IT Solutions Focus

TECHNOLOGY EVOLUTION AND ITS IMPACT ON LIMS FUNCTIONALITY, COST, AND RoI

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For many organisations, their Laboratory Information Management System (LIMS) is a mission-critical component of their overall corporate Information System (IS) -- whether the company is in a regulated industry such as pharmaceutical manufacturing or in a non-regulated industry such as petrochemicals. LIMS provide the integral connections to these companies' laboratory data, instruments, analysis and reports.

Today, LIMS are in the fourth generation of evolution, and many organisations must upgrade or modify their LIMS to ensure optimum interoperability with the overall corporate IS infrastructure. Now, the proliferation of choices makes selecting the best LIMS architecture more critical than ever. The task of selecting the correct LIMS for an organization is complicated further because many of the terms used to describe different LIMS and system architectures are used interchangeably. This article will provide clarification of the terms as well as the capabilities of each type of solution.

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UNDERSTANDING THE TECHNOLOGICAL STRENGTHS AND LIMITATIONS

FROM FIRST GENERATION LIMS TO WEB FUNCTIONALITY

The first commercial LIMS were introduced in the 1980's by analytical instrument manufacturers. These first generation LIMS placed laboratory functions onto a single centralised computer, providing greater lab productivity and functionality as well as the first automated reporting capabilities. These were quickly followed by second generation LIMS which utilised third-party commercial relational databases (RDB) to provide application-specific solutions.

The third generation LIMS, emerged in the 1990's, combined the PC's easy-to-use interface and standardised desktop tools with the power and security of minicomputer servers in a client/server configuration. By the mid-1990s, fourth generation LIMS decentralised the client/server architecture further, thereby optimising resource sharing and network throughput by enabling processing to be performed anywhere on the network.

When the Internet took off in 1996, the first web-enabled LIMS were soon introduced, followed by web-based and thin-client solutions. Most of these thin-client solutions were developed in Java, and web-based systems on Microsoft's .NET® platform.

Thick-Client Versus Web-Enabled Versus Web-Based Versus Thin-Client

Understanding the differences between thick-client, web-enabled, web-based and thin-client LIMS is challenging because the terms are often used interchangeably, making it difficult to develop a well-informed decision when choosing the "right" LIMS. Because these terms actually apply to very different types of platforms, it can prove costly when organisations find out that their new software does not deploy or function as expected.

Thick-client is used to describe an application designed to run in a client/server environment, meaning that a portion of the software resides on the server and the other portion resides on the user's workstation. A thick-client has the LIMS installed on the PC hard drive. It connects to the database server, but the processing is done on the client side (See *Figure 4*). Each time administrators change the configuration or customises the LIMS, changes are required on each client workstation.

> ***"THE FIRST COMMERCIAL LIMS WERE INTRODUCED IN THE 1980'S BY ANALYTICAL INSTRUMENT MANUFACTURERS"***

Web-enabled is used to describe the add-on web browser component of an application designed to run in a client/server environment. The web-enabled portion of the application allows access to data from a web browser, but the user is limited to the product functionality that is available on the web portion of the system (*Figure 1*).

Thin-client or web-based offers end-users full application functionality from a browser. A thin-client does not have significant hard drive or memory requirements, as it does not store or process data. The LIMS resides on the application server(s) while the thin-client simply presents the screen display and allows users to use the keyboard and mouse to interact with the application server. A true thin-client LIMS is designed to specifically run on the web, with zero-footprint on the end-user client. No downloads, applets, or other programs exist on the end-user client, other than the browser (*Figure 2*).

Thin-Client Versus Web-Based Versus Web-Enabled Versus Thick-Client

Thin-Client. Provides full LIMS functionality through the web browser with "zero footprint" and processing on the end-user's client.

- Less expensive end-user "dumb" clients can be used, since no data processing occurs on the client, reducing hardware costs.
- System changes are made on the application server, rather than on each client, reducing ongoing maintenance expenses.
- Cross-platform programs are not needed reducing overall software costs.
- No need to update any .NET framework reducing maintenance expenses and removing reliance on Microsoft supported application servers.

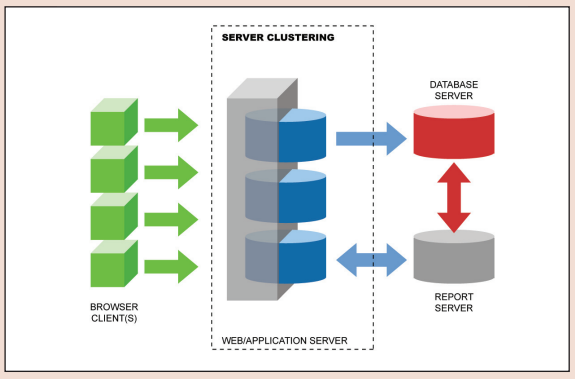

Figure 1. Configuration of a Typical Thin-Client LIMS

Web-Based. Provides full LIMS functionality through the web browser, but uses the .NET framework to download and run the LIMS application on the end-user's thick-client and connection to the server.

- More expensive end-user "fat" clients are needed, since these clients share the bulk of data processing, increasing hardware costs.
- Requires use of Microsoft .NET and supported application servers.
- System administrators must update the .NET framework to make changes on the end-user's thick client, increasing maintenance expenses.
- May limit the use of certain PDA, tablet PCs, and hand-held devices.

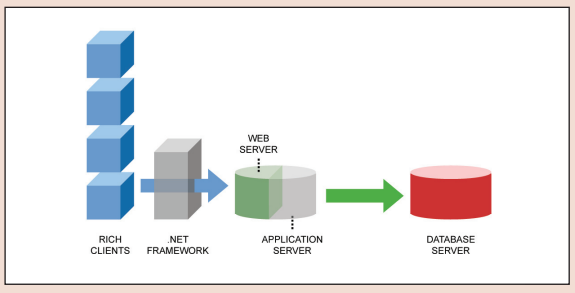

Figure 2. Configuration of a .NET Web-Based LIMS

A .NET application that runs on the .NET framework installed on the end-user client is required to render the browser pages from the thick-client server. In essence, the browser is not showing HTML, but instead, is showing a thick-client-server-like application. In addition, these applications also rely on the local client for computer processing, and therefore require a rich, rather than, dumb end-user client (*Figure 3*).

Web-Enabled. Most of the LIMS resides on the user's PC or workstation, but add-on portions run through the web browser.

- Limits functionality available to users through the web browser.
- More expensive end-user "fat" clients are needed to perform the bulk of data processing, increasing hardware costs.
- Cross-platform programs are needed to support an enterprise deployment increasing overall expenses.
- System administrators are forced to make changes on most end-user thick-clients increasing maintenance expenses.

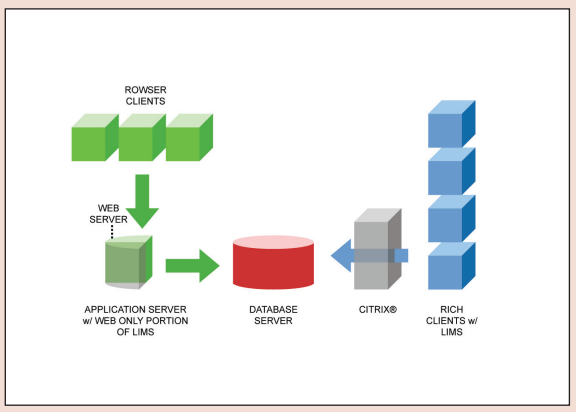

Figure 3. Configuration of a Typical Web-Enabled LIMS

Thick-Client. The LIMS resides on the user's PC or workstation.

- More expensive end-user "fat" clients are needed to perform the bulk of data processing, increasing hardware costs.
- Cross-platform programs are needed to support an enterprise deployment increasing overall expenses.
- System administrators are forced to make changes on each end-user thick-client increasing maintenance expenses.
- No functionality available to users through a web browser.Web-based LIMS typically transmit data between he .NET framework and traditional client/server architectures to offer a web-based application. In such systems, the thick-client is somewhat hidden because it runs in a browser. However, there is more running on the client than just the browser.

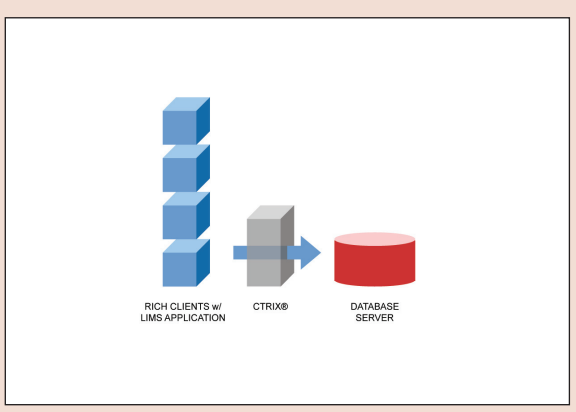

Figure 4. Configuration of a Typical Thick-Client LIMS

TRADE-OFFS OF EACH SOLUTION

Integrating a LIMS into the overall IS should take into consideration the company's current infrastructure, long-term plans for the IS, and investment in hardware and human resources to manage the IS. This decision in turn affects the cost of clients and servers, third party software needed to connect these LIMS clients, and the resources needed to deploy and maintain the LIMS.

Network Bandwidth. Thick-clients and web-enabled solutions typically require less network bandwidth. Moreover, because thick-clients themselves do much of the application processing, they do not require an application server for processing. Web-enabled and some web-based systems offer a hybrid to this approach, depending on where the functionality resides (i.e., on the client or on the server).

Redundancy. Thick-clients provide some level of redundancy. If the LIMS server fails, the client can still collect and hold data until a connection is re-established. In a thin-client application, however, redundancy is achieved through clustered application servers that provide load balancing and fail-over.

Performance. Thick-clients tend to have advantages in multimedia-rich applications that would be bandwidth intensive if fully served. For example, thick-clients are well suited for chemical drawing and molecular modeling programs that require a significant amount of computing power. However, advances in technologies such as Ajax (Asynchronous JavaScript and XML) provide more dynamic and interactive thin-client functionality than previously available over the Web.

Access. With a thin-client, users can access the LIMS from virtually any Internet-ready device. The lab's applications and data are maintained centrally, thus allowing any number of people to share them in a secure way by simply plugging in a thin-client browser. Thin-clients also enable connectivity by critical users external to the lab, such as executives, customers, and partners. Thick-clients must be installed at each end-user and have no remote access capabilities. Web-enabled systems offer some remote access but with limited functionality available via the browser.

Security. With thin-clients, all the applications and data are maintained on a central server. Access is role-based and password protected and no LIMS data ever resides on the client, preventing unwarranted data transfer or copying to local drives.

Ease of Use. A thin-client browser interface has the familiar and intuitive web-site look and feel, which keeps initial and ongoing training costs low. Because end-user adoption is easier, the LIMS can be integrated with the organisation's workflows quicker. This enables organizations to leverage their investment and reap the benefits of enhanced productivity sooner.

Hardware, Software & IT Costs. Thin-client solutions reduce the cost per user and IT manpower requirements while delivering a solution that is easily upgradeable and expandable (without interrupting business). Software updates are done once from a central server and are immediately available to all; desktop upgrades are not required. A thin-client LIMS enables IT to deploy, maintain and support only one central LIMS, thereby increasing return on investment (ROI). Thick-client and web-enabled systems require IT to upgrade all end-user thick-clients, along with each regional server and cross-platform programs residing on them.

Thin-client hardware is generally less expensive than thick-clients because they require less local disk space, application memory, or processors. The total hardware requirement for a thin-client system (including both servers and clients) is usually much lower as well. One reason for this is that the hardware is better utilized. A thick-client CPU is idle most of the time. With thin-clients, memory can be shared. If several users need to access the LIMS, it only needs to be loaded into the RAM once on a central application server. With thick-clients, each workstation must have its own copy of the LIMS in memory. Ultimately, the real value of thin-client computing emerges when determining the "total cost of ownership" (TCO), which includes not only the upfront price of the hardware and software, but also the much larger cost of installing, supporting and updating the system over time.

SELECTING THE RIGHT SOLUTION

There are significant differences between thick-client, web-enabled, web-based, and thin-client solutions. Thick-clients are desktop client applications that connect to a remote database. Web-enabled solutions are more oriented toward thick or rich clients, while web-based solutions offer some of the benefits of thin-client applications. Thin-clients, on the other hand, are true HTML applications that do not require additional end-user client downloads, applets or frameworks. Just be sure you know what you're getting by being cognisant of the differences, advantages and disadvantages of each type of solution in relation to your existing or planned infrastructure. Many organisations are choosing thin-client solutions and paving the way toward a simplified infrastructure that delivers lower cost of ownership, better usability, and less complexity. Make sure the LIMS you select is the best fit for your organisation.

References

1. See "An Introduction to LIMS" by Helen Gillespie on www.LIMSource.com and "A Brief History of LIMS" by Dr. Gerst Gibbon, published in Laboratory Automation and Information Management Issue 32, 1996, pages 1-5.