

Benefits of Client-Server Systems for Quality Control with Vis-NIR Spectroscopy



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Analyzer systems monitoring product quality can offer substantial advantages when organized in a client-server network compared to the more traditional local installation. This white paper presents different client-server setups and their benefits. Security aspects that need to be considered are discussed based on the example of the client-server Vis-NIR (visible near-infrared) spectroscopy software Vision Air, widely used for quality control in the chemical, polymer, pharmaceutical, and petrochemical industry.

Metrohm White paper

Status Quo

A glance into today's quality control labs shows that analytical systems are often configured in such a way that measurements, data storage, and system maintenance are all performed using a local PC. This PC might be connected to an ERP or LIMS system for transmitting results to central decision points. However, depending on the complexity of the analytical method used, (several) highly trained users are required for maintenance and configuration (figure 1).

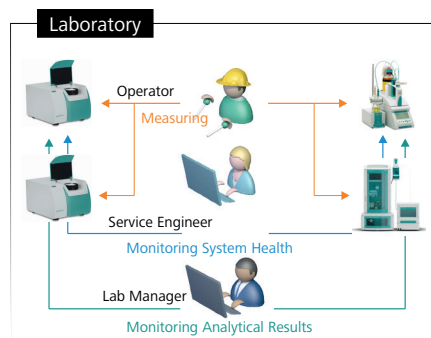


Figure 1. Overview of know-how needed to maintain and operate analytical instruments for quality control in a laboratory environment

This is also true for visible near-infrared (Vis-NIR) spectroscopy systems where users creating prediction models and libraries may differ from users conducting routine analysis. Routine analysis with Vis-NIR spectroscopy can, due to its simplicity, be performed by untrained users, but prediction model and

library development require special training. However, the latter must not necessarily be performed on the local PC, but can be achieved more efficiently and safely using a client-server setup. Furthermore, such a setup reduces costs, especially when used to outsource more difficult tasks.

Basics of a Client-Server System

Before going into detail, the most basic setup for a client-server system in a quality control environment is presented in figure 2.



Figure 2. General setup of a client-server system for quality control. The setup consists of three elements: server client, routine client, and server database

The purpose of the server client, as shown in figure 2, is to configure and define access rights of the routine client. The routine client itself is used for measurements and instrument calibrations. The server database acts as central storage for all data and settings.

Based on this general setup, three different scenarios (figure 3) are described in the following chapters. For each, the advantages over a non-client-server setup (figure 1) are presented.

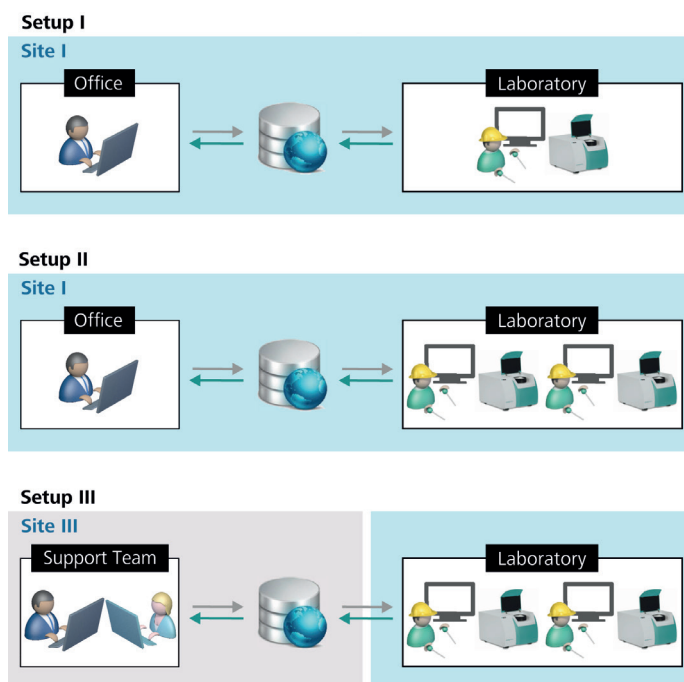
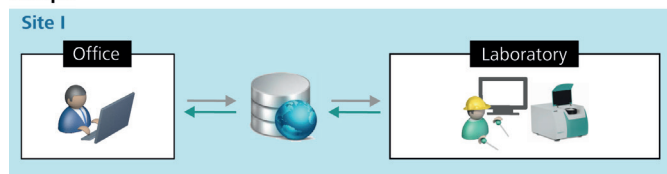


Figure 3. Client-server setups described in this white paper. Setup I and II differ in the number of clients. Setup III differs in the installation location of the individual elements of a typical client-server setup

Setup 1: Single Client

Setup I



The single client-server setup offers the possibility to increase productivity through convenient monitoring of instrument performance and easy access to analytical results without interfering with routine analysis operations. Permanent, not locally restricted monitoring of instrumental and analytical performance creates peace of mind and simplifies pro-active maintenance to avoid downtimes, thus providing cost savings.

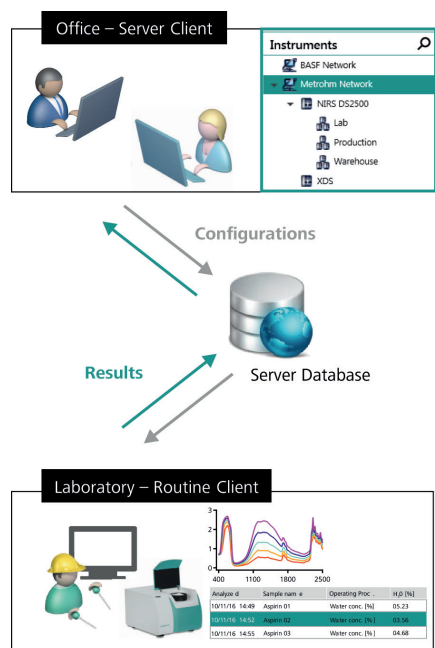


Figure 4. Simple client-server setup with only one spectrometer system offering significant advantages over a local installation.

Figure 4 displays such a setup in more detail, where data collected during routine analysis in the laboratory (routine-client) are stored automatically on the server database. Database access is regulated but flexible (e.g., from the office) and permits convenient creation and update of prediction models/libraries using the Server Client. Moreover, the user of the server client can monitor the system health and in an ideal case, the client-server software warns automatically about possible issues or errors. Additionally, data access can be more efficiently regulated with a single centralized database.

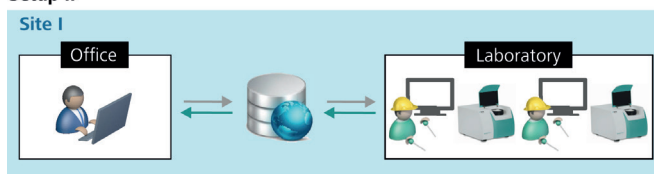
Besides improving operational security, data security is enhanced when using a client-server system. This results from the presence of a server database acting as an automatic backup drive, which in the event of a total breakdown of the local operating system prevents loss of data and also makes it possible to quickly resume operation.

Advantages in a nutshell

- Simultaneous data access
- No interference with routine operation
- Convenient monitoring of instrument and analytical performance

Setup 2: Multiple Clients

Setup II



An additional benefit becomes evident when several installations are maintained in a client-server network instead of a stand-alone set-up. Redundant actions are significantly reduced since changes can be executed for multiple instruments in just one step. Besides the possibility for more efficient instrument maintenance, human errors are minimized as a result of simplified workflows. Figure 5 exemplarily displays the process of a prediction model update for multiple instruments.

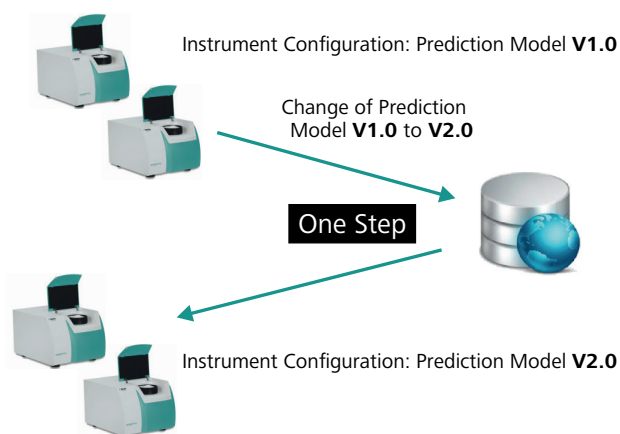


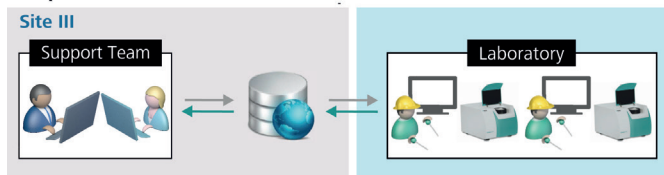
Figure 5. Update of multiple instruments in a single step using a client-server setup.

Advantages in a nutshell

- Reduction of redundant steps
- Easy update of multiple instruments in one step
- Convenient monitoring of multiple instruments

Setup 3: Outsourcing

Setup III



Another beneficial aspect of the client-server system is the possibility to outsource complex tasks. For customers mainly interested in the improved data security aspects of a client-server setup, outsourcing of only the IT infrastructure is possible. Suppliers providing the IT infrastructure have in this case no access to the data collected. For users interested in more extended support, outsourcing of both prediction model development and instrument health monitoring is possible. Figure 6 shows such a full care service offer from Metrohm.

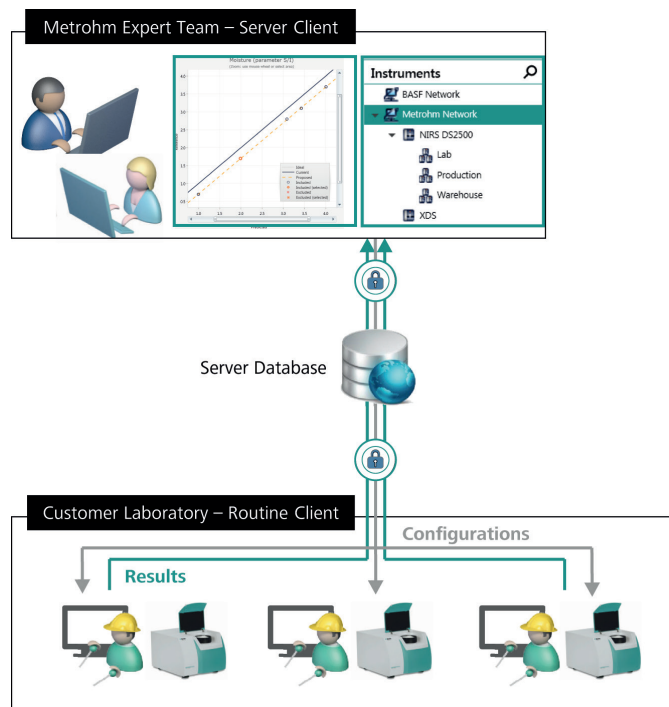


Figure 6. Full care service reducing the total workload of customers.

Advantages in a nutshell

- Improved use of human resources
- Optimized prediction model
- Simplified service

Boundary Conditions Client-Server

To implement the outsourcing scenario setup 3, different data security aspects need to be considered. Additionally, the associated partner must make sure that the confidentiality of all client data is guaranteed at all times. In the following, an example is presented on the basis of Metrohm's approach with Metrohm's client-server software Vision Air.

In general, a statement of confidentiality has to be available for a common understanding about data handling. Metrohm, for example, does not reveal or disclose information (sample data, spectral data, trade or service mark, methods, processes, know-how, and other proprietary information) that it receives or accesses through the Vision Air client-server solution to any third party, nor does it use that information otherwise than for the purpose of providing support to the customer.

Besides this common agreement between involved parties, the data communicated needs to be defined and security measurements restricting external access need to be put in place.

Data Communication and External Access

Data transferred between a Vision Air client and a Vision Air server are measurements (spectra, results, and reference values), instrument health information (diagnostic test, low flux test, photometric tests), and events (user authentication, instrument events).

All connection and communication between the server/server-clients (Vision Air Manager Network) and the clients (Vision Air Routine) are encrypted. Keys and certificates are embedded into the application and communication between the server (Vision Air Manager Network) and the clients (Vision Air Routine) is based on Windows Communication Foundation (WCF) encrypted with AES-256 and signed using an SSL Certificate. This technology is used in a similar way for https and is regarded as completely safe.

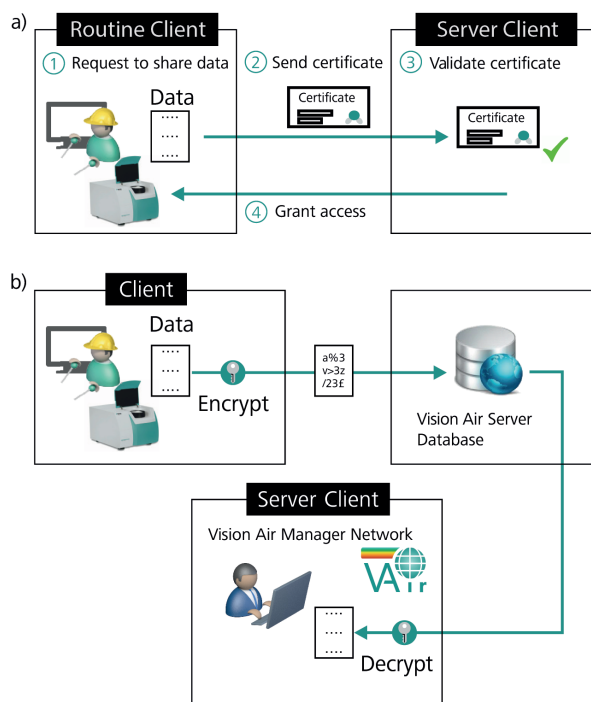


Figure 7. Schematic representation of data security achieved by the Metrohm Client-Server solution: a) Process for request of data transfer between client and server. b) Data transfer client to server and encryption process. Both processes a) and b) take place in the same way for data transfer server to client.

Advantages in a nutshell

- Secured data transfer
- Fast and easy data transfer

Security Data Manipulation

System configurations created in Vision Air Manager and uploaded to individual Vision Air Routine clients are signed each with an individual code guaranteeing authenticity and non-modification. Results collected with Vision Air Routine are also signed and the result is highlighted once it has been successfully transferred to the database. Manipulation of both configurations created by the Vision Air Manager and results collected in Vision Air Routine will result in a loss of signature

Server Access

In addition to software-related security aspects, hardware-related aspects have to be addressed to maintain data security and data integrity. The single point access to the Metrohm server room, for example, is restricted to authenticated staff and secured with video cameras monitoring room access. Automatic backup, 24/7 surveillance and safety personnel are additional measures to ensure customer data security. Additional power sources are available to compensate for power failure. Access to Vision Air Manager Network and any data stored on those servers is limited to the Metrohm IT team and specific members of the Competence Center spectroscopy.

Servers are backed up once per day and data is retained for 28 days. All backup systems are tested regularly to ensure data recoverability.

Offline Mode and Data Recovery

Last but not least, it is crucial that routine analysis remains possible in the case of loss of network connectivity or in case of a break-down of both client and server.

The integrated offline mode in Vision Air Routine permits measurements even if the internet connection is interrupted. Data collected is stored on both the local database and the Metrohm Server database, where the customer can define which data is uploaded to the Metrohm Server.

- **Loss of network connectivity** between the client (Vision Air Routine) and server (Vision Air Manager Network) will not affect the local operation of the NIR instrument and measurement can continue unaffectedly with the current configuration data. Potential new configuration data that has been prepared on the server will wait for the download until network connectivity is re-established.
- **A server breakdown** will not affect the local operation of the NIR instrument and measurement can continue unaffectedly with the current configuration data. The server will be restored according to the disaster recovery plan. New data to be uploaded to the server will be cached locally and will be uploaded once network connectivity is re-established.
- In the case of a **client breakdown** where locally stored backups cannot be backed up, the connection with the server will allow downloading the most recent configuration. Measurements can therefore still be performed.

Summary

In this white paper, the potential of a client-server system is highlighted displaying the possibility to reduce costs while increasing data security. Reasons are simultaneous operation and access to data while stored in a secured database. Furthermore, faster and consistent updates of multiple instruments in a single workflow are possible.

This white paper also presents security aspects of such a client-server system when outsourcing critical tasks, which offers the potential to increase productivity and simplify operation. This is especially true for NIR spectroscopy, where support for prediction model/library development is very common. Finally, security implementation requirements for a service oriented client-server setup are described on the basis of Metrohm's client-server spectroscopy software Vision Air.