

PrepMaster Software Suite

HERZOG

Your partner for automatic sample preparation

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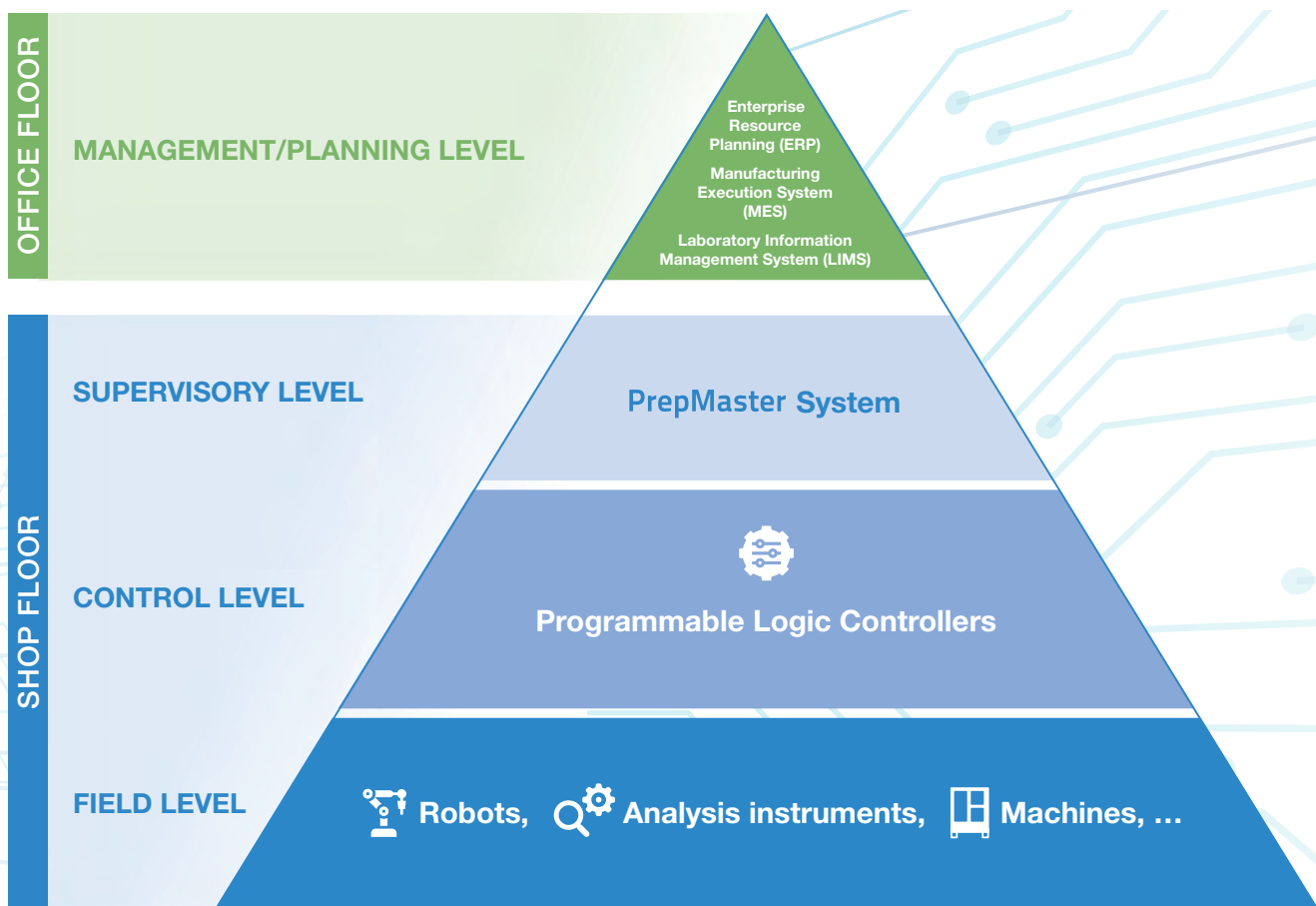
Introduction

The HERZOG software solutions are perfectly tailored to the monitoring and control of automated systems in laboratory and plant environments.

HERZOG looks back on decades of experience in process control and optimisation, and is constantly working on the development of new innovative software concepts. For this reason, our systems achieve optimum process reliability and simultaneously incorporate modern Industry 4.0 applications for intelligent data analysis and networking of processes.

The PrepMaster Suite from HERZOG is a complete package of high-quality software and hardware that seamlessly integrates all levels of automation. The Shop Floor network exhibits real-time performance so that all components at the field level, such as analysis instruments, machines and sensors communicate without delay and at reproducible transmission rates. Automation control is realised both by sophisticated PLC programs and – at the supervisory level – the PrepMaster software modules. Moreover, the universality and openness of the HERZOG solutions makes it very easy to establish communication with all the customer's Office Floor applications at the management and planning level. Typical Office Floor IT systems are ERP, MES or LIMS applications.

PREPMASTER STRUCTURE



HERZOG's software solutions ensure the optimal integration of all levels of the Shop Floor and build flexible and robust connections to the customer's Office Floor applications.

The PrepMaster Suite from HERZOG contains all the relevant application features and information necessary for uncomplicated, trouble-free and efficient automation control operations. This minimises unforeseen shutdowns, long downtimes and extensive maintenance tasks on the system. Thus, HERZOG's software solutions make an essential contribution to the long-term investment security of industrial plants.

The following three main functions are performed by PrepMaster Suite:

Control and visualisation of the system



HERZOG software systems reduce complexity for users and enable informed decisions. They visualise all relevant processes in real time and give the user full control over the individual components and the entire system.

Data analysis and reporting



The PrepMaster software systematically collects all laboratory and plant data, displays it and forwards it to other systems as required. Thanks to a wide range of drivers and open interfaces, third-party components can be easily integrated. The **PrepMaster Analytics** software evaluates the data in real time, summarises them into key performance indicators and uses them for functions such as Tool Condition Monitoring (TCM) and Preventive Maintenance (PM).

Engineering and maintenance



The parameterisation and programming of HERZOG software projects is done with engineering modules such as **PrepMaster IDE**. This ensures that the latest configuration files, drivers and routing routines are used. In addition, the implemented automatic error detection, among other things, significantly reduces the time required for installation and commissioning. With the help of service routers, HERZOG technicians can connect to the system after consultation with the laboratory and carry out any necessary service and maintenance work. As with the installation of the automation system, attention is paid to the highest safety and security standards.

This brochure provides an overview of the structure, technical details and functionality of HERZOG software solutions. It is intended to give users and specialists an initial insight into the scope and requirements for integrating our systems into their IT infrastructure.



PrepMaster Core

PrepMaster IDE

PrepMaster Remote

PrepMaster Analytics

PrepMaster Entry

Overview – Functions of PrepMaster modules

HERZOG PrepMaster is a fully integrated SCADA (Supervisory Control and Data Acquisition) system used for the automation, control, monitoring and evaluation of all processes in the laboratory and plant.

The PrepMaster software is fully scalable, modular, and easily expandable. It is designed to integrate a wide range of application-specific machines and instruments from a variety of original equipment manufacturers. The PrepMaster Suite can be easily integrated into the customer's IT infrastructure, and offers powerful interfaces for inter-process communication. As a result, PrepMaster can easily connect to other instances on the Shop Floor and Office Floor, such as manufacturing execution systems (MES), enterprise resource planning (ERP) systems or laboratory information management systems (LIMS) applications.

PrepMaster Suite modules include:

PrepMaster Core

PrepMaster Entry

PrepMaster Remote

PrepMaster IDE

PrepMaster Analytics

Each of these modules is specifically designed to meet the rigorous needs of quality control laboratories, and can be precisely customised to meet the requirements of each individual customer.

OVERVIEW – FUNCTIONS OF PREPMASTER MODULES

PrepMaster Core	PrepMaster Entry	PrepMaster Remote	PrepMaster IDE	PrepMaster Analytics
Automation monitoring and control (SCADA System)	Automation monitoring and control (SCADA System)	Web-based operator terminal for multi-user capability of PrepMaster Core and Entry	Integrated developer environment for configuring and programming PrepMaster Core and Entry	Recording, documentation and monitoring of all relevant laboratory data
Appropriate for any automation system	For automation systems with up to two analysers and one functional sample preparation unit	Appropriate for any automation system	Appropriate for any automation system	Appropriate for any automation system with PrepMaster Core and Entry
<ul style="list-style-type: none"> ▶ Sample registration ▶ Sample routing ▶ Management of worksheets ▶ Overview of sample status ▶ Overview of the functional status of the system ▶ Establishment of interfaces to all system components and Office floor systems ▶ Management of reference samples 	<ul style="list-style-type: none"> ▶ Sample registration ▶ Sample routing ▶ Management of worksheets ▶ Overview of sample status ▶ Overview of the functional status of the system ▶ Establishment of interfaces to all system components and Office floor systems ▶ Management of reference samples 	<ul style="list-style-type: none"> ▶ Overview of the functional status of the system ▶ Sample registration ▶ Control of the unit status ▶ Amendment of the sample status 	<ul style="list-style-type: none"> ▶ Configuration of projects ▶ Configuration of individual units, programs and parameters ▶ Programming of sample routing ▶ Configuration of handling systems ▶ Automatic error detection 	<ul style="list-style-type: none"> ▶ Processing of analysis data ▶ Monitoring of calibration status ▶ Validation of analysis data ▶ Determination of measurement uncertainty ▶ Monitoring of system performance ▶ Summary of all sample data (Sample Vita) ▶ Planning of service activities ▶ Tool condition monitoring ▶ Predictive maintenance ▶ Rawmix and Blending module for cement production



PrepMaster Core

PrepMaster Core – the key application of the PrepMaster Suite – is used to monitor and control HERZOG automatic systems. The entire software architecture is based on a machine-oriented code and geared towards high reliability to guarantee 100% automation availability. In addition, great importance was given to the usability of the software, which allows the user to operate the system as simply and effectively as possible.

The main functions of PrepMaster Core:

- Automatic and manual registration of samples
- Routing of the samples through the system according to sample priority
- Management of sample worksheets
- Overview of the processing status of all samples in the system
- Overview of the functional status of all system components
- Setup of interfaces to all integrated system components and Office Floor systems

PrepMaster Entry

PrepMaster Entry is based on the same software architecture as **PrepMaster Core** and offers the **same high performance**.

PrepMaster Entry is designed **for smaller automation systems** and is therefore limited to the integration of one functional sample preparation unit and two analysers. In addition, customers must ensure that the interfaces to their own applications and the drivers to other OEM devices comply with the PrepMaster standard and do not need to be adapted.





PrepMaster Remote

PrepMaster Remote extends **PrepMaster Core** to a **multi-user system**. **PrepMaster Remote** provides web-based access to all key operational and monitoring functions.

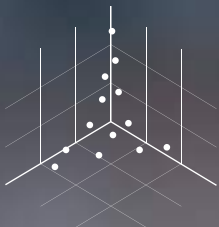
PrepMaster IDE

PrepMaster IDE is an integrated developer environment for **configuring and programming PrepMaster automation projects**.

PrepMaster IDE includes, among other things, access to comprehensive libraries with current drivers and configuration files, the use of effective standard routines and automatic error detection. The intuitive graphical user interface makes project creation and editing very easy, leading to a significant reduction in commissioning time and costs.



CAPTURE DATA



ANALYSE DATA



PRESENT DATA

PrepMaster Analytics


PrepMaster Analytics is a **modern, Industry 4.0 application for recording, logging and monitoring** all relevant data and processes of the automated system. **PrepMaster Analytics** provides a holistic overview of all important key performance indicators and improves process efficiency as well as the reproducibility of sample preparation and analysis.

PrepMaster Analytics features include:

- Recording, display and processing of analysis results
- Monitoring of the calibration status of analytical instruments by means of statistical process control (SPC)
- Automatic validation of analysis results
- Automatic determination and evaluation of measurement uncertainty
- Monitoring of system performance
- Overview and summary of all important sample data
- Planning, documentation and monitoring of service and maintenance activities
- Tool condition monitoring and predictive maintenance of sample preparation machines
- Rawmix and Blending module for cement production



Design of the PrepMaster Software Suite



PrepMaster Core and PrepMaster Analytics are autonomous modules that can be used independently of each other. However, the full PrepMaster functionality is only available when both modules are installed and can communicate with each other. PrepMaster Remote is a supplement to PrepMaster Core, which allows the extension of PrepMaster to a multi-user system.

PrepMaster Core establishes communication in the backend communication to all components in the automation layer of the plant.

Any component of a network that is ready to communicate with others and exchange data can be used as a communication partner. **PrepMaster Core** has integrated communication channels for programmable logic controllers (PLCs) from Siemens, Allen Bradley and other suppliers. Connections to further components are usually established using TCP/IP-based techniques. These include standard communication interfaces such as XML, JSON and OPC. In addition, proprietary interfaces based on peer-to-peer socket applications are typically set up for analysis and handling instruments. **PrepMaster Core** comes standard with a comprehensive interface library for all leading instrument manufacturers. In addition to TCP/IP networks, **PrepMaster Core** can also be used to implement serial connections in the form of point-to-point connections and fieldbus systems.

PrepMaster Analytics usually receives data from analysis instruments via TCP/IP connections such as JSON. File-based solutions are also used to transfer data between different platforms, executing the jobs automatically as defined in the workflow.

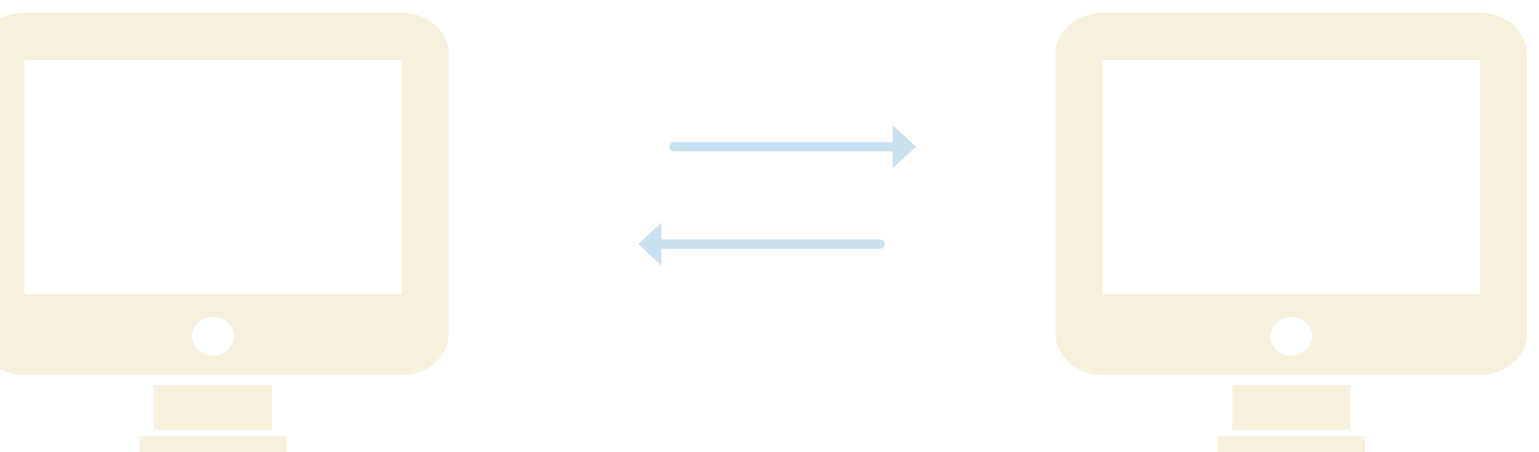
Generally, information that forms the basis for tool condition monitoring (TCM) is read directly from the PLC or from sensors within the machine. Information about the functional status of the system is transmitted from **PrepMaster Core** to **PrepMaster Analytics** via a TCP/IP interface. This information is used to evaluate aspects such as cycle times, throughput and workload.

PrepMaster Remote is based on a Scala application that accepts requests from a website, processes them or passes them on to PrepMaster Core, and sends the answers back to the website.

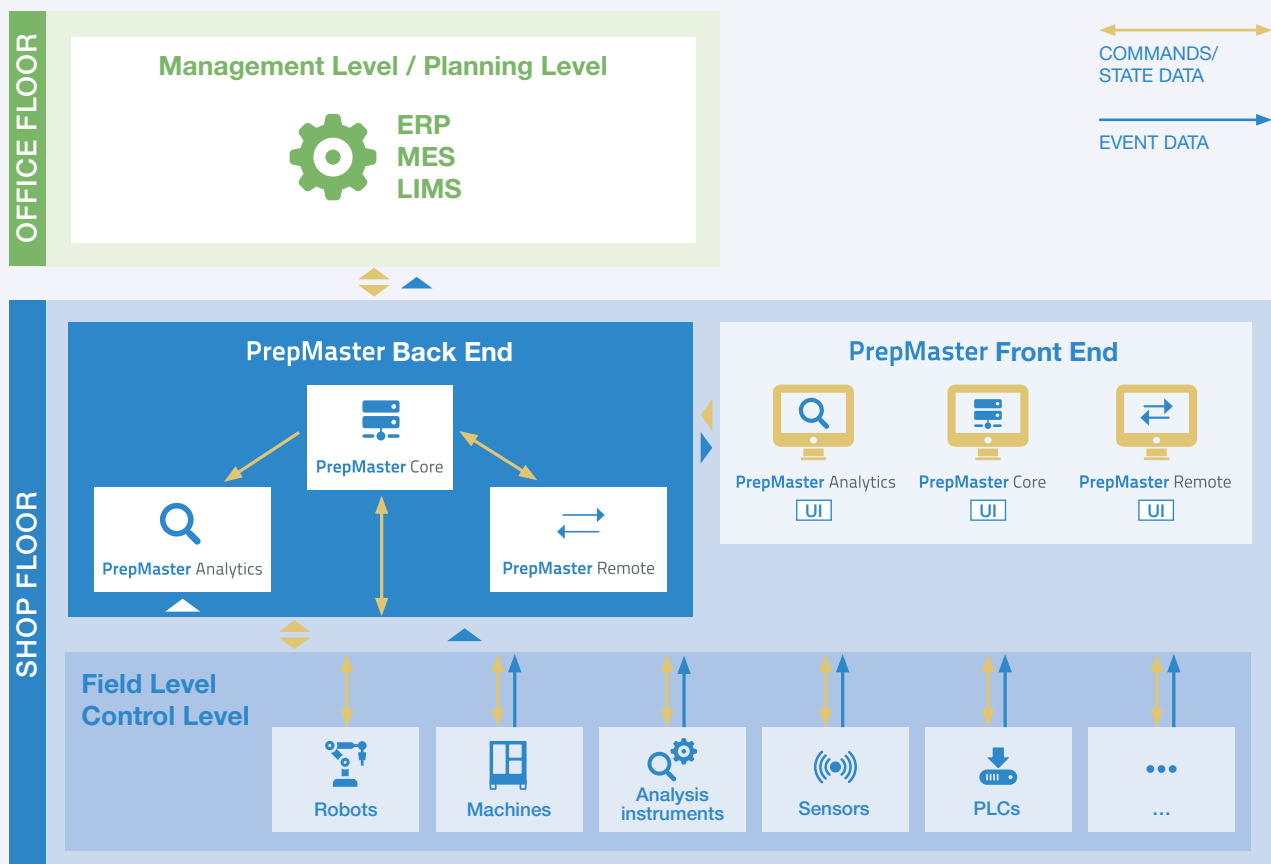
For this communication route, **PrepMaster Remote** is permanently connected to **PrepMaster Core** via TCP/IP and to the web clients via web sockets.

In the front end, the data and processes are processed in such a way that the functional status of the system is displayed as clearly as possible, allowing easy operation. The graphical user interface is specially adapted to the tasks and requirements of the respective PrepMaster module.

In addition, **PrepMaster Core** and **PrepMaster Analytics** can establish connections to Office Floor systems at the management and operations level. These can include process control computers for production control (MES), ERP and LIMS applications. The interface is usually TCP/IP-based, but file transfer protocols are also possible.



PREPMASTER STRUCTURE



Basic schematic of the structure of PrepMaster systems. The components of the field and control level are connected to the back ends of the respective PrepMaster modules at the supervisory level. Each PrepMaster module has a specific user interface (UI) at the front end, that can be optimised for the specific tasks of the automated system. The back end of the PrepMaster modules establishes the connection to the Office Floor applications at the management and planning level.



Network – Basic Structure

The network structures used for HERZOG automations are designed to allow smooth communication both for Shop Floor processes in the laboratory and plant and for the exchange of analysis and operating data with higher-level control systems on the Office Floor.

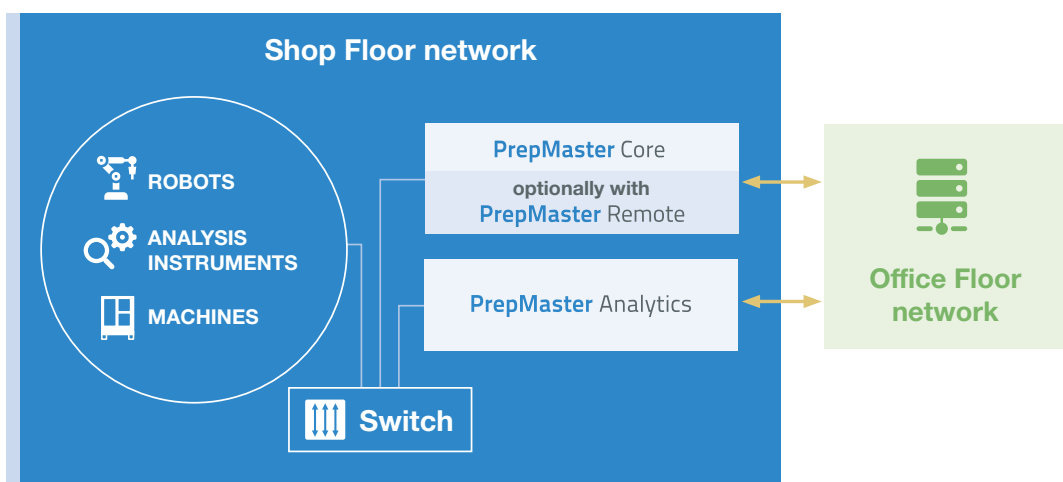
The Shop Floor network is generally based on an industrial TCP/IP standard, which enables connection via cable, fibre optics or wireless.

The network is designed for complete interoperability, meaning that not only HERZOG machines, but also all other components can be incorporated without problems, regardless of the manufacturer. Deterministic networking and hard real-time communication ensure that all time-critical and process-relevant applications can run with high reliability. The topology of the Shop Floor network can be individually adapted to the requirements of each customer. If necessary for the customer's processes, a redundant ring structure can be provided to enable bumpless switchover.

The integration of the Shop Floor network into the analysis and enterprise communication of the Office Floor can be done in different ways. The optimal solution (**Configuration 1**) is that **PrepMaster Core** and **PrepMaster Analytics** computers or servers are integrated into both the Shop Floor and

Office Floor networks. In this case, **PrepMaster Analytics** receives the data from the analysis instruments that are integrated into the Shop Floor network. Subsequently, PrepMaster Analytics forwards the data to the corresponding instances on the Office Floor. This configuration offers a high level of

cybersecurity, as both the PrepMaster hardware and all Shop Floor components are completely separated from Internet access. In addition, the interfaces between PrepMaster and the Office Floor network are configured in such a way that a hacker attack is virtually impossible.



CONFIGURATION 1

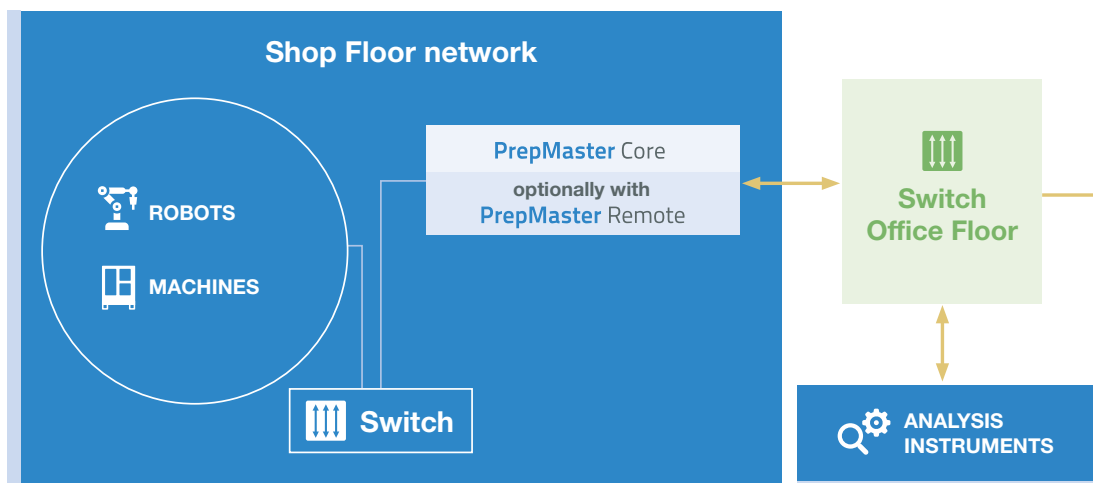
PrepMaster Core and **PrepMaster Analytics** are integrated into both the Shop Floor network and the Office Floor network. **PrepMaster Analytics** receives the analytics data, which it forwards to the appropriate instances on the Office Floor.

This is the preferred solution.

If **PrepMaster Analytics** is not part of the software system (**Configuration 2**), the analysis

data are usually forwarded directly from the analysis instruments to the Office Floor network. For this

purpose, the analysers are usually connected directly to a switch within the Office Floor network.



CONFIGURATION 2

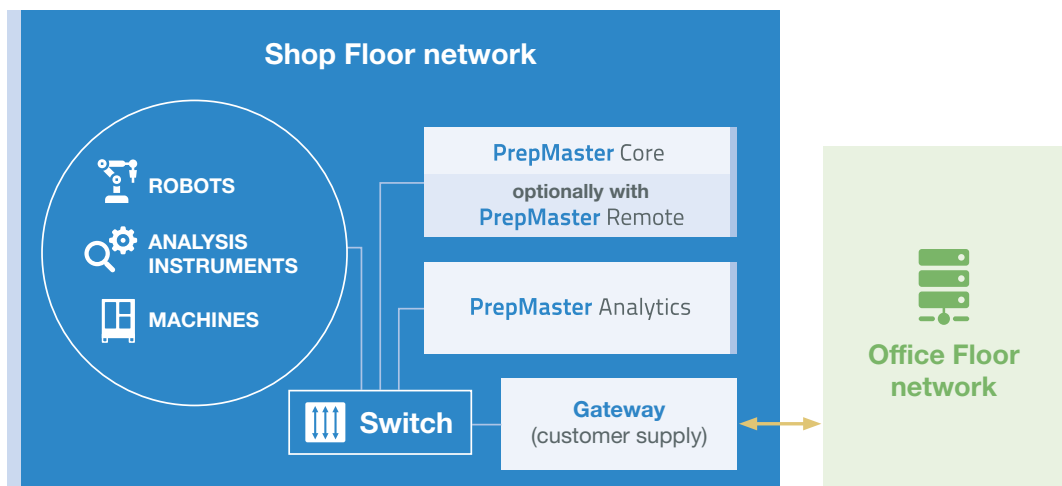
If **PrepMaster Analytics** is not part of the PrepMaster Suite, the analysers are connected directly to a switch within the Office Floor network.

The analysis data are then forwarded directly to the Office Floor network.

If heterogeneous networks are to be interlinked, it is possible to connect Shop Floor and Office Floor networks via a gateway (**Configuration 3**). The gateway

allows targeted data exchange between the two networks. However, especially in the case of non-conforming networks, it is often necessary to adapt the gateway

protocols due to the different flow control requirements. This may lead to more intensive programming requirements in some cases.



CONFIGURATION 3

Shop Floor and Office Floor networks can be interlinked by a gateway.

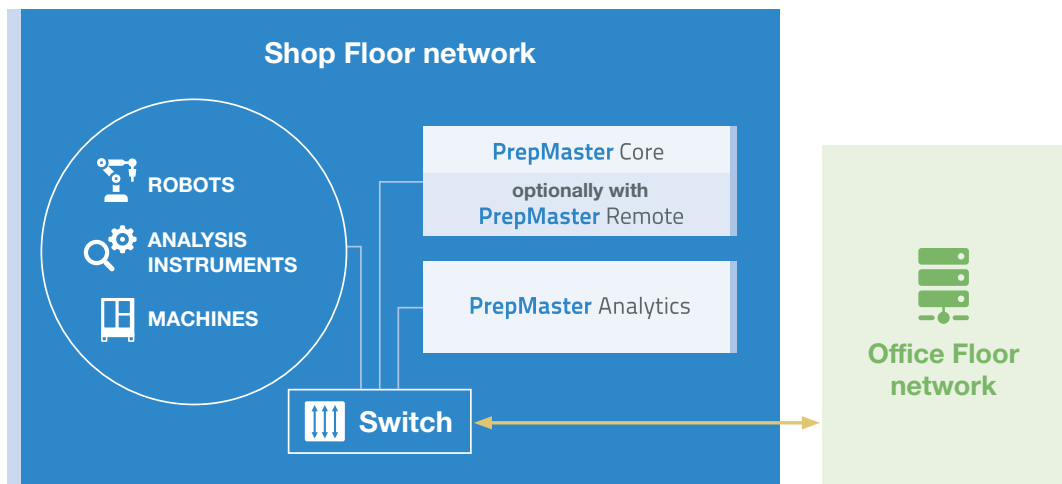
This often requires an adaptation of the gateway protocols and is associated with more intensive programming requirements.



Finally, the Office Floor network can be connected directly to the Shop Floor network (**Configuration 4**). However, this “shirt-sleeve” approach is generally not advisable,

as it could have a negative impact on the performance of the Shop Floor network. The additional data fed into the network can have an unfavourable influence on the dy-

namics of the real-time behaviour, possibly leading to a deterioration in response times or even to process interruption.



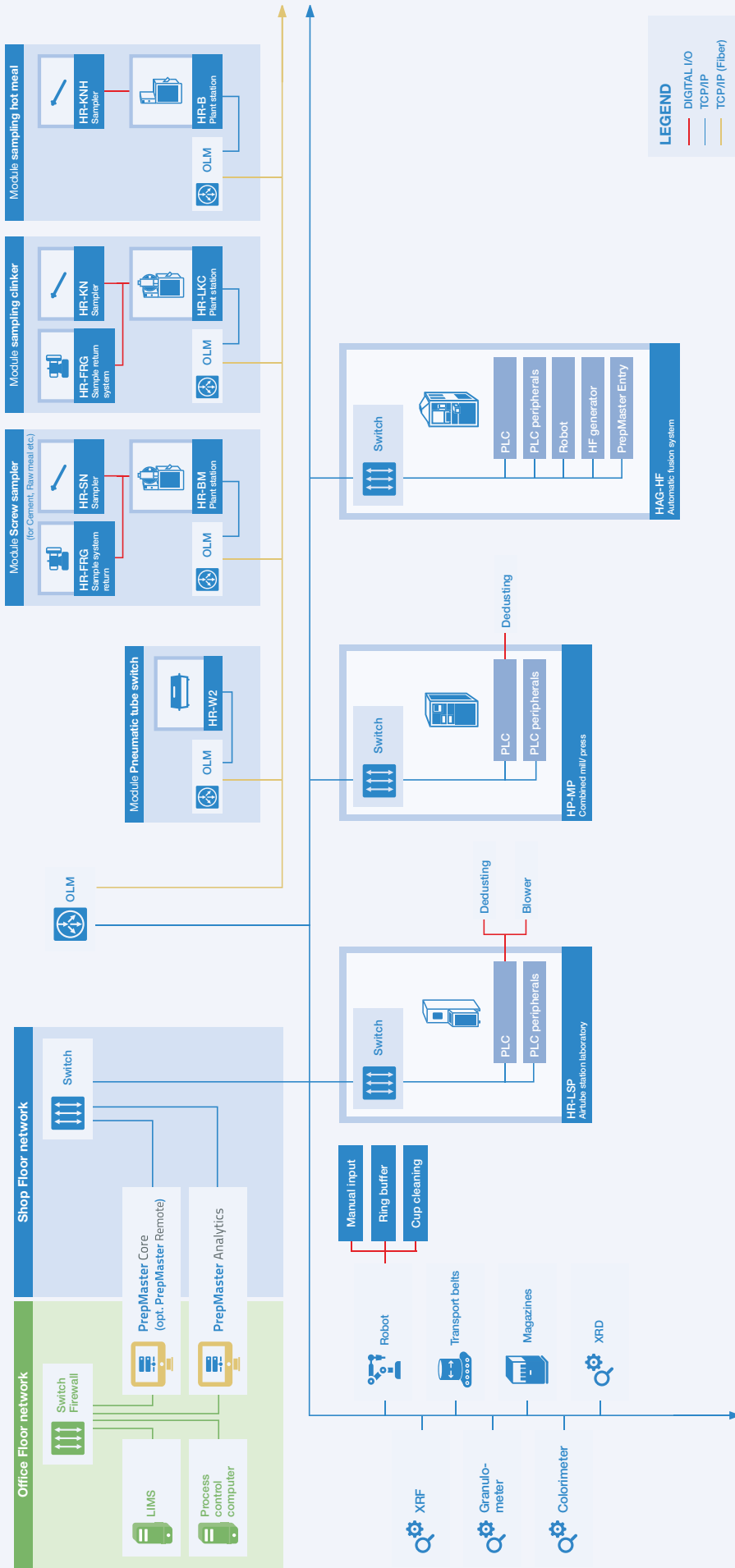
CONFIGURATION 4

The Office Floor network can be connected directly to the Shop Floor network via a switch.

Not recommended, as response times may deteriorate due to excessive data traffic.

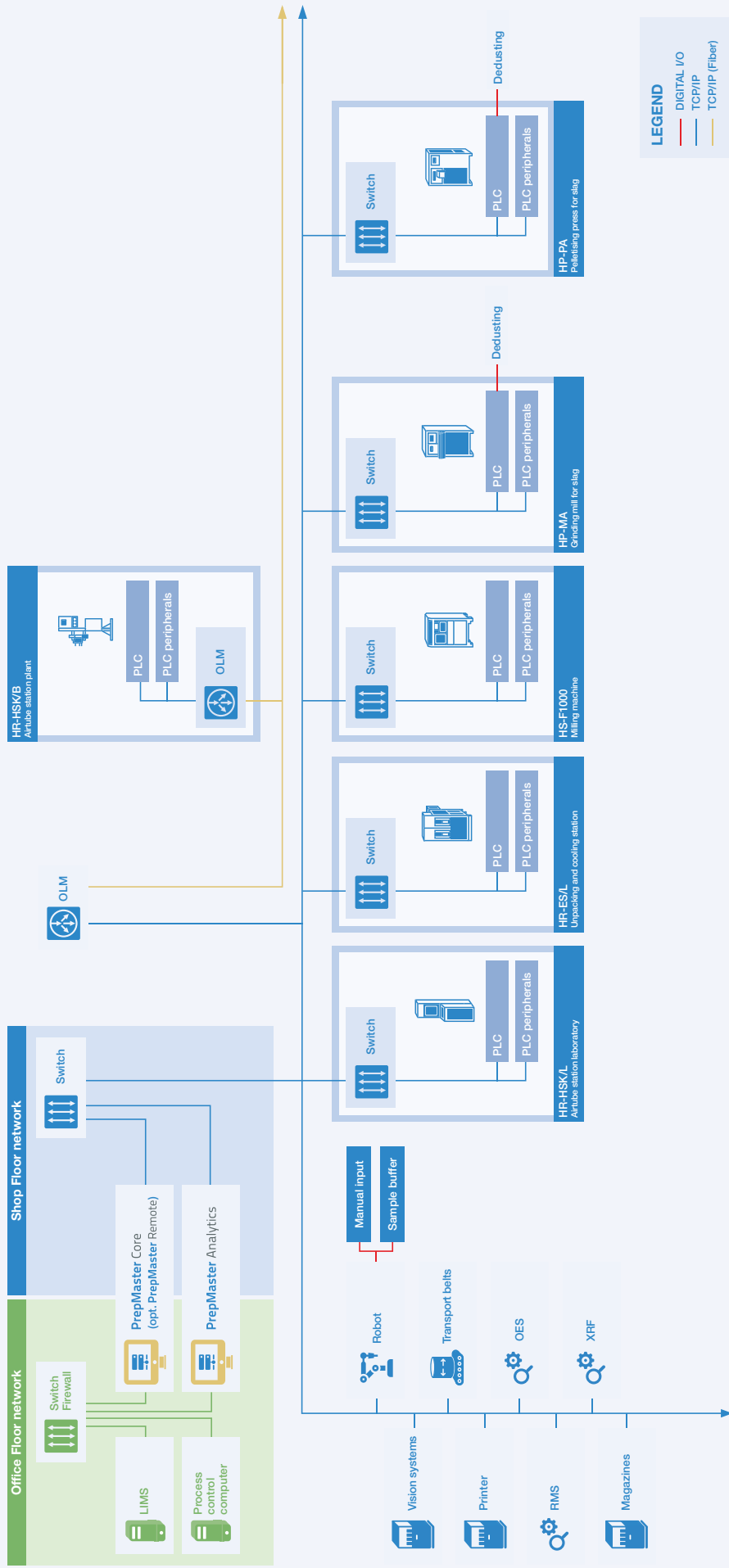


NETWORK PLAN: BASIC STRUCTURE – CEMENT AUTOMATION



This network example corresponds to Configuration 1. The samplers in the production line are linked to the pneumatic airtube plant stations via digital inputs and outputs. These, in turn, are connected via optical fibre converters (OLM) to the plant's optical fibre network, which is coupled to the laboratory network. The laboratory's sample preparation machines, such as the HR-LSP pneumatic airtube receiving station or the HP-MP combined mill and press, are connected to the Shop Floor network switch. Handling devices, such as robots or conveyor belts as well as analysis instruments such as XRF, XRD, granulometers, and colorimeters, are also plugged into this switch. PrepMaster Core and PrepMaster Analytics are integrated into the Shop Floor and Office Floor networks, and forward the data to higher level systems such as LIMS or MES.

NETWORK PLAN: BASIC STRUCTURE – STEEL AUTOMATION



This network example is based on standard Configuration 1. HR-HSK/B pneumatic airtube plant stations are connected via fibre optic converters (OLM) to the plant's fibre optic network which is connected to the laboratory network. In turn, the laboratory's pneumatic tube stations HR-HSK/L, the unpacking and cooling station (HR-ES-/L) and the sample preparation machines (such as the HS-F 1000 milling machine, the HP-MA grinding mill and the HP-PA pelletising press) are integrated into the laboratory network. In addition, robots, conveyors, vision systems and analysis instruments such as RMS, OES and XRF are connected to the Shop Floor network switch. PrepMaster Core and PrepMaster Analytics are integrated into both the Shop Floor and Office Floor networks, and forward the data to higher-level systems such as LIMS or MES.

CYBERSECURITY

Hacker attacks and manipulation attempts against industrial plants are becoming more and more frequent. To prevent such attacks, the applications of the PrepMaster Software Suite are designed for maximum cybersecurity: HERZOG always uses the latest versions of operating systems, as well as the most recent versions of libraries.

HERZOG's developers support the customer's IT department in insulating the PrepMaster applications to minimise target points for virtual attacks. Services that are not needed are switched off, firewall rules are set as restrictively as possible, and network segments are confined up to completely isolated solutions. PrepMaster's operating systems support a wide range of antivirus and monitoring programs, as well as external data backups such as Veeam.

PrepMaster Core and PrepMaster Analytics provide advanced user management that protects systems against manipulation attempts within a plant; users' access rights can be perfectly tailored to their activity.

Login information, consisting of the username and IP of the computer, is saved in **PrepMaster Analytics** for tracking whenever data is manipulated.





PrepMaster Core and PrepMaster Entry

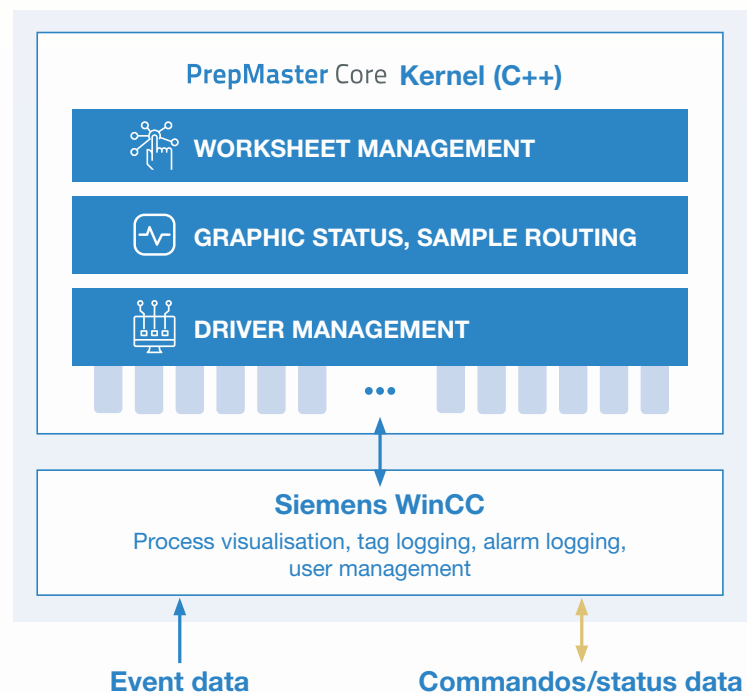


STRUCTURE

PrepMaster Core and PrepMaster Entry (for the rest of the text, referred to only as PrepMaster Core) essentially consist of two different function blocks: the PrepMaster Core Kernel and Siemens WinCC.

The central features of **PrepMaster Core** are implemented in the kernel. These include worksheet management, routing of samples through the plant, and driver management. **The PrepMaster Core** Kernel is written in the C++ programming language and thus enables memory access via addresses as well as the manipulation of individual bits. The machine-oriented programming of the kernel produces a highly efficient, fast and compact creation of routines. Another crucial advantage is that the program structure of the C++ kernel is highly stable and thus offers maximum process reliability. Finally, the requirements of the small runtime system of the **PrepMaster Core** Kernel on the runtime environment are very low.

For the visualisation of processes in automation, HERZOG uses the world's leading process visualisation system: SIMATIC WinCC from Siemens. The engineering tools available in the software enable the easy and efficient generation and dynamisation of process images. In addition, **PrepMaster Core** utilises Siemens' tag logging, alarm logging and user management concepts.







HARDWARE CONFIGURATION AND FAIL-SAFE MECHANISMS

Customers can choose between various hardware configurations, depending on their failover requirements. With Single PrepMaster Core, the software is installed only on one PC, so that no backup system is available in the event of a hardware failure.

With Double **PrepMaster Core**, automation control takes place with the help of the primary active PC. A passive secondary PC is also given access to the **PrepMaster Core** data resources, and logs all relevant data. In the event of a system failure of the primary PC, an up-to-date image with all relevant sample and process information is available on the secondary PC. Thus, automatic operation of the system can be continued within a few minutes after switching over to the secondary PC.

PrepMaster Core AND PrepMaster Entry HARDWARE CONFIGURATION

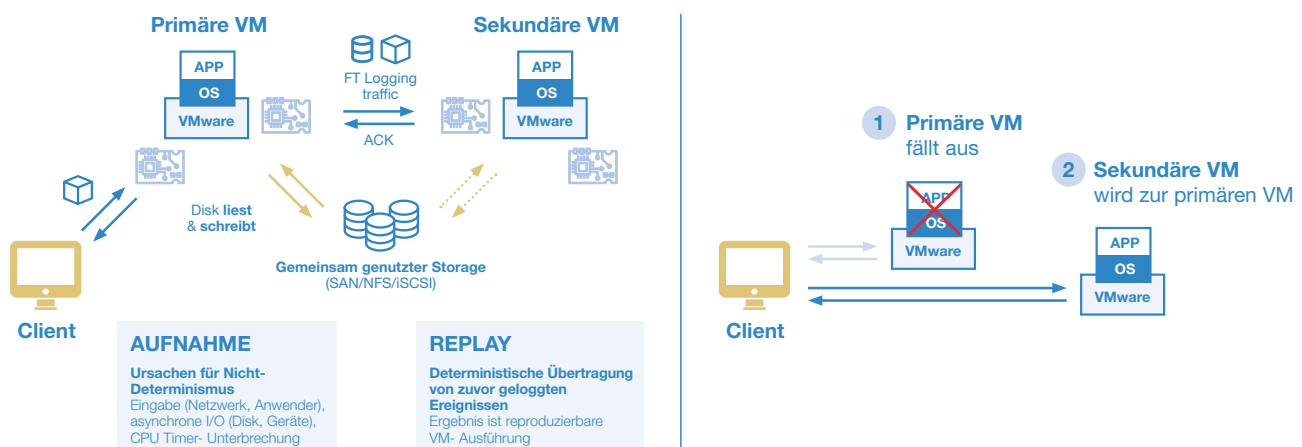
HARDWARE – FAIL-SAFE PERFORMANCE 			
	Single PrepMaster Core	Double PrepMaster Core	PrepMaster Core in FT mode
			
Description	<ul style="list-style-type: none"> ▶ One PC ▶ No backup 	<ul style="list-style-type: none"> ▶ Active primary PC ▶ Passive secondary PC ▶ No hot standby 	<ul style="list-style-type: none"> ▶ Solution for servers with multiple blades or server cluster ▶ Hot standby (fault tolerance)
Hardware configuration	Multicore-CPU with 3.5 GHz 8 GB working memory Monitor resolution: 1920 * 1080 (Full HD) ¹	Multicore-CPU with 3.5 GHz 8 GB working memory Monitor resolution: 1920 * 1080 (Full HD) ¹	DELL VRTX or customer-specific solution
IT prerequisite of the customer for virtualisation	Computing power equivalent to above-mentioned hardware	Computing power equivalent to above hardware on independent servers	Computing power equivalent to hardware mentioned on the left, required licences for FT, additional display clients
Operating system	Windows 10 ²	Windows 10 ²	Windows Server 2016 / Server 2019 ²
Execution	Physical (virtual possible, incl. HA)	Physical (virtual possible, HA not useful)	Virtual

¹ The level of detail of the process image can only be displayed in Full HD or higher resolution

² The latest operating system released for WinCC is used

Finally, **PrepMaster Core** can also be run in Fault Tolerance (FT) mode on servers with multiple blades or server clusters. In this case, a secondary virtual machine (VM) is created and maintained on another host, which is identical to the first VM and is constantly available. The primary VM is constantly replicated to the secondary VM so that it can step in at any time. Transparent failover occurs when the primary VM's host fails. In this case, the secondary VM is immediately activated to replace the primary VM. A new secondary VM is also started to restore FT redundancy. The user usually notices no or only a minor interruption of the running operation.

PrepMaster Core FAIL-SAFE MECHANISMS IN VIRTUAL ENVIRONMENTS – FAULT TOLERANCE (FT)



Graphical representation of the basic structure of the **PrepMaster Core** fault tolerance system. The system is able to compensate for the failure of one or more components and ensure uninterrupted service.

All the configurations listed can also be virtualised on the customer's server infrastructure.

FUNCTIONALITY

PrepMaster Core is a SCADA system for the operation of automatic installations and laboratory systems. **PrepMaster Core** has been tried and tested for decades, and is constantly undergoing further development. Due to its sophisticated control concept, **PrepMaster Core** enables clear and simple monitoring and control, even for large automated systems with complex functional sequences.

The following pages outline the most important features of **PrepMaster Core** that cover all requirements of a full-blown SCADA system. In the case of special customer requirements, it is usually possible to adjust the system and provide extended functionality without major effort.

RELIABILITY AND EASE OF USE

PrepMaster Core gives an excellent overview of all pending, current and already processed samples. Vivid colours and clear icons allow instant insight into the status of all samples, machines and processes. All relevant information and functions are just a mouse click away, offering drill-down lists for direct access to detailed data and parameters. It goes without saying that all views can be configured according to customer requirements.



Clear GUI

- Clear representation of the functional state of the automation system
- Clear symbols for the condition of automation, machines and samples
- Easily accessible functional units



Overview of all system components

- Overview of all magazines in the system
- Listing of all relevant messages, errors and alarms
- Overview of the maintenance status of all system components



Access to all relevant sample and routing information

- All relevant sample information available at the click of a mouse
- Option to call up and amend worksheet information centrally
- Ability to manually trigger sample movements



Worksheet configuration

- Outstanding sample preparation control via worksheets
- Simple and user-friendly configuration of different worksheets
- Continuous online updating of worksheet information

POWERFUL SERVICE TOOLS

Several preinstalled service tools enable rapid diagnosis of the system's functional status, facilitate the analysis of any errors, and help to optimise the system. The corresponding diagnostic information can be evaluated by the user or sent as diagnostic files to HERZOG specialists. If desired, **PrepMaster Core** offers secure remote access that HERZOG technicians can use to connect to the system.



Integrated playback function

- Powerful tools for fault and condition analysis
- Routine saving of all sample movements over a period of 30 days
- Possibility to fully reconstruct any PrepMaster state



Structuring of all relevant information

- All relevant information structured in lists and tables
- Easy access to and interpretation of all information in the system, including samples
- Comprehensive overview of the state of the system

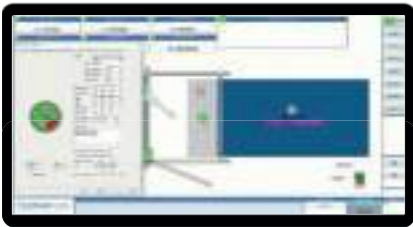


Detailed information for the expert

- Accessibility to all detailed information
- Ability to view all parameters for samples, routing and device status
- Ability for experts to perform comprehensive and rapid system analysis

REFERENCE SAMPLE MANAGEMENT AND CONTROL

The management and control of reference samples, including monitor and recalibration samples, is a major challenge in laboratory control. The individual requirements and workflows of the laboratory must be considered in the same way as the internal processing algorithms of the analysis instruments. **PrepMaster Core** provides a wide range of tools to enable the smooth and efficient processing and measurement of reference materials.



Reference sample configuration

- Intuitive configuration menu for recalibration and monitor samples
- Easy input of sample dimensions and spark positions for OES analysis
- Current overview of sample condition, height and remaining spark positions



Configuration of reference sample groups

- Pooling of reference samples into groups
- Clear menu navigation and sample display
- Easy management of parameters for sample preparation and analysis



Creation of schedules for reference samples

- Easy creation of schedules for the measurement of reference samples
- Numerous configuration options
- Graphical display of schedules



Creation of worksheets for reference samples

- Easy and convenient creation and editing of worksheets
- Numerous configuration options
- Easily adaptable to the requirements of the relevant analysis instrument

SPARKPOINT MODULE: AN AUTOMATIC VISION SYSTEM FOR SPARK POINT OPTIMISATION

The SparkPoint module is a standard component of the **PrepMaster Core** software.

The module has been specially developed for the automatic inspection of sample surfaces using vision systems. Based on camera images and customer-defined parameters, the SparkPoint module calculates the optimal spark point position for optical emission spectroscopy (OES). The SparkPoint module can be used for steel, iron and non-ferrous samples.



Automatic determination of the spark point

- The SparkPoint module is standard in **PrepMaster Core** and **Entry**
- Easy configuration of spark point positions on the sample surface
- Applicable in the HERZOG SteelLab and MetalLab



Powerful configuration tools

- Numerous options for configuring basic parameters and framework conditions
- Easy definition of sample shape and size, spark point diameter and number of analyses
- Specification of the distance between spark points, distance to the sample edge and distance to the pin



Graphical user interface

- Drag & drop of the desired spark point regions on the sample surface
- Easy changing of the priority, position and size of the analysis regions
- Calculation of the exact spark point positions by means of a special optimisation algorithm



Documentation of the spark point positions

- Storage of all data from the SparkPoint module for later evaluation
- Transfer of data and camera images to PrepMaster Analytics
- Execution of correlation analysis, e.g. with spectroscopic analysis data



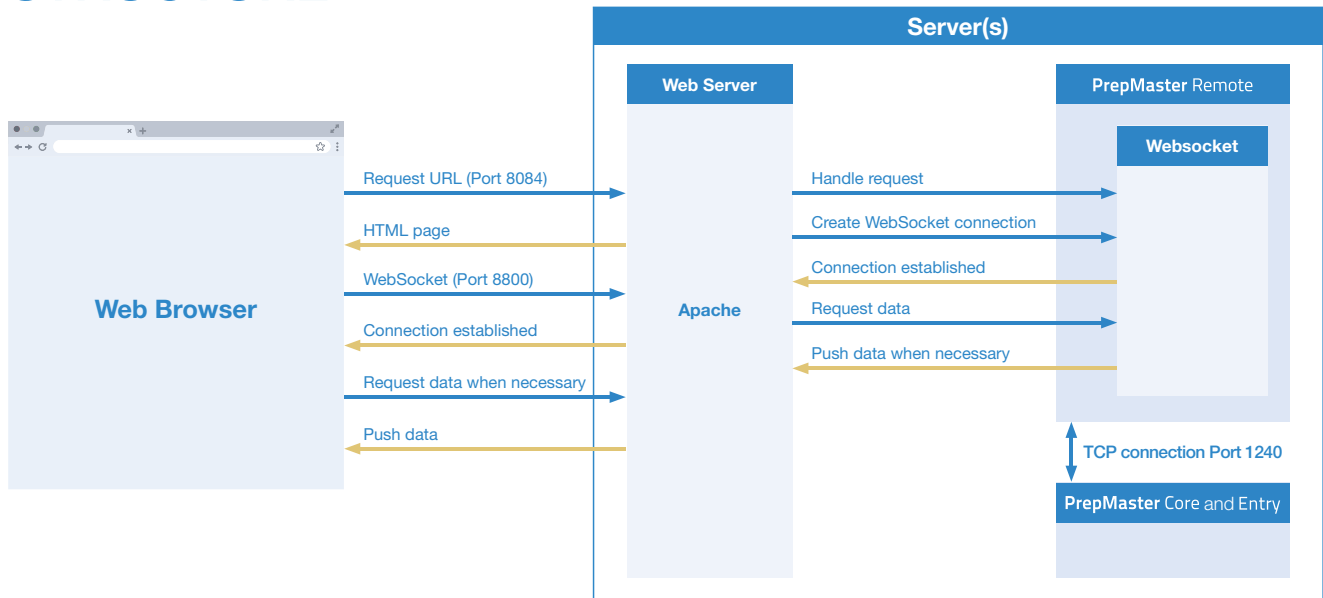
PrepMaster Remote

STRUCTURE AND HARDWARE CONFIGURATION

PrepMaster Remote connects to **PrepMaster Core** and makes all the relevant information and functions of **PrepMaster Core** available anytime, anywhere.


PrepMaster Remote uses a minimum of resources and runs on almost any client computer and browser. The main component of **PrepMaster Remote** is a Scala program that accepts requests from the website and processes them or passes them on to **PrepMaster Core**. In addition, **PrepMaster Remote** also sends responses back to the website. To communicate this data **PrepMaster Remote** is connected to **PrepMaster Core** via a TCP connection, and to web clients via web sockets. To establish this communication, it is necessary to install an Apache web server, **PrepMaster Remote**, and the data of the website accessed by the Apache web server. Usually, installation takes place on the **PrepMaster Core** computer.

PrepMaster Remote STRUCTURE



Graphical representation of the basic structure of the communication path between **PrepMaster Core / Entry**, **PrepMaster Remote** and the web clients.

PrepMaster Remote HARDWARE CONFIGURATION

PrepMaster Remote Client	
	
Description	<ul style="list-style-type: none"> ▶ One PC ▶ No backup
Hardware configuration	Multicore-CPU with 3.5 GHz 8 GB working memory Monitor resolution: 1920 * 1080 (Full HD) ¹
Operating system	Windows 10 ²
Execution	Browser

¹ The level of detail of the process images can only be displayed in Full HD or higher resolution

² The latest operating system released for WinCC is used

MULTIUSER SYSTEM

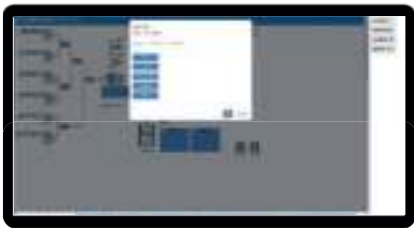
FOR PrepMaster Core AND PrepMaster Entry

PrepMaster Remote gives users an overview of the status of the computer's system, including unit status, messages and sample position. **PrepMaster Remote** also provides a wide range of essential control functions for **PrepMaster Core** and **PrepMaster Entry**. These include sample registration and status changes of units and samples. This makes PrepMaster a true multi-user system.



Overview of the functional state of the plant

- **PrepMaster Remote** runs on standard web browsers
- Display of unit status, position of individual samples, unit errors, robot positions, etc.
- Buttons take the user to overview windows and other forms



Unit form

- Ability to change the state of individual units (Unit mode)
- Ability to use buttons to send commands, including any programs needed, to the unit
- Ability to read the unit configuration and available commands from the **PrepMaster Core**



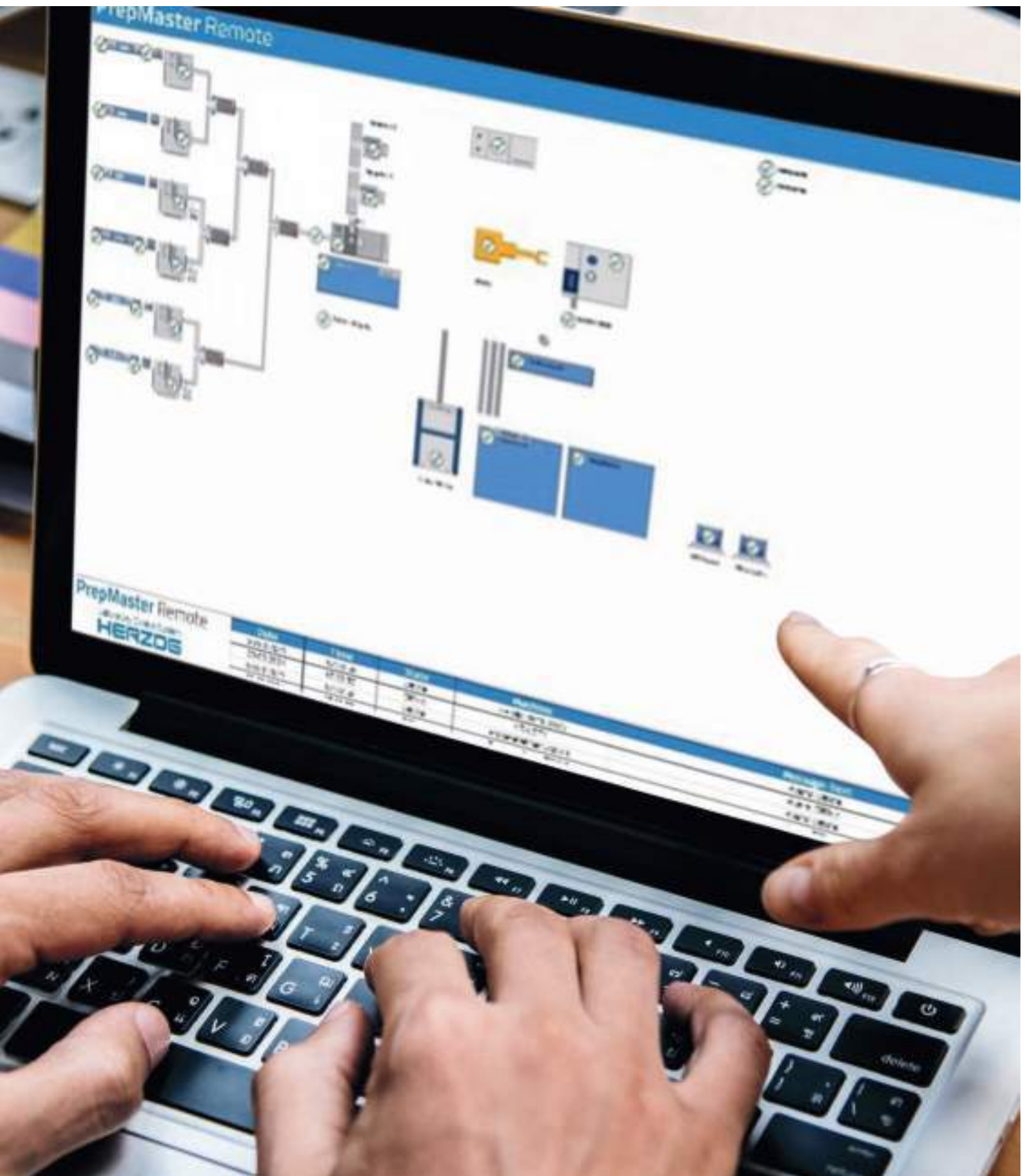
Sample form

- Ability to move a sample to the desired position
- Ability to read out possible positions from **PrepMaster Core**
- Sending of feedback to the user as to whether or not the command has been executed



Sample registration

- Manual registration of samples in the system
- Input of various sample information via input fields
- Automatic configuration of dial-up fields via **PrepMaster Core**





PrepMaster IDE

STRUCTURE AND HARDWARE CONFIGURATION

PrepMaster IDE is a GUI-based tool for configuring and programming **PrepMaster Core** and **PrepMaster Entry** projects. **PrepMaster IDE** is based on Eclipse, a widely distributed open-source programming tool used for developing various types of software. **PrepMaster IDE** is made up of two main components: the Project Manager and the Routing Manager.

All configuration files for a PrepMaster project are compiled and modified in the Project Manager. The machines and devices used in the automation system are dragged and dropped from the component and alarm library into the configuration editor. In this way, all relevant information can be seamlessly transferred to the PrepMaster project.

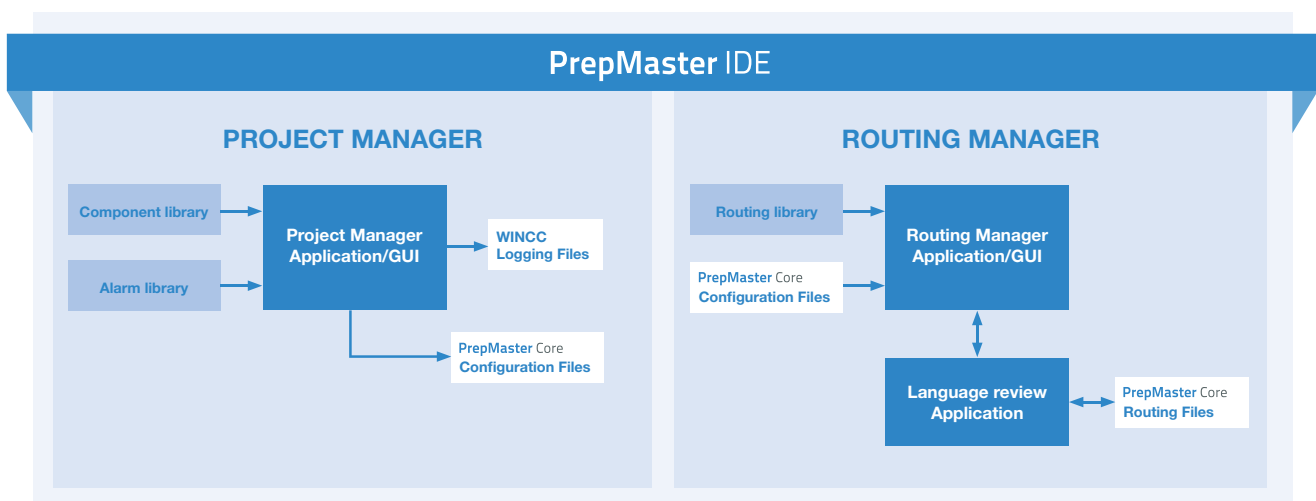
The use of constantly updated libraries also ensures that only the most recent configuration files are applied. Any imported component and alarm information can be adjusted according to project requirements, saved in the editor, and transferred to WinCC and the Routing Manager of **PrepMaster IDE**.

Developers use the Routing Manager to define the sequences and logic of the sample routing within the automation system. This is a central part of PrepMaster programming, and determines the efficiency and processing speed of the system. All routing commands can be dragged and dropped from the routing command library into the workspace, where they can be parametrised.

The Routing Manager also contains a language review application that automatically verifies the syntax used and immediately highlights any errors. The module is based on the XTEXT framework, which allows the development of in-house programming languages as well as the related infrastructure. After compiling the routing, the routing files are transformed into a format that the PrepMaster Core Kernel can read.

The computer used to run the **PrepMaster IDE** software does not require any special features.

PrepMaster IDE STRUCTURE / HARDWARE CONFIGURATION



Graphical representation of the basic structure of **PrepMaster IDE**:

All configuration files are compiled in the Project Manager. The programming of the sample sequence through the system takes place in the Routing Manager.

INTEGRATED DEVELOPMENT ENVIRONMENT FOR PrepMaster Core AND PrepMaster Entry

PrepMaster IDE helps PrepMaster programmers to configure and develop automation projects quickly and without errors. They can refer to proven and highly efficient standard solutions that are stored in comprehensive libraries. One major advantage of **PrepMaster IDE** is the significant amount of time saved on installing and commissioning systems. Users are able to immediately identify the automation configuration, parameters and routing sequences with the help of the GUI. Users can also adjust settings and make minor changes.



Easy configuration of new projects

- Drag & drop selection of components
- Numerous libraries available
- Clear listing of all available information



Configuration of individual units

- Selection of parameters, commands, interfaces, etc.
- Direct adjustment of all link and network information
- Easy change of all parameters, including positions, status bits and PLC programs



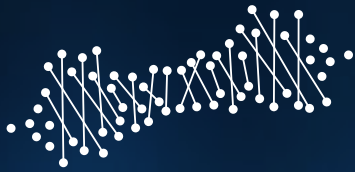
Configuration of the sample routing

- User-friendly GUI that greatly simplifies the programming of flows and procedures
- Extensive and clearly arranged library, many substitution and array functions
- Automatic fault detection for significantly reduced installation and commissioning times

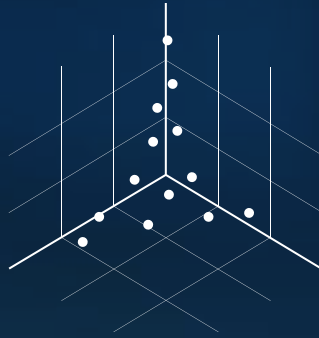


Handling system configuration

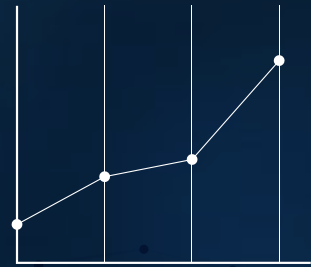
- Easy implementation of handling systems such as robots
- Simple creation, configuration and changing of specimen positions in the system
- Simplified programming of even complex magazine functions



CAPTURE DATA



ANALYSE DATA



PRESENT DATA

PrepMaster Analytics

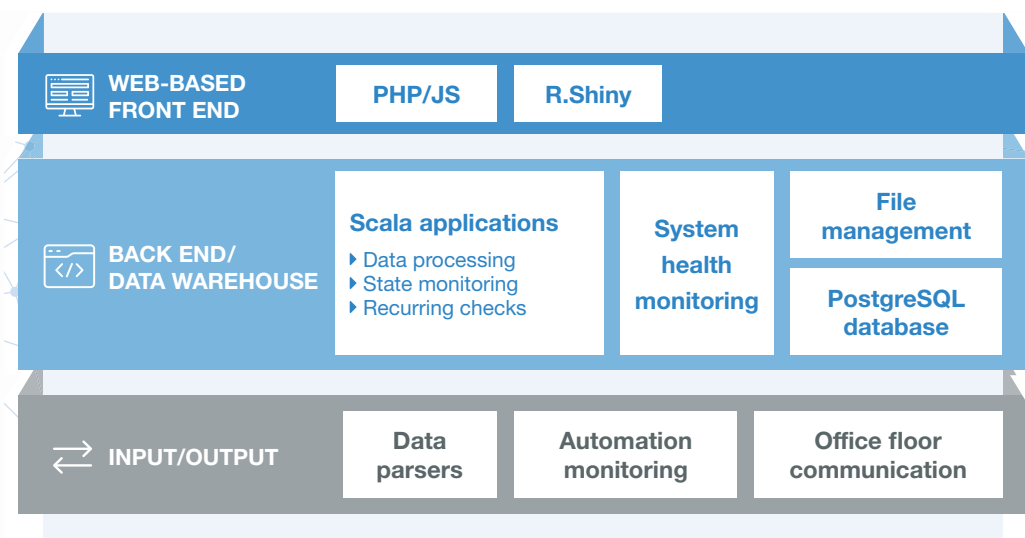
STRUCTURE

PrepMaster Analytics has a three-layer structure. All the relevant applications required for data processing, status and threshold monitoring, etc. run in the back end. This is also where system health monitoring of the entire system takes place. For this purpose, parameter data on the hardware and software status are automatically recorded, evaluated and made available to the user. An effective data warehousing with intelligent file management as well as PostgreSQL enable the management of large data quantities and the execution of complex queries within a short time.

The processing of information, e.g. from analysis instruments, takes place within the input/output layer with the help of various data parsers. The communication setup and data transfer to and from Office Floor instances is implemented in this layer. The entire communication flow from all data sources is constantly tracked with the help of automation monitoring.

PrepMaster Analytics is a modern web application. Javascript is used on the client side to create interactive and dynamic dashboards. The server-side functions, such as creating customised web content or editing requests, are executed in PHP. By combining these two scripting languages, **PrepMaster Analytics** provides not only a modern web design, but also high-performing and stable full-stack applications for complex purposes. R.Shiny is a framework of the statistics program R, which can manage large amounts of data and provides powerful libraries with all common statistics functions.

PrepMaster Analytics STRUCTURE







Three-layer structure of **PrepMaster Analytics** software with web-based front end, back end and data warehouse as well as the input/output layer for data acquisition and transmission.

HARDWARE CONFIGURATION AND FAIL-SAFE MECHANISMS

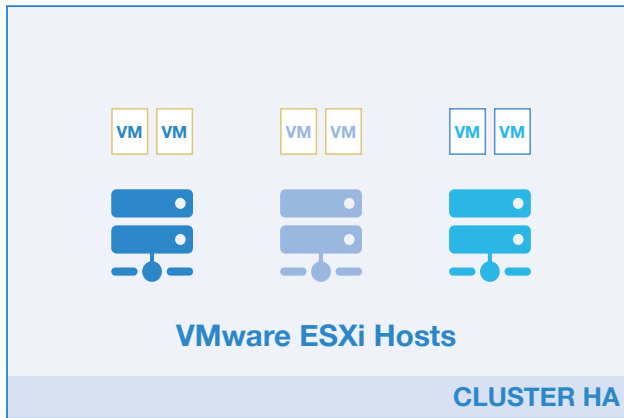
PrepMaster Analytics is an application based on a client-server model, where most of the data processing takes place on the web server. The results of the data processing are then transferred to the local client computers of the users (display PCs).

PrepMaster Analytics HARDWARE CONFIGURATION

HARDWARE – FAIL-SAFE PERFORMANCE 			
	Small-scale server	Standard server	HA cluster
Description	 <ul style="list-style-type: none"> ▶ Single blade server ▶ Raid 1 (2 drives) ▶ 1 power supply ▶ 1 local display PC with Full HD Display* 	 <ul style="list-style-type: none"> ▶ Single blade server ▶ Raid 5 (5 drives) ▶ 2 power supplies ▶ 1 local display PC with Full HD Display* ▶ Availability in Office Floor network 	 <ul style="list-style-type: none"> ▶ Solution for server with several blades or server cluster ▶ Cold standby (high availability) ▶ 1 local display PC with Full HD Display* ▶ Availability in Office Floor network
Hardware configuration	DELL T440 ▶ Intel Xeon Silver 4214 2.2 GHz, 12C/24T ▶ 32 GB RAM ▶ 2 x 480 GB Mixed Use SSDs	DELL T640 ▶ 1 Intel Xeon Gold 6140 2.3 GHz 18C / 36T ▶ 64 GB RAM ▶ 5 x 480 GB Mixed Use SSDs	DELL VRTX ▶ 2 blades with each: ▶ 1 Intel Xeon Gold 6140 2.3 GHz 18C / 36T ▶ 64 GB RAM ▶ 5 x 480 GB Mixed Use SSDs in joint RAID or customer-specific solution
IT prerequisite of the customer for virtualisation	Computing power equivalent to above-mentioned hardware	Computing power equivalent to above-mentioned hardware	Computing power equivalent to above-mentioned hardware, licence for HA
Operating system	Ubuntu 20 VMs on ESXI 6.7 made available as vmk	Ubuntu 20 VMs on ESXI 6.7	Ubuntu 20 VMs on ESXI 6.7

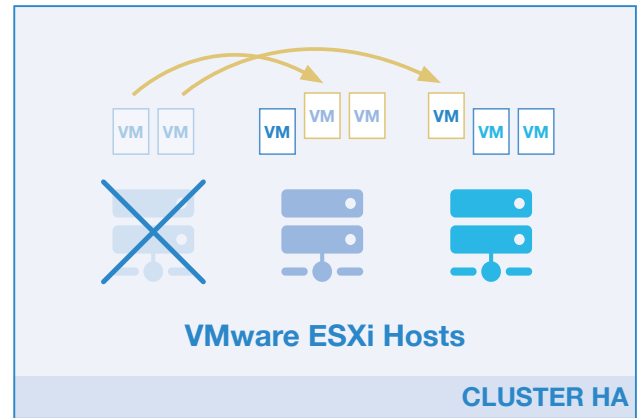
* The wealth of available data can only be displayed in Full HD or higher resolution.

Depending on the customer's requirements, a small-scale server with RAID 1 configuration or a standard server with a RAID 5 configuration are available. For critical applications, a high-availability cluster can be used, which ensures continuous service in the event of a failure of system components. In this case, the servers of the cluster monitor each other. In the event of a hardware or software failure, the intact backup servers automatically step in and restart the application without the intervention of an administrator. This typically results in very short downtimes.



Operating state

Computing load is distributed among servers



Failover case

In case of hardware or software failure, the intact backup servers automatically jump in and start the application.

Schematic illustration of the High Availability mode for a **PrepMaster Analytics** application with multiple blades or server clusters.

PrepMaster Analytics FUNCTIONALITY

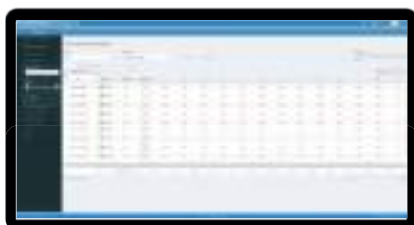
PrepMaster Analytics is a true Industry 4.0 application that helps users to monitor, control and evaluate all relevant processes and data.

PrepMaster Analytics has a modular structure. This enables the compilation of an application portfolio that is completely tailored to the specific wishes and requirements of each customer. HERZOG is constantly developing new applications, and expanding and improving existing modules. Previously installed **PrepMaster Analytics** systems can be upscaled, updated and enhanced with new modules.

ACQUISITION, PRESENTATION AND PROCESSING OF ANALYTICAL RESULTS

One of the essential tasks of PrepMaster Analytics is the automatic acquisition of analysis data.

For this purpose, PrepMaster Analytics includes preconfigured interfaces for a wide range of analysis instruments. Data can be displayed in a variety of ways in tabular and graphical form on various dashboards. They can be edited manually or automatically, with all changes logged automatically. All data can be tracked and monitored in many ways.



Clear presentation of analytical data

- Automatic data acquisition of all integrated analysis instruments via network connections (SMB, TCP, FTP)
- Tabular display with extensive functionality (grouping, colour coding, etc.)
- Graphical representation, including statistical analysis of accumulated data



Processing and forwarding of analytical data

- Easy data processing for users with appropriate credentials
- Automatic logging of all changes with audit functions
- Manual or automatic data transmission to high-level system based on configurable rules



Automatic monitoring of analytical data

- Monitoring according to specified or transmitted thresholds
- Display in easy-to-read dashboards
- Automatic notification of authorised users about threshold violations



Customised dashboards

- Individualised configuration of dashboards
- Merging of different data sources in dashboards
- Quick overview of the performance status of the system

MONITORING THE CALIBRATION STATUS OF ANALYTICAL INSTRUMENTS AND VALIDATION OF ANALYTICAL RESULTS

The reference sample module of **PrepMaster Analytics** allows the automatic display and continuous monitoring of reference analyses using statistical process control (SPC) tools. On request, it links the relevant analyses of a production sample with the relevant reference analyses. This ensures that each analysis in the laboratory is performed and validated under referenced conditions. These procedures are logged automatically and are available in the event of an audit, e.g. within the context of ISO 17025



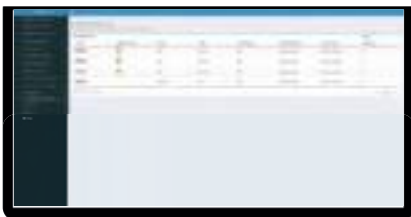
Monitoring of reference samples by means of statistical process control (SPC)

- Automatic display and monitoring of reference sample analysis
- Clear presentation by dedicated dashboards
- Automatic notification of authorised users about threshold violation



Management of SPC rules and reference materials

- Individual compilation of specific SPC rules
- Automatic import, management and update of reference samples in the system
- Configuration of warning and intervention thresholds for each reference material



Automatic monitoring of the calibration status of analysis instruments

- Clear display of the calibration status of all analyzing instruments
- Automatic evaluation of reference material measurements I
- Automatic notification of authorised users about status changes



Automatic evaluation of monitor sample measurements

- Evaluation of each monitor sample according to SPC rules
- Clearly laid out display of analysis results of all monitor and recalibration samples
- Consideration of measurement uncertainty
- Listing of all affected production samples if monitor measurement fails



Validation of analytical results

- Linkage of production sample analyses with reference analyses
- Automatic validation of production sample analyses
- Consideration of measurement uncertainty
- Warning and, if necessary, automatic reanalysis in case of a lack of validation

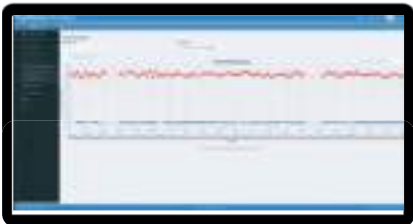
MONITORING THE AUTOMATION PERFORMANCE

PrepMaster Analytics provides all the necessary tools for visualising and monitoring the performance of an automatic system. Important key performance indicators can be tracked and evaluated in real time. Typical KPI's relevant for evaluating the performance include sample throughput, cycle time, and processing times. Simultaneously, the data provide information about further optimisation options within the system.



Monitoring of sample throughput

- Automatic acquisition of the number of samples within a certain time
- Separate evaluation for different sample types
- Graphical representation and statistical evaluation



Monitoring of cycle times

- Monitoring of sample preparation and analysis times
- Separate evaluation for different sample types
- Graphical representation and statistical evaluation



Dynamic sample throughput

- Monitoring of specific sections within the automation system
- Evaluation of sample throughput and processing times
- Simple configuration of the monitoring function

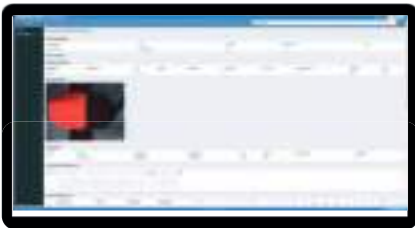


Statistical evaluation

- Accumulation of all relevant data
- Evaluation over any time periods and automation sections
- Appropriate graphical representation

OVERVIEW AND SUMMARY OF ALL IMPORTANT SAMPLE DATA

The **Sample Vita module of PrepMaster Analytics** combines all relevant data on the preparation and analysis of a specific sample in a central data dashboard. It clearly presents all the relevant routing data, machines and analysers used, sample preparation times and steps, as well as analysis results for a sample. This means that all data are available at any time for complete documentation of sample preparation and analysis, e.g. as part of an ISO 17025 audit.



Summary of all important sample data in the Sample Vita

- Summary of all relevant sample-related data
- Quick insight into analysis results, measured values, graphics and photos
- Accessible from all modules at the click of a mouse



Display and evaluation of sample preparation parameters

- Complete documentation of the equipment involved in sample preparation and analysis
- Listing of preparation times in the automation system, machines and subunits
- Visualisation of the sample preparation parameters and materials used



Validity of the analysis results

- Demonstration of the validity of analytical results based on baseline and confirmatory reference measurements
- Display of reference materials and elements involved if the calibration status is insufficient
- Automatic notification of authorised users



Automatic grouping of sample data

- Grouping of individual samples (e.g. heats)
- Automatic grouping and listing of sample groups
- Quick access to relevant data of related samples

DOCUMENTATION, PLANNING AND MONITORING OF SERVICE AND MAINTENANCE ACTIVITIES

PrepMaster Analytics contains various tools that make maintenance, service and issue resolution much easier. The maintenance module enables the simple setup and definition of automation components and related maintenance tasks. Furthermore, maintenance progress and efficiency can be evaluated statistically. The systematic recording of availability, as well as warning and error messages not only facilitates fault analysis, but also provides laboratory staff with a quick overview of the system performance.



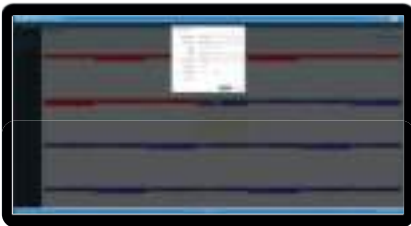
Automatic monitoring of the functional state of the automation system

- Overview of the status of the entire automation system and individual components
- Graphical representation using bar charts and pie charts
- Statistical evaluations for operators and service engineers



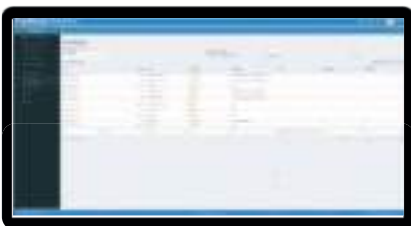
Statistical evaluation of maintenance activities

- Statistical evaluation of the maintenance status of the entire automation system and individual components
- Representation of maintenance requirements for the entire automation system and individual components
- Documentation of all relevant information, including spare parts lists



Configuration and monitoring of maintenance tasks

- Definition of automation components and maintenance tasks
- Assignment of maintenance tasks to team members
- Automatic notification of upcoming or delayed maintenance tasks



Overview of errors and warnings

- Clear display of all errors and warnings with numerous filter functions
- Automatic linking of errors with video sequence
- Error analysis and statistical error evaluation

CONDITION MONITORING AND PREDICTIVE MAINTENANCE TOOL

PrepMaster Analytics offers optional modules for monitoring different machine tools using sensor data.

This enables users to monitor appropriate sample preparation, the control of the tool condition (TCM), and the performance of predictive maintenance.



Milling machine monitoring

- Monitoring of the condition of cutting inserts by means of vibration and torque
- Overview of the status of all milling tools in the system
- Automatic alarm or tool change when limit value is exceeded



Monitoring of vibrating disc mills

- Use of modern sensor technology for acceleration monitoring
- Automatic monitoring of the condition of the grinding set and swing aggregate
- Predictive maintenance of the grinding unit by means of SPC



Quantitative evaluation of grinding cycles

- Qualitative and quantitative evaluation of grinding by measuring acceleration and power
- Identification of individual grinding phase
- Quantitative evaluation of surface and agglomeration energy of individual samples



Monitoring of thermal fusion processes

- Continuous recording of temperature and fusion power
- Automatic monitoring of the heating and fusion phases
- Evaluation of parameters for LOI, solubility and reproducibility



Pneumatic cylinder monitoring

- SPC monitoring of pneumatic cylinders
- Automatic detection of long-term changes due to, e.g. mechanical damage
- Predictive maintenance of pneumatic units

RAWMIX AND BLENDING MODULE FOR CEMENT PRODUCTION

The Rawmix and Blending module of PrepMaster Analytics is based on advanced optimisation algorithms and model predictive control mechanisms. As a result, optimal raw material flows are calculated even for complex initial situations and boundary conditions. The sophisticated software control makes it possible to reach defined setpoints quickly and accurately and to stay within them.



Simple configuration

- Quick access to all configuration menus
- Clear and sortable display of all data
- Easy change of parameters, e. g. of belt feeders, raw materials etc.



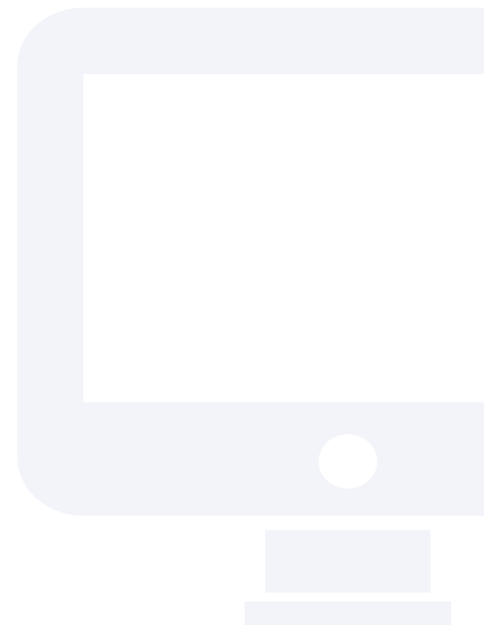
Clear dashboards

- Presentation of all relevant parameters for cement production
- Overview of all relevant modules and feeder settings
- State evaluation of the system, including goals achieved and fulfilled degrees of freedom



Automatic acquisition and calculation

- Automatic acquisition of analysis values
- Calculation of target values by means of the model predictive control algorithm
- Optimised target value achievement under the selected constraint conditions



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