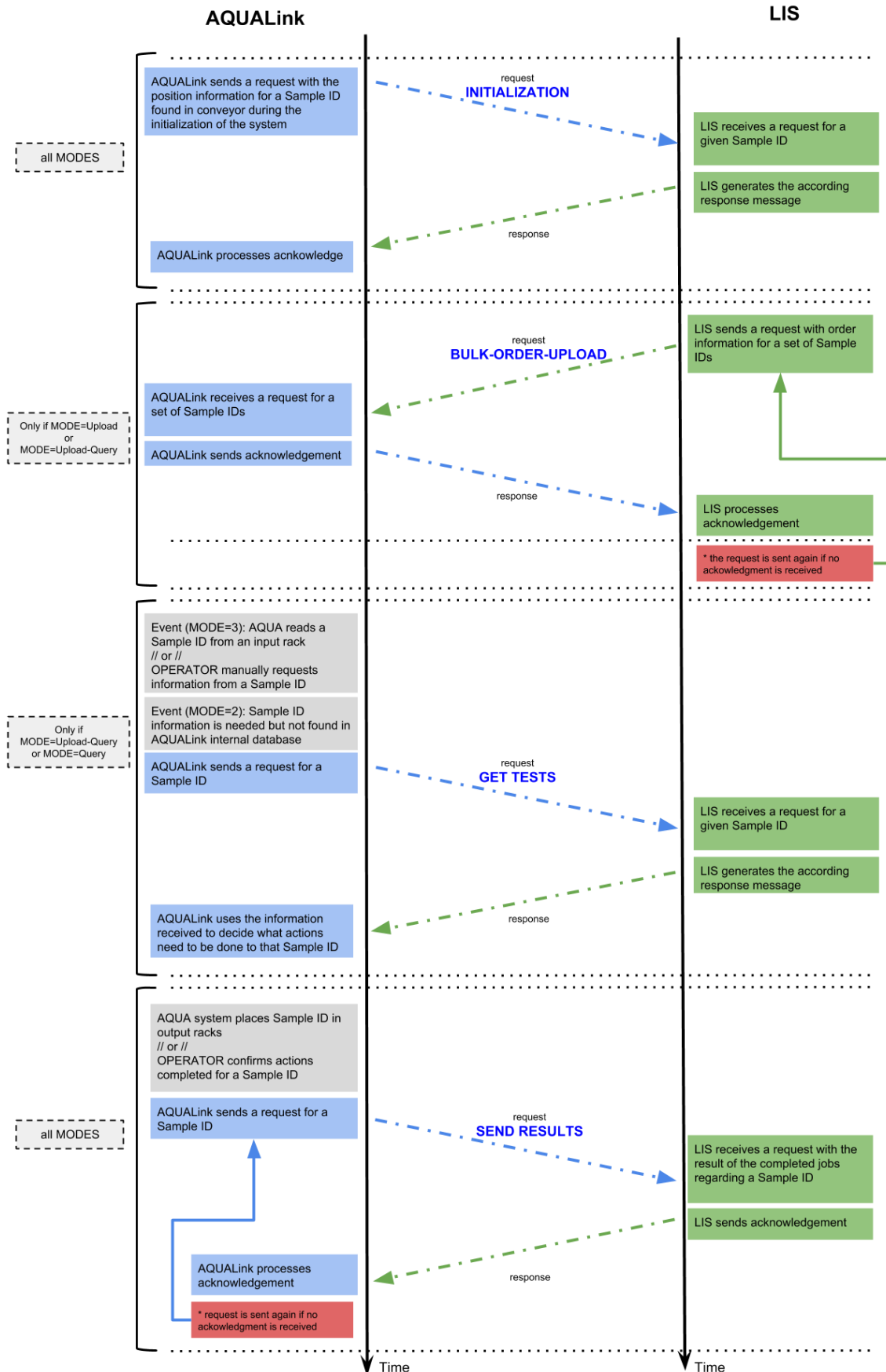
- Bulk Order Upload only (**Mode = 1 (Upload)**)
 - LIS is in charge of sending requests with all sample ID
 - AQUALink checks the information previously received from the LIS every time it picks a tube from the input racks
- Bulk Order Upload with Query (**Mode = 2 (Upload-Query)**)
 - LIS is in charge of sending requests with all sample ID
 - AQUALink checks the information previously received from the LIS every time it picks a tube from the input racks.
 - If no information is found, AQUALink sends a query message for every sample ID picked at input racks to the LIS or if an operator manually requires it.
- Query (**Mode = 3 (Query)**)
 - AQUALink sends a query message for every sample ID picked at input racks to the LIS or if an operator manually requires it.

2.4. AQUALink Port

If Bulk Order Upload is used, AQUALink act also as a server and will be listening for requests at a specific communications port, and the same WSDL mentioned above applies to the AQUALink web server.

3. Communication flow

The communication flow between AQUALink and the LIS follows this diagram:



3.1. Retries to send information

When AQUALink fails to receive the confirmation of a message sent with information the message is stored as pending and retried every 5 minutes during the next 24h.

4. AQUALink requests to LIS

The LIS module **must be** listening at a given TCP port for incoming HTTP SOAP/XML requests. AQUALink (in this case, the client) sends requests to the LIS (in this case the server) and waits for a response. The timeout to receive a response is 30s. If the response time exceeds 3s, the communication will affect the system's performance.

There are three types of payloads:

- Initialization
- Get Tests
- Send Results

4.1. Initialization

This message is sent from AQUALink to the LIS when an AQUA system is in initialization of the conveyor and an unknown sample tube is found in a transport puck. The sample is read by the output robot and the information regarding the position where it is placed is sent to the LIS for traceability.

4.1.1. Request message

```
<?xml version="1.0" encoding="UTF-8"?>
<S:Envelope xmlns:S="http://schemas.xmlsoap.org/soap/envelope/">
  <S:Body>
    <ConveyorInitialization xmlns="http://www.ngnydevices.tech/aqualis/3-0">
      <ClientId>CLIENT_ID</ClientId>
      <Tube>
        <Id>TUBE_ID</Id>
        <Location>
          <RackId>RACK_ID</RackId>
          <HoleId>HOLE_ID</HoleId>
        </Location>
      </Tube>
    </ConveyorInitialization>
  </S:Body>
</S:Envelope>
```

Variable	Description	Example Value	Usage
CLIENT_ID	installation identifier – usually Serial number of the AQUA Sytem hardware where the operation is performed.	AQUA7103	Mandatory
TUBE_ID	identifier of the primary tube as read on the barcode	312011223344	Mandatory
RACK_ID	identifier of the rack where the tube has been placed	10003245	Mandatory
HOLE_ID	coordinates in the rack where the tube has been placed	B4	Mandatory

4.1.2. Response message

```
<?xml version="1.0" encoding="UTF-8"?>
<S:Envelope xmlns:S="http://schemas.xmlsoap.org/soap/envelope/">
  <S:Body>
    <ConveyorInitializationResponse xmlns="http://www.ngnydevices.tech/aqualis/3-0">
      <Result>Success</Result>
    </ConveyorInitializationResponse>
  </S:Body>
</S:Envelope>
```

This message acknowledges the reception of this information at the LIS

4.2. Get Tests

This message is sent from AQUALink to the LIS for three possible reasons:

1. An AQUA System hardware has picked a sample from an Input rack and has read the sample ID barcode
2. An Operator has manually asked the information and actions related to a sample ID code from an AQUALink interface.
3. There is no information concerning a Sample ID in AQUALink internal database in mode Upload-Query

4.2.1 Request message

```
<?xml version="1.0" encoding="UTF-8"?>
<S:Envelope xmlns:S="http://schemas.xmlsoap.org/soap/envelope/">
  <S:Body>
    <GetTests xmlns="http://www.ngnydevices.tech/aqualis/3-0">
      <ClientId>CLIENT_ID</ClientId>
      <PrimaryTube>
        <Id>TUBE_ID</Id>
        <Location>
          <RackId>RACK_ID</RackId>
          <HoleId>HOLE_ID</HoleId>
        </Location>
      </PrimaryTube>
    </GetTests>
  </S:Body>
</S:Envelope>
```

Variable	Description	Example Value	Usage
CLIENT_ID	installation identifier – usually Serial number of the hardware where the operation is performed.	AQUA7103	Mandatory
TUBE_ID	identifier of the primary tube as read on the barcode	312011223344	Mandatory
RACK_ID	identifier of the rack from where the tube has been picked	InputRack1	Mandatory
HOLE_ID	coordinates in the rack from where the tube has been picked	C6	Mandatory

When manually operated requests are sent, the RACK_ID and HOLE_ID can be left blank.

4.2.2 Response message

By **default**, the response from the LIS should **only include the list of Pending tests**. However, if there are special requirements for sorting and aliquoting it is possible to send the complete list of tests and, for each test it is possible to specify its status.

***** NOTE:** the AQUALink software calculates what actions to do (sorting primary destination, decapping, aliquots, volumes of aliquots...) with the list of tests received. The tests can be real analytic determinations that are pending in the LIS database, or can be virtual tests that are agreed with the LIS and are configured during installation and startup. For example one virtual test per each possible aliquot type can be used. The volume and properties of the aliquot are configured in AQUALink database.

```
<?xml version="1.0" encoding="UTF-8"?>
<S:Envelope xmlns:S="http://schemas.xmlsoap.org/soap/envelope/">
  <S:Body>
    <GetTestsResponse xmlns="http://www.ngnydevices.tech/aqualis/3-0">
      <Result>LIS_RESULT</Result>
      <PrimaryTube>
        <Id>TUBE_ID</Id>
        <Location>
          <RackId>RACK_ID</RackId>
          <HoleId>HOLE_ID</HoleId>
        </Location>
      </PrimaryTube>
      <Order>
        <Status>ORDER_STATUS</Status>
        <Priority>ORDER_PRIORITY</Priority>
        <Id>ORDER_ID</Id>
      </Order>
      <SampleSource>
        <ExtractionCenter>EXTRACTION_CENTER</ExtractionCenter>
        <Service>SERVICE</Service>
        <Section>SECTION</Section>
      </SampleSource>
      <Patient>
        <Id>PATIENT_ID</Id>
        <FamilyName>FAMILY_NAME</FamilyName>
        <FirstName>FIRST_NAME</FirstName>
        <MiddleName>MIDDLE_NAME</MiddleName>
        <Sex>PATIENT_SEX</Sex>
        <Physician>PHYSICIAN</Physician>
        <Type>PATIENT_TYPE</Type>
        <BirthDate>BIRTHDATE</BirthDate>
      </Patient>
      <CustomFields>
        <CF1>CF1_VALUE</CF1>
        <CF2>CF2_VALUE</CF2>
        <CF3>CF3_VALUE</CF3>
        <CF4>CF4_VALUE</CF4>
        <CF5>CF5_VALUE</CF5>
        <CF6>CF6_VALUE</CF6>
        <CF7>CF7_VALUE</CF7>
        <CF8>CF8_VALUE</CF8>
        <CF9>CF9_VALUE</CF9>
        <CF10>CF10_VALUE</CF10>
      </CustomFields>
      <Tests>
        <Test>
          <Id>TEST1</Id>

```

```

<Status>TEST_STATUS</Status>
<SecondaryTubeId>SEC_TUBE_ID1</SecondaryTubeId>
<SecondaryVolume>SEC_VOLUME</SecondaryVolume>
<SecondaryDestination>SEC_DESTINATION</SecondaryDestination>
<SecondaryName>SEC_NAME</SecondaryName>
</Test>
<Test>
  <Id>TEST2</Id>
  <Status>TEST_STATUS</Status>
  <SecondaryTubeId>SEC_TUBE_ID2</SecondaryTubeId>
</Test>
</Tests>
</GetTestsResponse>
</S:Body>
</S:Envelope>

```

Variable	Description	Example Value	Usage
LIS_RESULT	Result of the internal query of the LIS Valid values: Success // PrimaryTubeNotFound // InternalError	Success	Mandatory
TUBE_ID	identifier of the primary tube	312011223344	Mandatory
RACK_ID	identifier of the rack from where the tube was picked	InputRack1	Mandatory
HOLE_ID	coordinates in the rack from where the tube was picked	C6	Mandatory
ORDER_ID	Order identifier for the current sample ID	11223344	Optional
ORDER_STATUS	Status of the order for the current sample ID	Opened	Optional
ORDER_PRIORITY	Priority of the order for the current sample ID	Routine	Optional
EXTRACTION_CENTER	Identifier of the extraction center where the sample ID is coming from	12345	Optional
SERVICE	Identifier of the service demanding the current order for the current sample ID	AAA	Optional
SECTION	Identifier of the section of the laboratory in charge of the current sample ID	BBB	Optional
PATIENT_ID	ID of the patient	2233667744B	Optional
PATIENT_TYPE	Type of patient	Human	Optional
PATIENT_SEX	Sex of patient	Male	Optional
FAMILY_NAME	Family name of patient	Smith	Optional
FIRST_NAME	First name of patient	John	Optional
MIDDLE_NAME	Middle name of patient	Levin	Optional
PHYSICIAN	Name of the doctor	Conrad	Optional
BIRTHDATE	Birthdate of the patient (format dd/mm/yyyy)	18/03/1975	Optional
CF1_VALUE	Custom field #1 value		Optional
CF2_VALUE	Custom field #2 value		Optional
CF3_VALUE	Custom field #3 value		Optional
CF4_VALUE	Custom field #4 value		Optional
CF5_VALUE	Custom field #5 value		Optional
CF6_VALUE	Custom field #6 value		Optional
CF7_VALUE	Custom field #7 value		Optional
CF8_VALUE	Custom field #8 value		Optional
CF9_VALUE	Custom field #9 value		Optional
CF10_VALUE	Custom field #10 value		Optional
TEST1..N	Identifiers of the tests linked to a sample ID	GLU	Mandatory *
TEST_STATUS	Status of the current test for the sample ID Valid values: Validated // Done // Pending // Cancel	Pending	Mandatory
SEC_TUBE_ID1..N	ID to be printed in the generated aliquote tube according to each test. If not used, the standard rules to generate aliquote ID's will be used	12300001	Optional

SEC_VOLUME	Volume (in uL) to be dispensed in the aliquote tube. If not used, the standard rules to calculate the aliquote volume will be used	300	Optional
SEC_DESTINATION	Destination where the aliquote tube has to be sorted. If not used, the standard rules to determine the aliquote sorting destination will be used	IMMUNO	Optional
SEC_NAME	Name of the aliquot tube to be printed in label. If not used, the standard rules to determine the aliquote name will be used	ENA	Optional

*** If there are no tests for one sample ID, the response will include an empty test list.**

4.3. Send Results

This message is sent from AQUALink to the LIS for three possible reasons:

1. An AQUA system hardware has placed a sample at an Output rack (actions finished) and sends the results for every requested test.
2. An Operator has manually performed some actions related to a sample ID code and confirms the result of them.

4.3.1. Request message

```
<?xml version="1.0" encoding="UTF-8"?>
<S:Envelope xmlns:S="http://schemas.xmlsoap.org/soap/envelope/">
  <S:Body>
    <SendResults xmlns="http://www.ngnydevices.tech/aqualis/3-0">
      <ClientId>CLIENT_ID</ClientId>
      <ProcessedPrimaryTube>
        <Id>TUBE_ID</Id>
        <Status>PRIMARY_STATUS</Status>
        <Location>
          <RackId>RACK_ID</RackId>
          <HoleId>HOLE_ID</HoleId>
        </Location>
        <VisualAnalysis>
          <Width>PRIMARY_WIDTH</Width>
          <Height>PRIMARY_HEIGHT</Height>
          <VolumeEstimation>VOLUME_ESTIMATION</VolumeEstimation>
          <CapType>CAP_TYPE</CapType>
          <HValue>H_VALUE</HValue>
          <IValue>I_VALUE</IValue>
          <LValue>L_VALUE</LValue>
          <PictureUrl>PICTURE_URL</PictureUrl>
        </VisualAnalysis>
        <Comment>PRIMARY_COMMENT</Comment>
      </ProcessedPrimaryTube>
      <TestResults>
        <Test>
          <Id>TEST1</Id>
          <Status>TEST_ACTION_RESULT</Status>
        </Test>
        <Test>
          <Id>TESTN</Id>
          <Status>TEST_ACTION_RESULT</Status>
        </Test>
      </TestResults>
      <GeneratedSecondaryTubes>
        <SecondaryTube>
          <Id>SEC_TUBE_ID</Id>
          <Location>
            <RackId>RACK_ID</RackId>
            <HoleId>HOLE_ID</HoleId>
          </Location>
          <Comment>SECONDARY_COMMENT</Comment>
          <VolumeMl>SECONDARY_VOLUME</VolumeMl>
          <Status>SECONDARY_STATUS</Status>
        </SecondaryTube>
      </GeneratedSecondaryTubes>
    </SendResults>
  </S:Body>
</S:Envelope>
```

Variable	Description	Example Value	Usage
CLIENT_ID	installation identifier – usually Serial number of the hardware where the operation is performed.	AQUA7103	Mandatory
TUBE_ID	identifier of the primary tube as read on the barcode	312011223344	Mandatory
PRIMARY_STATUS	Status of the current actions for the primary sample ID Valid values: Success // Failure	Success	Mandatory
RACK_ID	identifier of the rack where the tube has been placed	200329	Mandatory
HOLE_ID	coordinates in the rack where the tube has been placed	A2	Mandatory
PRIMARY_WIDTH	Mesured width of the sample ID in mm	15.3	Optional
PRIMARY_HEIGHT	Mesured height of the sample ID in mm	100	Optional
CAP_TYPE	Cap type of the sample ID	Yellow	Optional
VOLUME_ESTIMATION	Estimated available volume of the sample ID in mL	2.4	Optional
H_VALUE	Estimation of Hemolyzed Sample ID	True	Optional
I_VALUE	Estimation of Icteric Sample ID	False	Optional
L_VALUE	Estimation of Lipemic Sample ID	False	Optional
PICTURE_URL	HTTP address where to download the captured image of the primary tube in JPEG format	http://10.0.0.10/32131434.jpeg	Optional
PRIMARY_COMMENT	Comment related to the integrity of the primary tube	Label placed too low	Optional
TEST1..N	Identifiers of the tests linked to a sample ID	GLU	Mandatory
TEST_ACTION_RESULT	Result of the operations done according to that test Valid values: Success // Failure	Success	Mandatory
SEC_TUBE_ID	Identifier of the secondary tube generated	223011223344	Mandatory
SECONDARY_COMMENT	Comment related to the generated secondary tube	not capped	Optional
SECONDARY_VOLUME	Volume dispensed in the secondary tube in mL	0.7	Optional
SECONDARY_STATUS	Valid values: Success // AspirationError // TubeGenerationError // FamilyCancelError // LisError // DispenseError // PipettorStateError // NoResult // AliquotePending // DiameterTooHighForOutputHole // TubeCheckFailure	Success	Mandatory

Examples of situations:

- a Sample ID has multiple sorting destinations related to different tests and the tube is sorted to the one with higher priority
 - o the answer will include “Success” in the TEST_ACTION_RESULT only for the tests leading to that destination, and “Failure” for the tests that had different sorting destination.
- a Sample ID has multiple secondary tubes to generate and it fails because there is not enough sample
 - o the answer will include “Success” in the TEST_ACTION_RESULT only for the tests that were included in the secondary tubes completely filled, and “Failure” for the tests included in the secondary tubes not filled completely.

4.3.2 Response message

```
<?xml version="1.0" encoding="UTF-8"?>
<S:Envelope xmlns:S="http://schemas.xmlsoap.org/soap/envelope/">
  <S:Body>
    <SendResultsResponse xmlns="http://www.ngnydevices.tech/aqualis/3-0">
      <Result>RESULT_RECORDED</Result>
    </SendResultsResponse>
  </S:Body>
</S:Envelope>
```

Variable	Description	Usage
RESULT_RECORDED	Valid values: Success // InternalError	

5. LIS requests to AQUALink

The LIS module **can** send requests at any time to the AQUALink module, which is listening for requests at a given TCP port. In this case LIS is the client while AQUALink acts as the server. There is only one of type of payload which is used to upload bulk order requests. In this case, the same WSDL applies.

5.1. Bulk Order Upload

This message is sent from LIS to AQUALink to update the information concerning the expected samples in the lab.

5.1.1. Request message

```
<?xml version="1.0" encoding="UTF-8"?>
<S:Envelope xmlns:S="http://schemas.xmlsoap.org/soap/envelope/">
  <S:Body>
    <BulkOrder xmlns="http://www.ngnydevices.tech/aqualis/3-0">
      <Sample>
        <BulkPrimaryTube>
          <Id>TUBE_ID</Id>
        </BulkPrimaryTube>
        <Tests>
          <Test>
            <Id>TEST1</Id>
            <Status>TEST_STATUS</Status>
            <SecondaryTubeId>SEC_TUBE_ID1</SecondaryTubeId>
            <SecondaryVolume>SEC_VOLUME</SecondaryVolume>
            <SecondaryDestination>SEC_DESTINATION</SecondaryDestination>
            <SecondaryName>SEC_NAME</SecondaryName>
          </Test>
        </Tests>
        <CustomFields>
          <CF1>CF1_VALUE</CF1>
          <CF2>CF2_VALUE</CF2>
          <CF3>CF3_VALUE</CF3>
          <CF4>CF4_VALUE</CF4>
          <CF5>CF5_VALUE</CF5>
          <CF6>CF6_VALUE</CF6>
          <CF7>CF7_VALUE</CF7>
          <CF8>CF8_VALUE</CF8>
          <CF9>CF9_VALUE</CF9>
          <CF10>CF10_VALUE</CF10>
        </CustomFields>
        <Patient>
          <Id>PATIENT_ID</Id>
          <FamilyName>FAMILY_NAME</FamilyName>
          <FirstName>FIRST_NAME</FirstName>
          <MiddleName>MIDDLE_NAME</MiddleName>
          <Sex>PATIENT_SEX</Sex>
          <Physician>PHYSICIAN</Physician>
          <Type>PATIENT_TYPE</Type>
          <BirthDate>BIRTHDATE</BirthDate>
        </Patient>
        <SampleSource>
          <ExtractionCenter>EXTRACTION_CENTER</ExtractionCenter>
          <Service>SERVICE</Service>
          <Section>SECTION</Section>
        </SampleSource>
      </BulkOrder>
    </S:Body>
  </S:Envelope>
```

```

<Order>
  <Status>ORDER_STATUS</Status>
  <Priority>ORDER_PRIORITY</Priority>
  <Id>ORDER_ID</Id>
</Order>
</Sample>
</BulkOrder>
</S:Body>
</S:Envelope>

```

Variable	Description	Example Value	Usage
TUBE_ID	identifier of the primary tube	312011223344	Mandatory
ORDER_ID	Order identifier for the current sample ID	11223344	Optional
ORDER_STATUS	Status of the order for the current sample ID	Opened	Optional
ORDER_PRIORITY	Priority of the order for the current sample ID	Routine	Optional
EXTRACTION_CENTER	Identifier of the extraction center where the sample ID is coming from	12345	Optional
SERVICE	Identifier of the service demanding the current order for the current sample ID	AAA	Optional
SECTION	Identifier of the section of the laboratory in charge of the current sample ID	BBB	Optional
PATIENT_ID	ID of the patient	2233667744B	Optional
PATIENT_TYPE	Type of patient	Human	Optional
PATIENT_SEX	Sex of patient	Male	Optional
FAMILY_NAME	Family name of patient	Smith	Optional
FIRST_NAME	First name of patient	John	Optional
MIDDLE_NAME	Middle name of patient	Levin	Optional
PHYSICIAN	Name of the doctor	Conrad	Optional
BIRTHDATE	Birthdate of the patient (format dd/mm/yyyy)	18/03/1975	Optional
CF1_VALUE	Custom field #1 value		Optional
CF2_VALUE	Custom field #2 value		Optional
CF3_VALUE	Custom field #3 value		Optional
CF4_VALUE	Custom field #4 value		Optional
CF5_VALUE	Custom field #5 value		Optional
CF6_VALUE	Custom field #6 value		Optional
CF7_VALUE	Custom field #7 value		Optional
CF8_VALUE	Custom field #8 value		Optional
CF9_VALUE	Custom field #9 value		Optional
CF10_VALUE	Custom field #10 value		Optional
TEST1..N	Identifiers of the tests linked to a sample ID	GLU	Mandatory *
TEST_STATUS	Status of the current test for the sample ID Valid values: Validated // Done // Pending // Cancel	Pending	Mandatory
SEC_TUBE_ID1..N	ID to be printed in the generated aliquote tube according to each test. If not used, the standard rules to generate aliquote ID's will be used	12300001	Optional
SEC_VOLUME	Volume (in uL) to be dispensed in the aliquote tube. If not used, the standard rules to calculate the aliquote volume will be used	300	Optional
SEC_DESTINATION	Destination where the aliquote tube has to be sorted. If not used, the standard rules to determine the aliquote sorting destination will be used	IMMUNO	Optional
SEC_NAME	Name of the aliquot tube to be printed in label. If not used, the standard rules to determine the aliquote name will be used	ENA	Optional

5.1.2. Response message

```
<?xml version="1.0" encoding="UTF-8"?>
<S:Envelope xmlns:S="http://schemas.xmlsoap.org/soap/envelope/">
  <S:Body>
    <BulkOrderResponse xmlns="http://www.ngnydevices.tech/aqualis/3-0">
      <Result>WORKORDER_RECORDED</Result>
    </BulkOrderResponse>
  </S:Body>
</S:Envelope>
```

Variable	Description	Usage
WORKORDER_RECORDED	Valid values: Success // InternalError	

If there is an error while storing the information in AQUALink database, the LIS should be aware of it and resend the information accordingly.

6. WSDL of communication

In this GitHub link you will find information and examples.
Also you will find a Code to Test using a ***curl*** command from a terminal.

<https://github.com/ngny/AQUALink-sample.git>

This WSDL will be backwards compatible while the main version number is not changed.