LUCULLUS

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Installation Requirements

securecell

LUCULLUS

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1 INTRODUCTION

This document describes the components and the requirements for the installation of Lucullus®, regarding hardware, operating system, and database. It furthermore gives an overview of how the different components can be connected by presenting different exemplary network configurations.

2 INSTALLATION COMPONENTS

For medium- and large-scale installations, Lucullus® has a Distributed (Client/Server) architecture that is scalable. It consists of the following components that need to be installed and configured:

- **Database Server**, using an operating system supported by Oracle
- **Application Server**, Linux System or Windows System
- **Workstation (Online Client)** with or without replication, Linux System or Windows System

For small environments (up to 8 bioreactors) it is possible to install all components on a single machine (Standalone Workstation / Installation).

In addition to those essential components, a variable number of the following (non-essential) components can be set-up:

- **X-Client** computer (only applicable if Workstations are running on Linux): visualization, running on any operating system providing an X-Server, to access the application on Linux system, VDI and RDS
- **Lucullus® Office**: for office computers running on Windows to access data from the database server with the known standard Lucullus® interface.

Table of typical components and their functionalities:

Type	Base	Database	Replication	Web Server	User Interface	Tasks
Database Server		×				Central Storage for all data (configuration, history, ...)
Application Server	×			×		Web Server, Reporting, DB Interface, Enterprise Edition, Off-line Evaluation
Workstation (Online Client) with replication	×	×	×		×	Data Acquisition and Process Control, autonomous
Workstation (Online Client) without replication	×				×	Data Acquisition and Process Control, not autonomous
Standalone Workstation / Installation	×	×		×	×	Entire functionality
Application Server and Database Server combined with Online functionality	×	×		×	×	Central Storage for all data (configuration, history, ...), Web Server, Reporting,DB Interface, Enterprise Edition, Off-Line Evaluation, Data Acquisition and Process Control
Lucullus® Office	×				×	Office computer application accessing (historic data, approx. 15min delayed for real-time experiments) process data on the database. All functionality except data logging or process control.
X-Client					×	Visualization of Lucullus® application on Workstation (only available for Linux Workstations). Allows to view and control full capabilities that are executed on the Workstation.

Table 1: Typical components of Lucullus® and their functionalities

3 INSTALLATION REQUIREMENTS

This chapter summarizes the requirements to install Lucullus® on the respective computer that is destined to become a functional component in the Lucullus® architecture (components explained before).

3.1 Hardware

This section summarized the requirements regarding the hardware. Depending on the intensiveness of use and number of variables being logged, we estimate 100 - 200 MB of data per bioreactor and year, that need to be kept by the database. However, we recommend reserving some space for future extensions and some overhead for backup, etc.

Besides the requirements mentioned in the table below, special consideration should be taken on the application and environment in which hardware will be placed and used, as well as any internal standards and restrictions (continuous operations, laboratory environment, cleaning, etc.). Therefore we generally DO NOT recommend passive cooling systems (e.g. fanless hardware), stacking hardware in closed and uncooled locations, etc. We DO generally recommend having uninterruptible power supply (UPS) and surge protection in use for all hardware components, spill-resistant accessories (e.g. spill-resistant keyboards, cable protectors), etc.

Component		Database Server	Application Server	Workstation (Online Client) with replication	Standalone Work station / Installation
Case		Rack / Virtual	Rack / Virtual	Rack / Tower / Virtual	Rack / Tower
CPU		1 or 2 (Intel i7 or higher, or server-class Intel Xeon)	1 or 2 (Intel i7 or higher, or server-class Intel Xeon)	1 or 2 (Intel i7 or higher, or server-class Intel Xeon)	1 or 2 (Intel i7 or higher, or server-class Intel Xeon)
RAM [GB]	Minimum	16	8	8	16
	Recommended	32	16	16	32
Disk storage [GB]	Standard	2×250	2×150	2×250	2×250
	Minimum for large installations	2×150 GB (System) 4×300 GB (Data)	2×150	2×250	N/A
RAID*		1	1	1	1
Network		2×Gigabit	2×Gigabit	2×Gigabit	2×Gigabit

Table 2: Hardware requirements for Lucullus® installation

* If RAID requirement depends on customers system availability of the system

3.2 Operating System

Lucullus® can be installed on Linux as well as Microsoft Windows operating systems. It is furthermore possible to set up mixed environments that consist of hosts with different operating systems.

Operating System	Database Server	Application Server	Workstation (Online Client) with replication	Standalone Workstation / Installation
Oracle Linux 8	✕	✕	✕	✕
Microsoft Windows 10 Pro and Enterprise Editions	✕	✕	✕	✕
Microsoft Windows Server 2019, 2016, 2012 R2	✕	✕	✕	✕
Any operating system supported by Oracle (acc. to supported Oracle Database version)	✕			

Table 3: Operating systems supported for Lucullus® installation

3.3 Database

Lucullus® uses an Oracle database for data storage.

Database	Edition (minimum)	Version
Oracle	Standard Edition Two (SE2)*	19.3
Oracle	Express Edition (only Standalone Workstation / Installation and Workstation (Online Client) with replication)**	18.4 11.2

Table 4: Oracle database types used with Lucullus®

Oracle database (incl. license) can be (1) provided by Securecell as part of the Lucullus® installation package or (2) can be acquired by the customer separately. Oracle database (incl. license) can be installed by (1) Securecell as part of Lucullus® installation or (2) can be installed by the customer according to instructions provided by Securecell. The expected annual growth rate of the database is 200 MB per online license. Example: Installation with 8 online bioreactor units has an expected growth rate of 1.6 GB per year.

The following information is intended as guidance and is subject to change according to Oracle licensing and pricing conditions. Securecell does not accept any responsibility or liability for any changes made by Oracle.

* Oracle SE2 requires an Oracle license which is not included in the application license. Licenses can be acquired per user (NUP) or per CPU. Breakeven is approx. 50 users, i.e. if you have more than 50 users, it is cheaper to license per CPU.

Hardware restrictions: Oracle Database Standard Edition 2 may only be licensed on servers that have a maximum capacity of 2 sockets. When used with Oracle Real Application Clusters, Oracle Database Standard Edition 2 may only be licensed on a maximum of 2 one-socket servers. In addition, notwithstanding any provision in Your Oracle license agreement to the contrary, each Oracle Database Standard Edition 2 database may use a maximum of 16 CPU threads at any time. When used with Oracle Real Application Clusters, each Oracle Database Standard Edition 2 database may use a maximum of 8 CPU threads per instance at any time. The minimums when licensing by Named User Plus (NUP) metric are 10 NUP licenses per server.

Virtual Machines: Only hard partitioning of CPUs is allowed to restrict the number of CPUs applicable for licensing. In the case of soft partitioning, licenses have to be acquired for the entire physical hardware.

It is possible to use Oracle Enterprise Edition, however, this is not a requirement.

** The Oracle Database 18c XE offers a full 12GB for user data alone. Oracle Database 18c XE is available for Windows and Linux platforms and is free of charge.

4 NETWORK CONCEPTS

The network scenarios exemplarily demonstrate how the different installation components can be linked and integrated into typical company networks. The network architecture is generally provided by the customer. The required firewall configurations and possibly relevant network services complete this chapter.

4.1 Network Scenarios

The following scenarios show how Lucullus® can fit into the company's network architecture. The examples are non-exhaustive, and the different presented elements can be flexibly combined to fit specific requirements.

Scenario 1: Shows a standalone solution (up to 8 bioreactors). The standalone workstation can be part of different networks (for example having physically separated networks using two network cards). It accesses the equipment to control and to log the data via the automation network. Other useful networked resources (e.g. printer, label-printer, file server) can be integrated on any of the network levels.

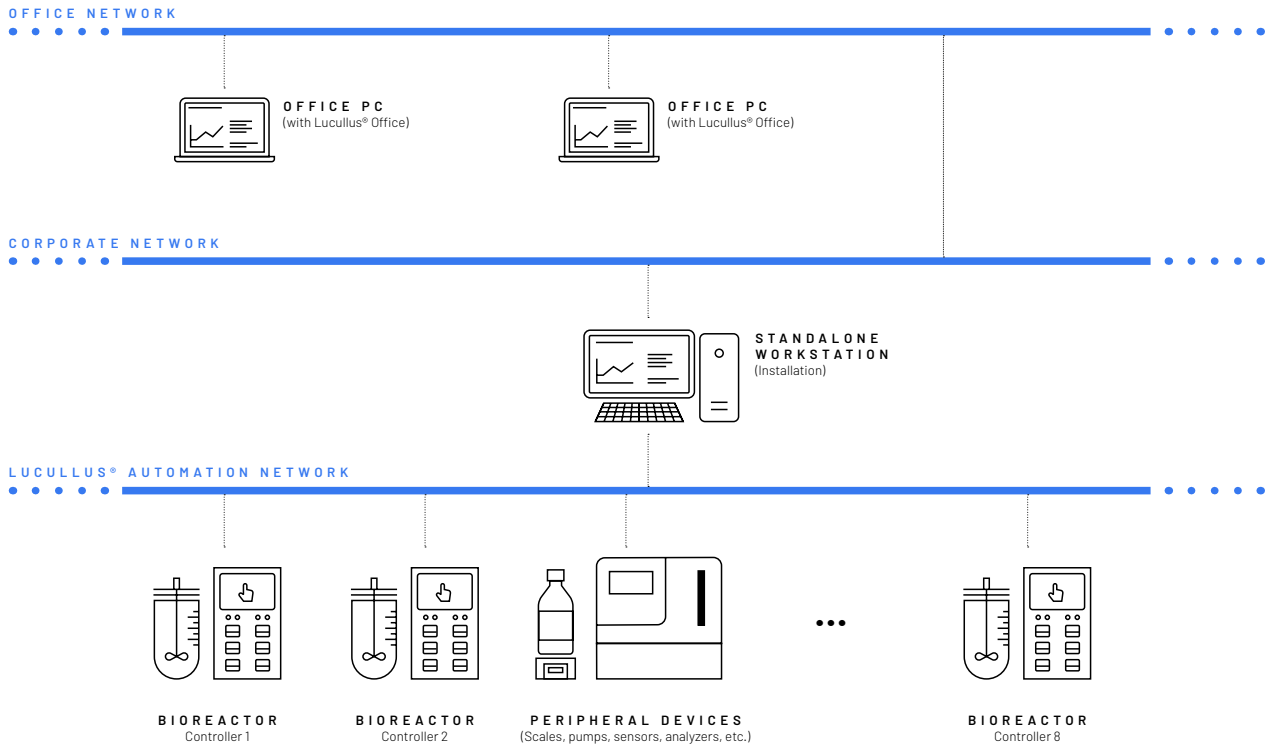

Figure 1: Presentation of network "Scenario 1" for Lucullus® installation

Scenario 2: This scenario shows a larger installation with Distributed (Client/Server) architecture. The Server (contains the Application Server and the Database Server) can be part solely of the corporate network whereas the Workstations (Online Clients) need access to the (Lucullus®) automation network(s) to communicate with the equipment. Workstations (Online Clients) can be restricted to their respective (Lucullus®) automation network (as shown here) or just share the workload resulting from a bigger shared (Lucullus®) automation network. Lucullus® Office on office computers accesses the data on the Database Server that is repeatedly synchronized with the Workstations (Online Client) data. A firewall exemplarily symbolizes the controlled traffic between the network layers. The firewall configurations are given at the end of this chapter.

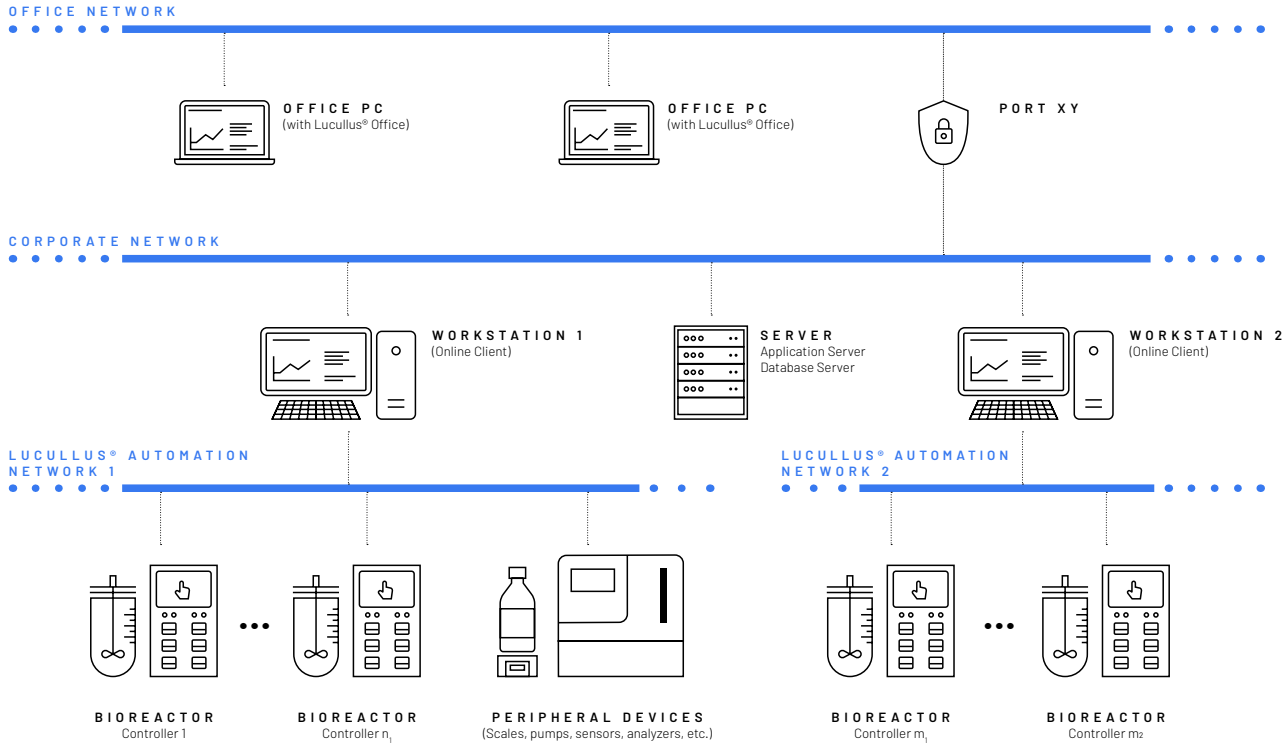

Figure 2: Presentation of network "Scenario 2" for Lucullus® installation

Scenario 3: In this scenario, Application Server, Database Server as well as one Workstation (Online Client) are virtualized. They can be located on some host in a data center. The virtualized Workstation (Online Client) still needs access to the automation network that can be controlled via the firewall. A stable network between the host that runs the virtualized Workstation (Online Client) and the equipment in the automation network is a prerequisite for this configuration.

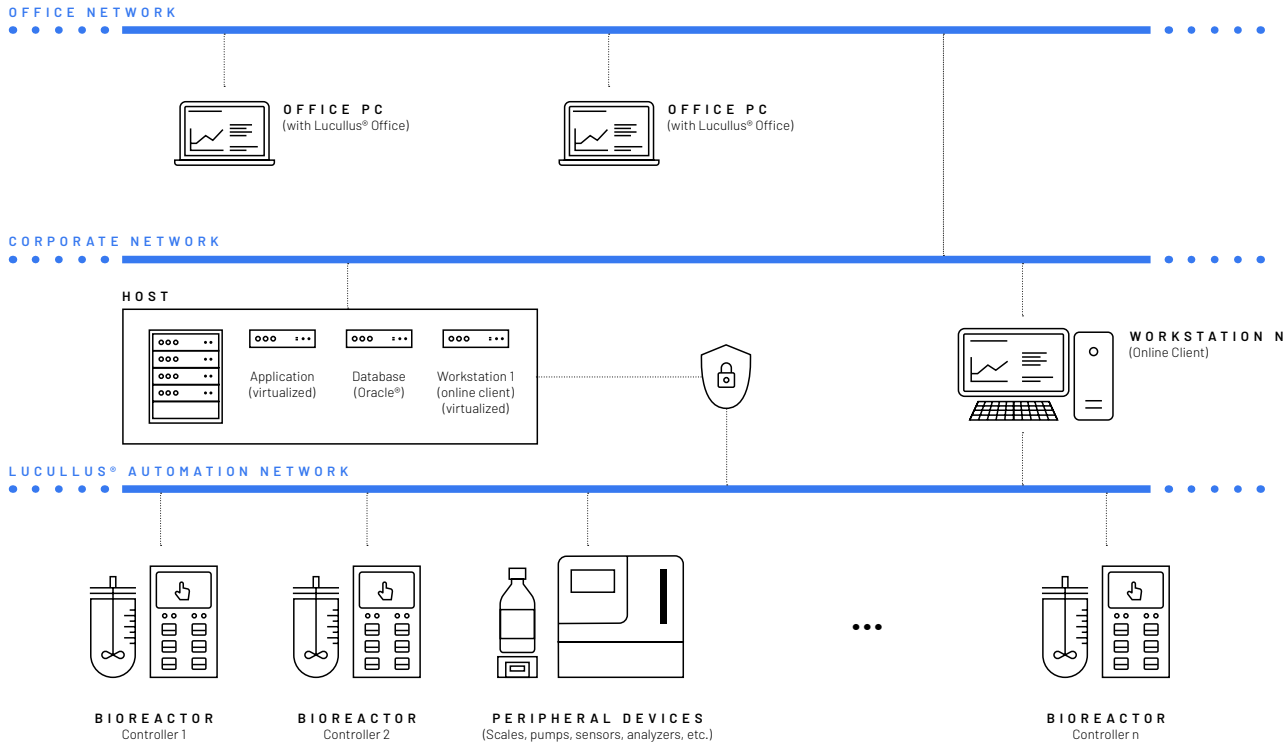

Figure 3: Presentation of network "Scenario 3" for Lucullus® installation

Scenario 4: For reasons of security and due to established company network layers, the network can be further split into sub-networks.

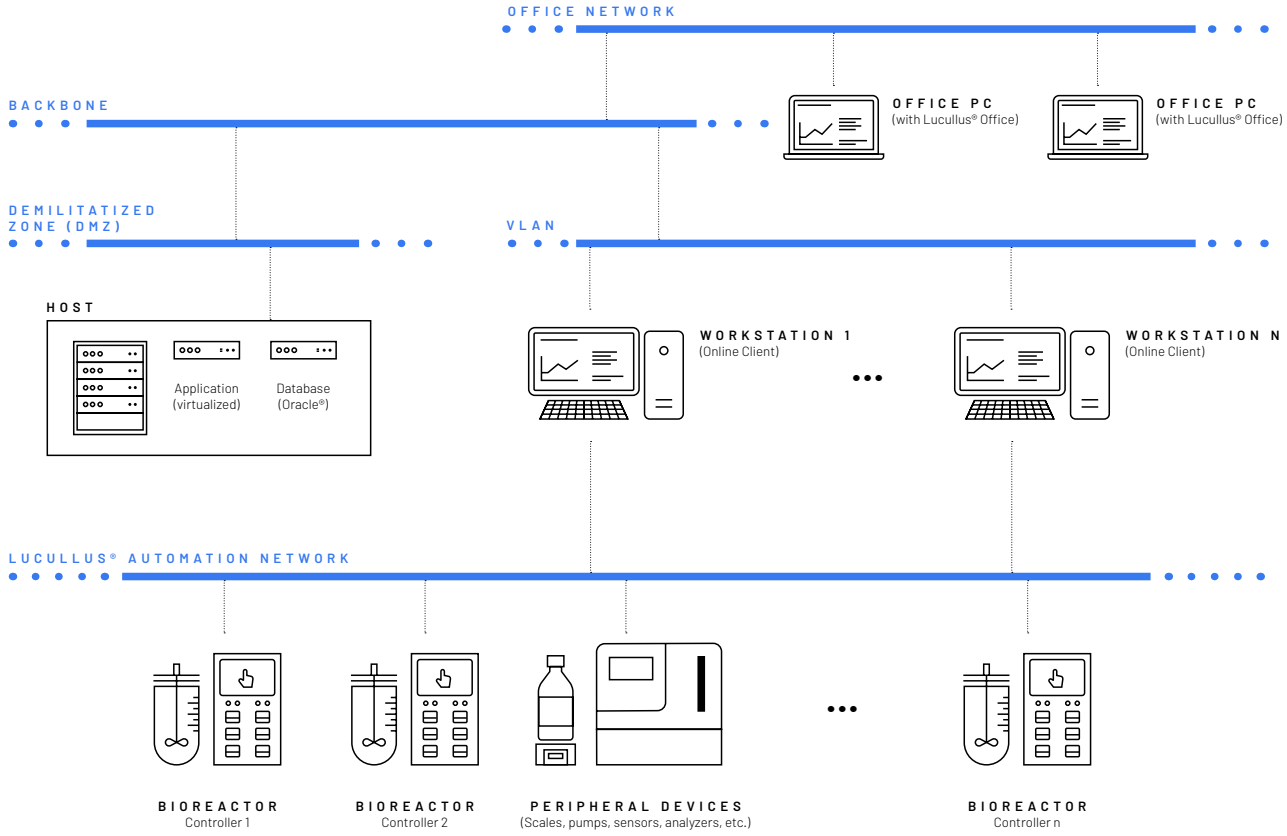

Figure 4: Presentation of network "Scenario 4" for Lucullus® installation

4.2 Firewall Configuration

In case you operate through a firewall, the following ports must be opened between the different components:

SRC \ DST	Database Server	Application Server	Workstation (Online Client)	Controller
Application Server	1521/tcp			
Workstation (Online Client)	1521/tcp	8080/tcp		*
Office PC (Offline Client)	1521/tcp	8080/tcp		*
X-Client		8080/tcp	22/tcp	

Table 5: Firewall config., Ports needed to be opened per components used

* In case your automation network is protected by a firewall, the ports that must be open for the Workstations (Online Clients) are device-dependent.

Examples:

SRC	DST	Port
Workstation (Online Client)	Applikon Controller	23 (telnet)
Workstation (Online Client)	Sartorius Biostat	21333
Workstation (Online Client)	OPC Server (via OPC Bridge)	3111 (default)

Table 6: Examples of SRC and DST ports
For Linux installations, port 22 (ssh) must be opened between all components for installation and maintenance.

4.3 Network Services

To be able to use the full functionality of the system, the components should have access to the following company network services:

Database Server	NTP (Time Server)	SMTP (Notifications)	File Sharing (Backup)	
Application Server	NTP (Time Server)	SMTP (Notifications)	File Sharing (Import/Export)	Printing
Workstations (Online Clients)	NTP (Time Server)	SMTP (Notifications)	File Sharing (Import/Export)	Printing

Table 7: Required access to company network services per component

5 AUTOMATED BACKUPS

Lucullus® stores all relevant configuration and process data inside the server database. To avoid data loss in case of hazards, this database needs to be backed up regularly. When the system is installed, a daily local backup will be configured, which results in a file or a couple of files. These files must be copied to a corporate backup server using file-sharing or ftp.

6 REMOTE ACCESS

Some steps of the system installation are possible and generally executed via remote access. This allows to spread out installation tasks, enables a smooth on-site installation and facilitates support afterwards. The customer is asked to a provide remote access on request for the installation and subsequent support (troubleshooting/service) activities via standard platforms (e.g. TeamViewer). Securecell can accommodate remote access restrictions and other requirements set by the customer (CDA/NDA, supervised remote access, etc.).

7 FREQUENTLY ASKED QUESTIONS (FAQS)

7.1 Server

1. Is it possible to virtualize the Database and Application server?
The Application server can be virtualized, the same requirements apply as for the physical server. Securecell does not recommend virtualization of the Database server. Virtualization of Database server should be taken with great care and it is a subject to Oracle license restrictions.

2. Is it possible to run the application and database on the same VM?
It is not recommended, Oracle on VM could lead to licensing problems.

7.2 Workstation (Online Client)

3. Additional special hardware interface for a workstation (online client)?
There are no additional special hardware interfaces required.

4. How is the workstation's (online client's) data secured?
Workstation's (online client's) data is automatically synchronized and backed up with the server.

5. Where is the system configuration saved?
The configuration is saved on the server.

6. What is backed up in event of loss of connection between workstation (online client) and server?
All the data is backed up on the workstation (online client) in the event of communication loss. The workstation (online client) has its own database which is autonomous from the server's database.

7.3 Communication

7. Is there any recommendation regarding security and architecture between integrated laboratory equipment (e.g. bioreactor control units, analytical devices), server, workstations (online clients) and office PCs?
It is recommended that integrated laboratory equipment (e.g. bioreactor control units, analytical devices) and workstations (online clients) are in network (i.e. "Automation network") separated from the company network. The server should be connected to both "Automation" and Company (Office)" network

8. How the office PC accesses data from Lucullus®? Which data are accessed and what can be controlled via office PC?
Office PC (with Lucullus® Office installed) accesses main (server) database with standard Lucullus® GUI or Lucullus® Web. Planning (Planning & Operations tool; preparation of processes (Process control step chains, Process scheduling, etc.), evaluation of processes (Graphic tool; view and evaluate current and historical processes), design and preparation of media and system configuration can be done via office client. Execution of processes (Online - Execution monitor tool; changes of setpoints and other real-time control functionality) will require a remote desktop session to the workstation (online client).

9. Is there any recommendation on minimal network speed?
100 Mbit connection should suffice for any standard system configuration

10. Are there any restrictions on the choice of IP network?
No special restrictions, apart from IPv4

11. What method of communication between server and workstations (online clients)?
Broadcast with fix IP addresses

11. How is the user authentication to the or software executed?
Lucullus® has its own user management system. Additionally, user's digital identities can be imported from external databases (LDAP directory)

12. Is secure connection to LDAP directory (LDAPS) supported?
Secure connection to LDAP directory (LDAPS) is supported

7.4 Database

14. Is Oracle XE database enough for server-client architecture and if not, why?
Due to licensing requirements and limited storage capacity Oracle XE version of the database is not sufficient for Distributed (Client/Server) architecture.

15. Is any other database type supported?
Currently, only Oracle database is supported

16. Can Oracle database be installed on other operating systems?
Database server hosting Oracle database can have any operating system supported by Oracle (acc. to supported Oracle Database version) and is not limited to Lucullus® supported operating systems (Windows, CentOS).