



*Be a step ahead! IT your fab!*



**Manufacturing Execution System (MES)**  
**Process Control System (PCS)**

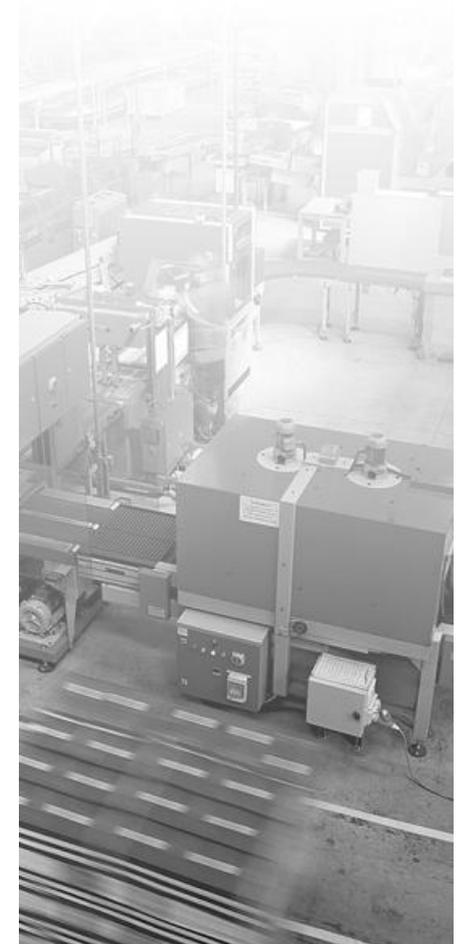
# Index

**1** MES Value in Manufacturing

**2** Basics and SOA architecture

**3** GUI

**4** MES Functionalities



# Index

- 1 MES Value in Manufacturing
- 2 Basics and SOA architecture
- 3 GUI
- 4 MES Functionalities



# InFrame Synapse SOA architecture and the major advantages

## High availability

- Limit the risk of changes within production
- Clear and well defined architecture

## Open for extension

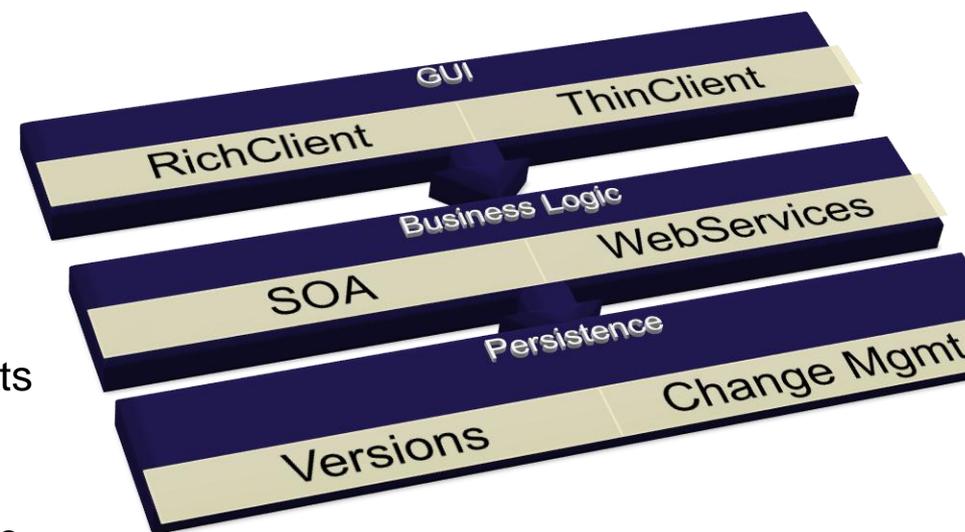
- State-of-the-art system architecture
- Well defined and documented interfaces

## Scalability

- Scalability for integration of new equipments

## Persistence Layer

- Decoupling of business logic and database
- Database is exchangeable depending on customer request (e.g. Oracle, MySQL, ...)



# Basic Functionalities of InFrame Synapse

## Traceability within production

- **Product** definition and **process** plan
- Material tracking („WIP Tracking“)
- Collection of history data (History Data Tracing)
- Collection of quality data (Quality Data Tracing)
- Statistical Process Control (SPC) / Process Diagnostics / Fault detection and classification (FDC) /Advanced Process Control (APC)

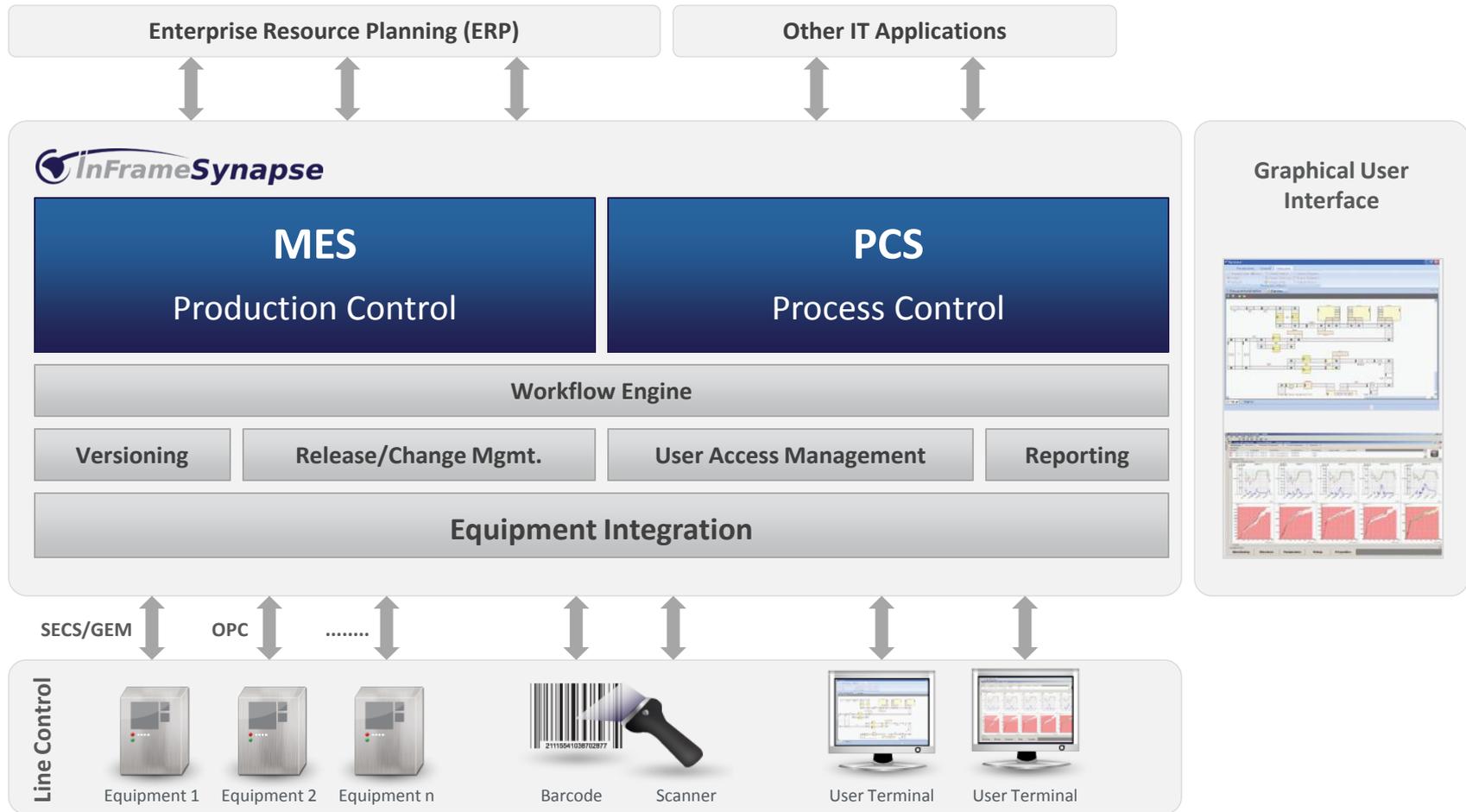
## Management of all resources (production equipment, operators, ... )

- State tracking, monitoring and visualization
- Skill management

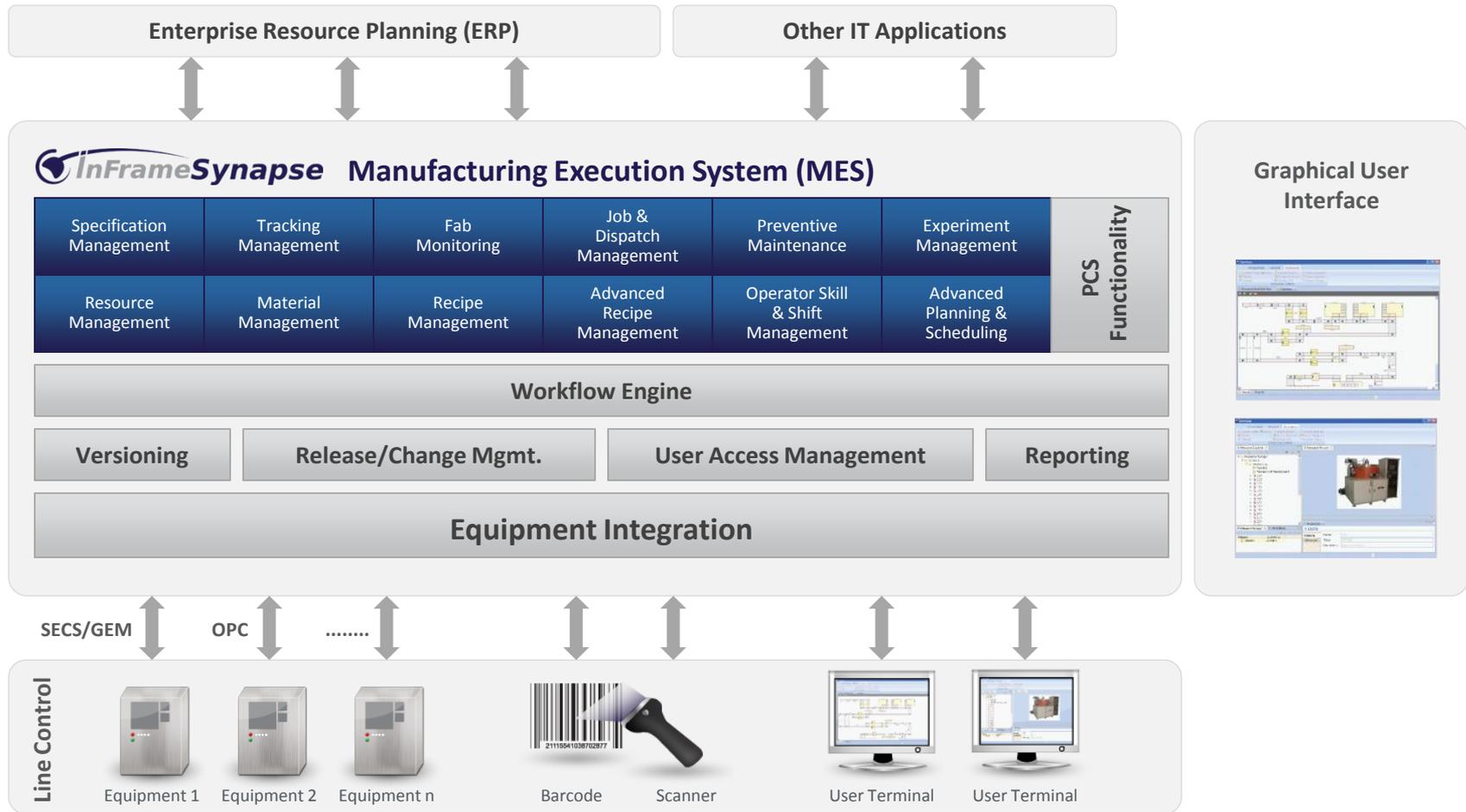
## Production control

- Control, execution and monitoring of all production flows
- Dispatching and Scheduling of production orders

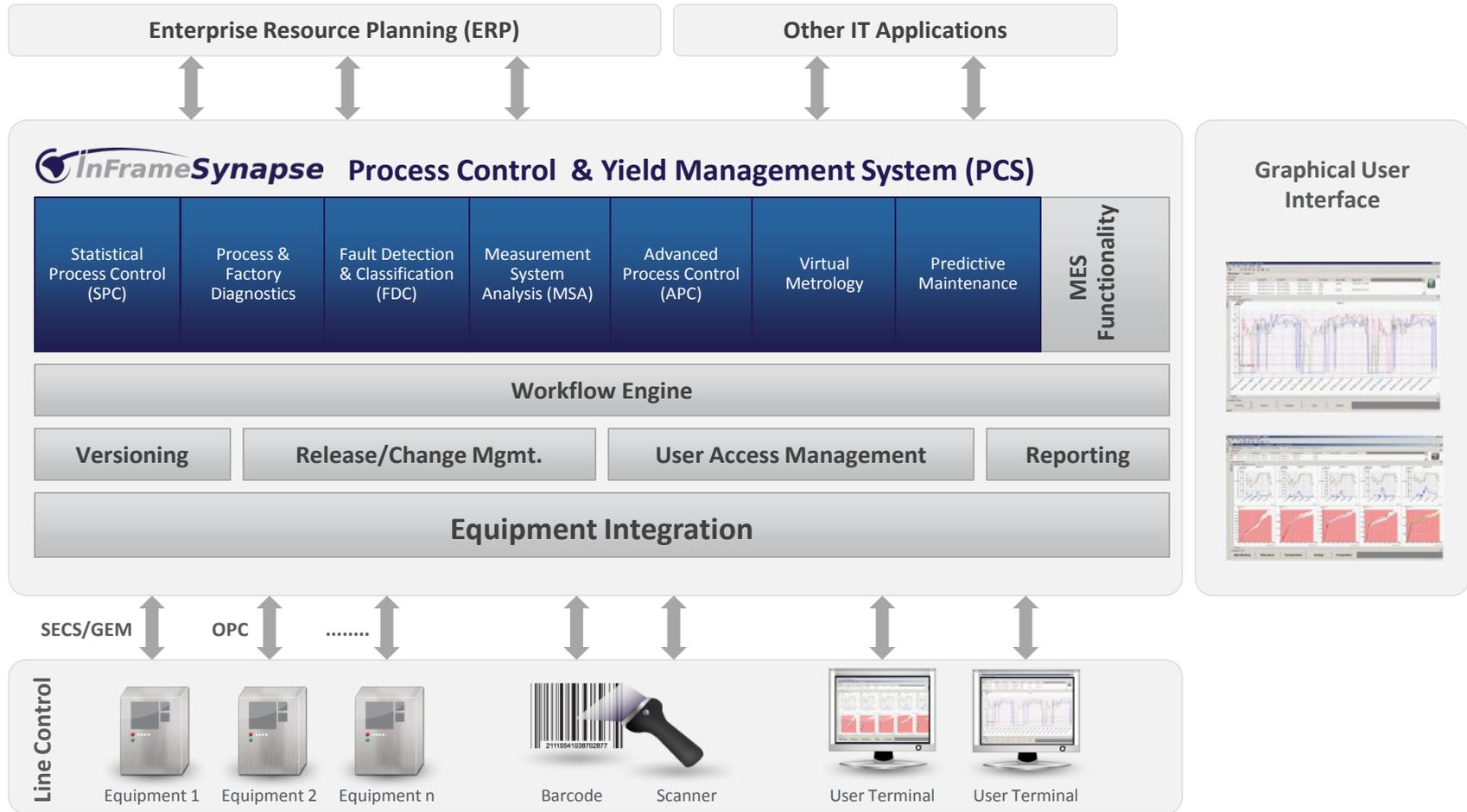
# InFrame Synapse offers an Integrated Functionality for Production Control and Process Control



# InFrame Synapse Manufacturing Execution System (MES)



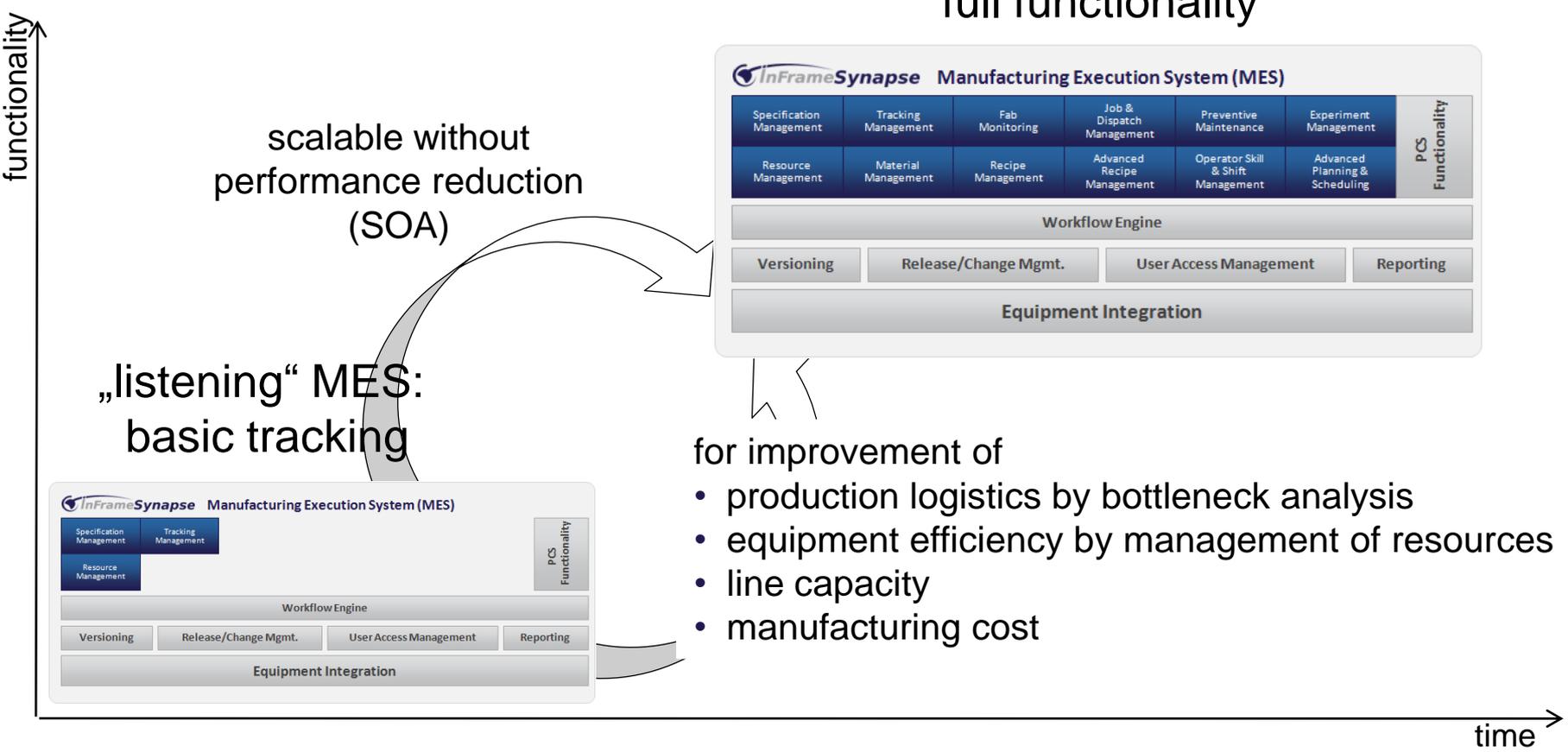
# InFrame Synapse Process Control System (PCS)



# Why InFrame Synapse?

InFrame Synapse MES ... is growing with the customers needs and experience

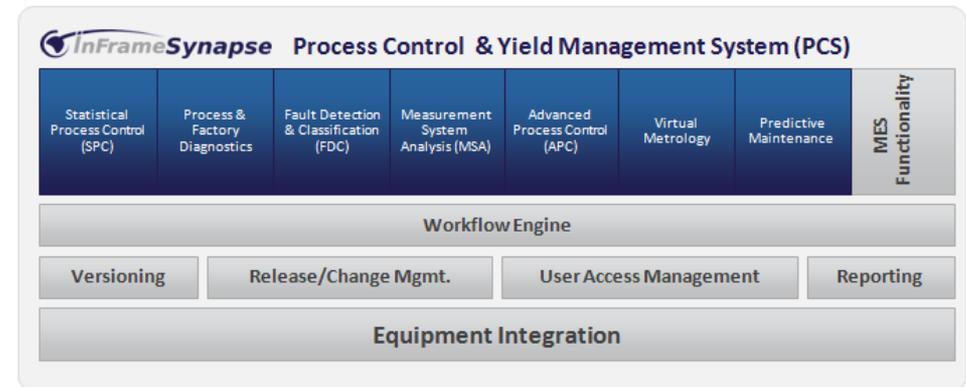
„Controlling“ MES:  
full functionality



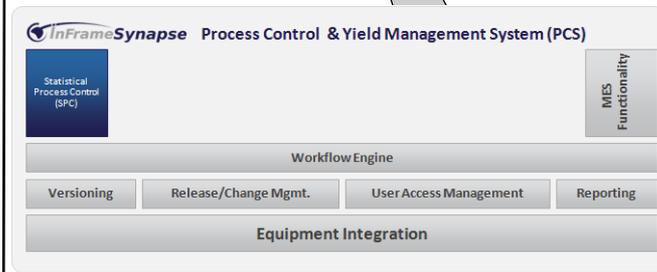
# Why InFrame Synapse?

InFrame Synapse PCS ... is growing with the customers needs and experience  
 „active controlling“ PCS:  
 full functionality

functionality ↑



Passiv process control



- for improvement of product quality
- controlling of process capabilities
  - managing process parameters
  - active correction of process parameter deviation

time →

# Essential features of the Synapse framework: Core

## Versioning of persistent Objects

- Access to database always via persistence layer
- Versioning of all persistent objects
- Change of an object leads to a new version
  - Complete history of changes for the complete lifecycle of an object

## Change- and Release management

- Based on Versioning management framework
- Related changes will be combined in a „Change Session“
- Objects from different services can be combined in one „Change Session“
  - Process plan, recipes, documents...
- Flow control of “Change Session” by using configurable state machines
- Different (complex) Review / Approval Scenarios are possible
  - E.g.: FMEA, Engineering, Release as Experiment, Review, Release to production



# Essential features of the Synapse framework: Core

## Workflows und Workflow-Engine:

- Workflows to customize and extend the basic functionality of Synapse MES
- Workflows can also be used by customer to extend the system
- Workflow-Engine to execute workflows
- Workflows are also persistent objects and will be versioned
  - complete history and rollback of all customizing and customer extensions
- Changes of workflows are also related to a „Change Session“
  - Review und Approval also for workflows



# Essential features of the Synapse framework: Core

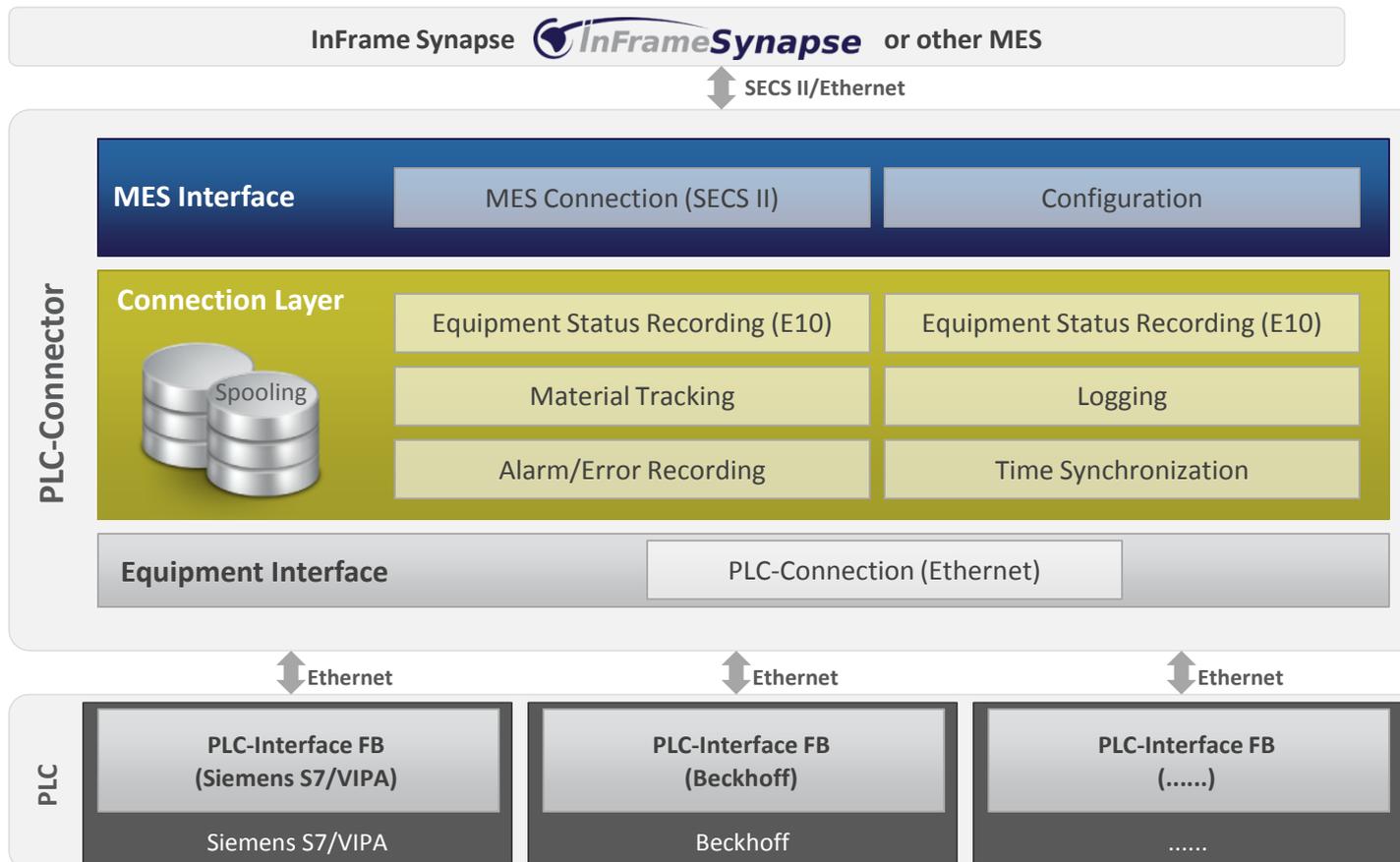
## Equipment Integration (1/2)

- Equipment Integration is completely integrated in Synapse
- Strong coupling between MES and Equipment Integration
- Different protocols are possible (SECS/GEM, OPC, proprietary)
- Each Equipment can be connected using a different protocol
- EI can be extended because it's done using workflows and workflow-engine
- EI changes will be done under Change- and Release management  
-> Changes to an EI adapter can be done within runtime



# EI: InFrame Synapse PLC-Connector (SECSII/GEM)

acp-IT's PLC-Connector (SECSII/GEM) provides a configurable bridge between equipment and the MES



# Index

- 1 MES Value in Manufacturing
- 2 Basics and SOA architecture
- 3 GUI
- 4 MES Functionalities



# Essential features of the Synapse framework: Core

## Graphical User Interface (GUI)

- Modularity
  - Versioning of different GUI features
  - Common look and feel for all roles (Operator, line manager,...)
- Exchangeable Views
  - Different views to the same data are possible depending on the user role
- Each role has its own perspective (build from different views)
- Automatic update mechanism available
- Short response time
  - Multi-Threaded





**Thank you for your attention.**

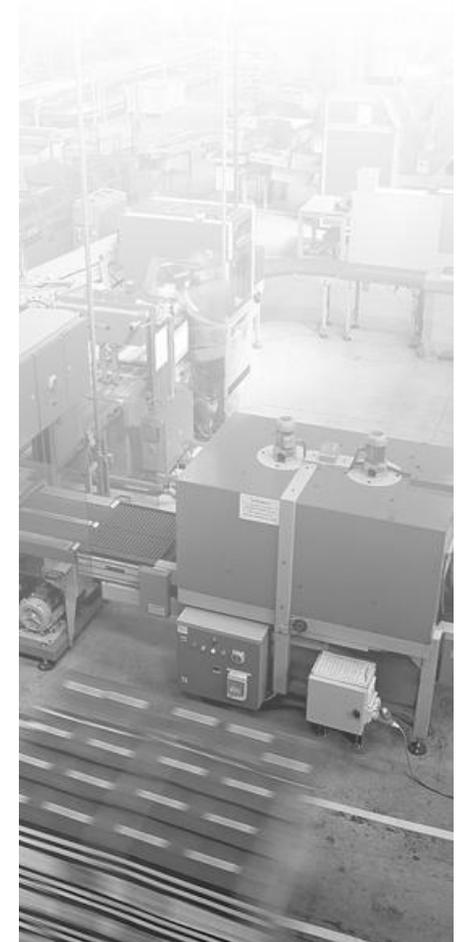
**acp-IT AG**

advanced clean production Information Technology AG  
Handwerkstr. 29, D-70565 Stuttgart

Telefon +49 (0)711-7824089-0  
Telefax +49 (0)711-7824089-10  
eMail [info@acp-it.de](mailto:info@acp-it.de)

# Index

- 1 MES Value in Manufacturing
- 2 Basics and SOA architecture
- 3 GUI
- 4 MES Functionalities



# MES Components: Recipe Management

## Customer Value:

### Management of recipes allows to

- up and download a recipe to a resource /equipment or activate a recipe at an equipment
- manage the usage of all recipes for production
- deploy recipes which are qualified for a product, a process and a resource
- Deploy recipes for human resources (Operator) as a working instruction



### Technical features:

- recipes also names managed centrally for all production resources
- active resources use recipes to achieve their process targets
- The Capability Mgr controls the assignment of recipes to resources
- Capabilities are requested by the process and provided by resources
- The Recipe and Capability Manager ensures that only executable recipes are assigned (implicit) to a certain resource.
- Special Operator-Terminals (GUI) are available for interaction with human resources



# MES Components: Advanced Recipe Management

## Customer Value:

### Advanced Management of recipes allows additional to Recipe Management to

- Hierarchical recipe definition
- Management of Recipe Parameters including limits and validation rules
- Based on latest SEMI Recipe and Parameter Standard
- Qualification of Recipes for certain equipments



### Technical features:

- Complex recipes for cluster equipment can be managed centrally
- Parameter management enables the support for parameter override in experiments and by Operators



# MES Components: Material Management

## Customer Value:

### Material Management allows to

- Define Raw Materials used in the production process
- Is used to define consumables tracked in the production process
- Free definable material types allows the tracking of all consumables
- Allows the definition of hierarchical Materials (Containers, Boxes, Bottles aso.)
- Enables simple tracking of material for warehouse purposes
- Consumables defined in the Material Management can be assigned to production resources and are tracked in the Job history



### Technical features:

- Complex material scenarios can be set up using the hierarchical material definition
- Material Types are the base for Consumable Management



# MES Components: Preventive Maintenance

## Customer Value:

### Preventive Maintenance extends the Resource Management to

- Define recurring maintenance tasks for all active resources
- Maintenance tasks can be run as Operator Tasks or integrated as regular production jobs into Dispatching
- Counter and Time based Tasks can be defined
- Multiple Tasks of each Task type can be assigned to a resource
- A escalation procedure can be defined if tasks are not executed



### Technical features:

- Counter based tasks are verified with each state change of a equipment
- Time based tasks can have a grace period before escalations are triggered



# MES Components: Resource Management

## Customer Value:

### Management and tracking of all resource states allows to

- analyze and optimize up time / downtime of resources (MTBF, MTR)
- identify bottle necks
- analyze failures leading to capacity and throughput problems
- to improve ROI of resources (OEE ; SEMI E10)
- schedule preventive maintenance and execute predictive maintenance strategies



### Technical features:

- InFrame Synapse differentiates between active and passive MES resources
- Active resources contain technical (equipment) resources as well as human resources
- Passive resources are e.g. carriers, magazines or trays
- Resources can be grouped and setup hierarchically to support the configuration of Clustertools



# MES Components: Experiment Management

## Customer Value:

### Definition of Experiments for Dispatch based Production lines allows

- Easy definition of Experiments including the definition of multiple material groups and process variants for steps
- Each experiment step can contain user definable work instruction as well as modified parameters based on advanced recipe definitions
- The Experiment execution is fully integrated into the regular Job Execution, not need for special Operator training
- Each Material Group can be assigned to different Material Types from the Material Management



### Technical features:

- The Advanced Recipe Management provides the basis for flexible recipe parameter override
- Material Management integration allows the reservation of special Material for experiments

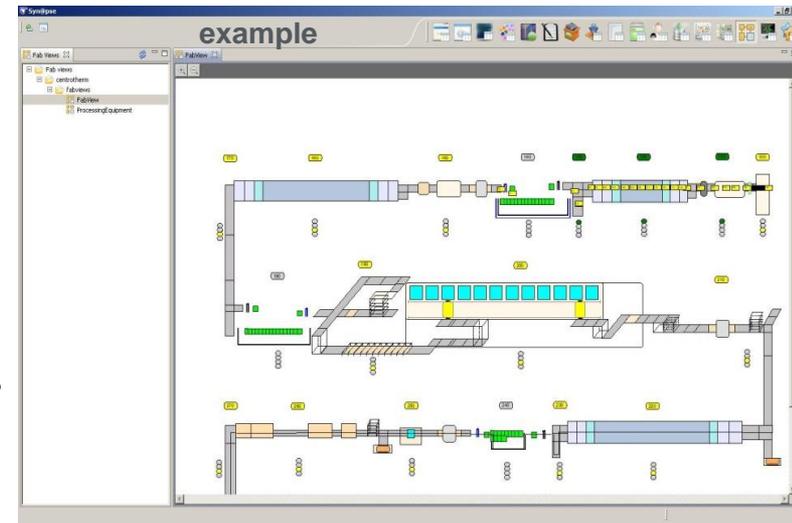


# MES Components: Fab-Monitoring

## Customer Value:

### Fab-Monitoring / FabView

- enables the graphical Online Display of the current shop floor status / equipment states
- includes all resources and production orders currently executed on the production line/ cluster / equipment
- Visualization of product data in the context of resources (e.g. position of lots within production line)
- Displays the status and other information of resources



### Technical features:

- The user can define different graphical views and link them to resources
- The view can be comfortably built with graphical library elements (drag & drop)



# MES Components: Reporting

## Customer Value:

- creation of reports over all stored MES data (Tracking and Resource data) in printable formats.
- reports are defined in a graphical user interface and thus can be adapted and extended by the user.
- powerful filters and grouping functionalities can be used within reports
- reports can either be created directly by user interaction or on a regular basis (e.g. daily/ weekly reports).
- Standard Reports are available:  
Tracking data reports, Equipment Data reports, Yield, Scrap and Fault reports, Throughput, Cycle-Time, Work in Progress, Overall Equipment Efficiency (OEE): overall, per line, cluster, or equipment, etc.  
various statistics reports
- other user definable reports

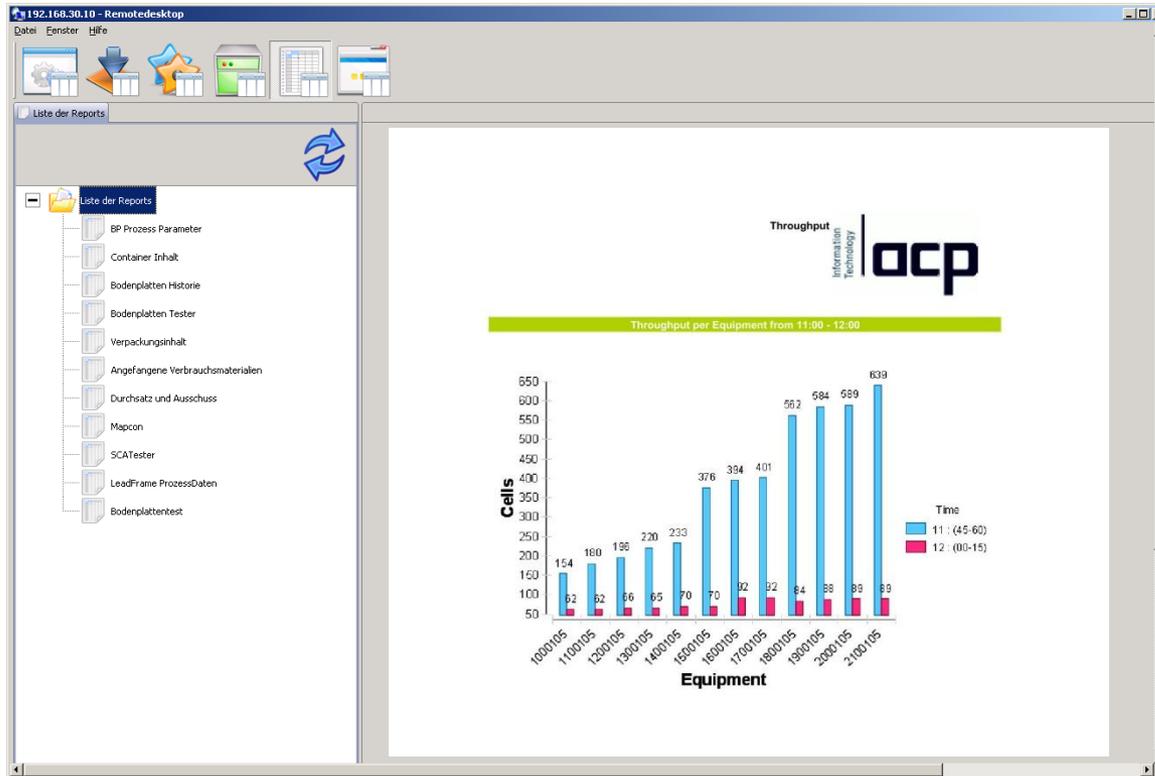


## Technical features:

- Reports can either be created directly by user interaction or on a regular basis (e.g. creation of daily or weekly reports).
- Graphical diagrams can be incorporated flexibly
- The user can define different graphical views and link them to resources
- The view can be comfortably built with graphical library elements (drag & drop)



# GUI: Examples



List of reports with one throughput example



# MES Components: Job Management and Dispatching

## Customer Value:

- Planning, dispatching and controlling of manufacturing orders
- definition of production orders, which are brought into the system (e.g. via ERP-system or manually) and covering of their assignment to customer orders.
- Assignment of production order to process plan and material.
- Manages and monitors execution and progress of the orders according to process plan .
- Possibility to group a set of materials using the Batch Manager component
- Capability / process goal will be send to dispatcher
- The execution and prioritization of capability/process goal will be done with workflows  
behavior of dispatch rules can be customized  
can be extended with complex dispatch rules



## Technical features:

- processing sequence of the defined orders can be configured via workflows.
- execution and prioritization of process steps will be done with workflows
  - execution behavior can be customized
  - extensible using different planning algorithms possible after installation
- Using the GUI it is possible to have different customizable views on the orders, e.g.



# MES Components: Tracking (&Tracing) Management

## Customer Value:

- continuously tracks all executed processes with respect to all MES relevant tracking information online. The following data are tracked:
  - Production Status Data
  - Process Times, Process Data and other Tracing Data (e.g. identification, time stamps, etc.)
  - Equipment Data, Equipment utilization, uptime etc.
  - Errors and Alarms
- evaluation and reporting of the recorded data at any point of time.



## Technical features:

- all tracking data can be visualized flexible and in real-time (either table formats or graphical formats using customized views).



# MES Components: Skill & Shift Management

## Customer Value:

- Allows a easy management of Operator Skills
  - Assignment of Skills required for a certain process
  - Management of skills provided by Operators
  - Integration into dispatch management allows the smart
- Flexible definition of Shifts for production resources.
  - Definition of multiple shift plans e.g. Two and Three shift plans for certain timeframes
  - Assignment of resources to shifts
  - Operator availability (calendar) definitions
  - Management of work and holiday calenders



### Technical features:

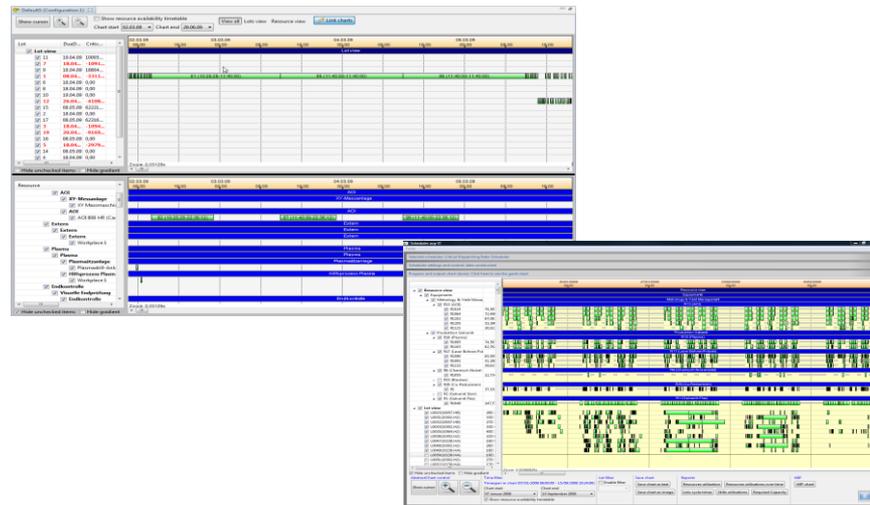
- Capabilities and resources are automatically filtered when using the Dispatch Manager



# MES Components: Advanced Planning & Scheduling (1/2)

## Customer Value:

- Calculation of a line-wide process operation schedule based on preconfigured optimization rules e.g.
  - Forward Planning algorithm using Critical Ratio and Static Prioritization
- Alignment to the Dispatching component can be provided
- Considers machines as primary resources and operators with their availability and skills as secondary resources.
- For midterm planning the operator availability and order release to the factory is considered as the input criteria for different planning scenarios.
- Different planning scenarios are calculated and can be compared by an experiment management functionality.



# MES Components: Advanced Planning & Scheduling (2/2)

## Customer Value:

- The Static Planning Extension
  - provides the possibility to calculate raw process times and resource times for individual orders considering the product structure and the lot size.
  - provides a calculation of required time of each specified resource in the operation plan consumed by specific orders.



### Technical features:

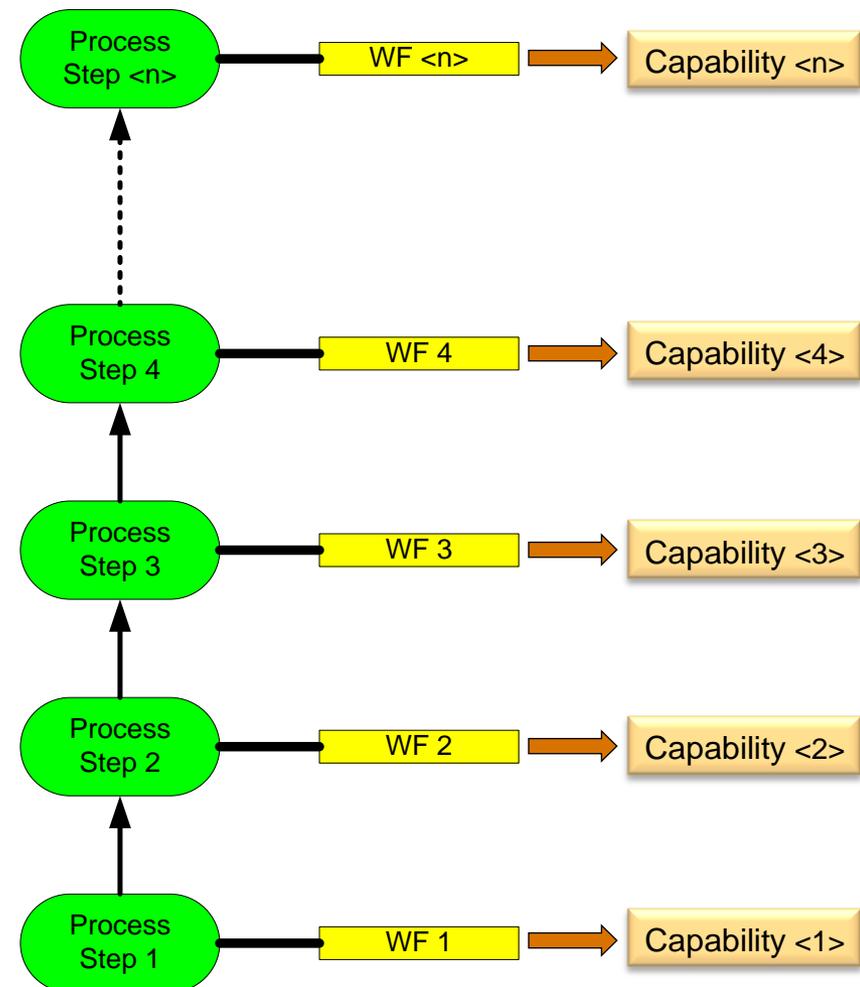
- using customized views the data can be visualized flexible and in real-time (either table or graphical formats).



# MES Components: Specification Management (1/4)

## Customer Value:

- definition of process plans using a series of process steps
- each process step executes a workflow (WF)
- a process plan can be associated to process step → hierarchical process plans are possible
- a workflow will execute one capability (process goal)
- a capability / process goal is defined by a list of Resource & Recipe
- a (active) resource can be a:
  - techn. resource (equipment)
  - human resource
- the decision of resource will be done immediately before process start



# MES Components: Specification Management (2/4)

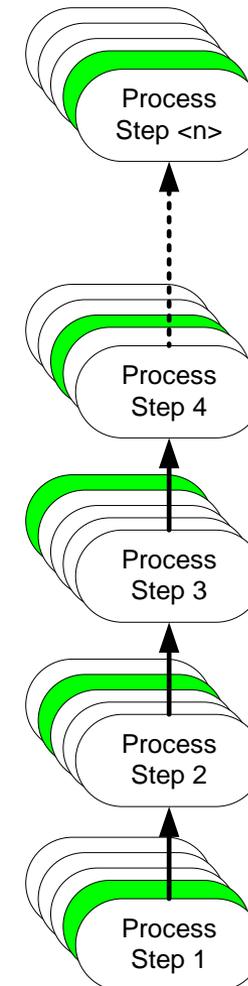
## Customer Value:

- enables the definition of products and semi-finished products within a graphical view.
- enables the user to define new products by managing and combining process plans and process targets.
- definition of product variants possible
- the definition of process plans includes the possibility to define alternative process flows, optional measurement process flows, as well as rework process flows.
- the production materials, properties and material groupings (classifications) are managed here.



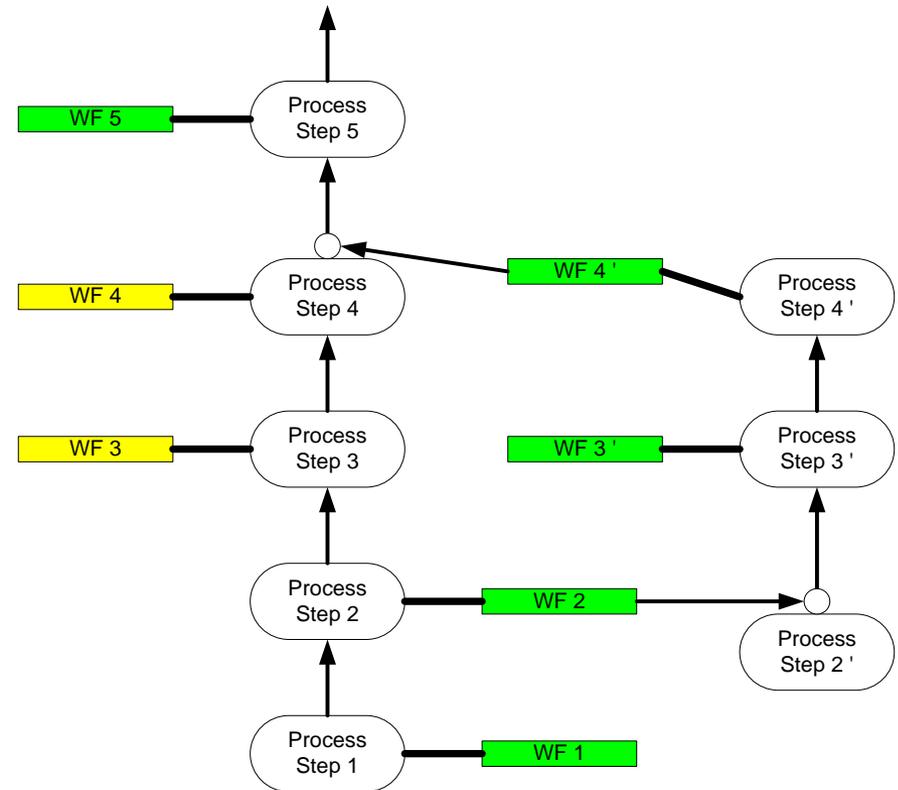
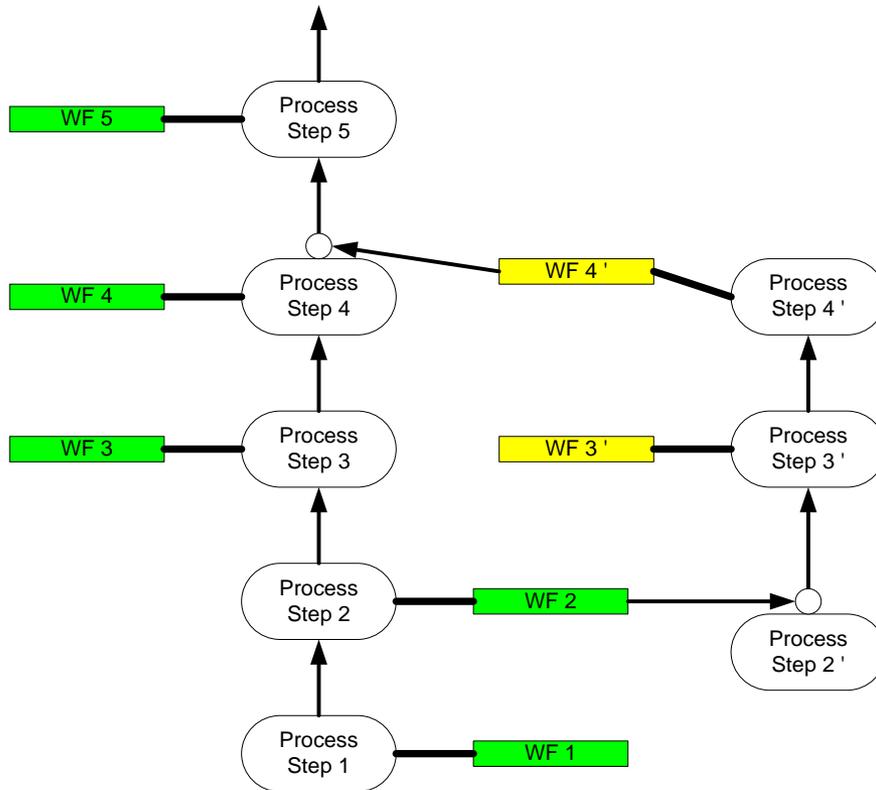
### Technical features:

- By using of Version- and Change-Management well defined changes of process steps within production are possible



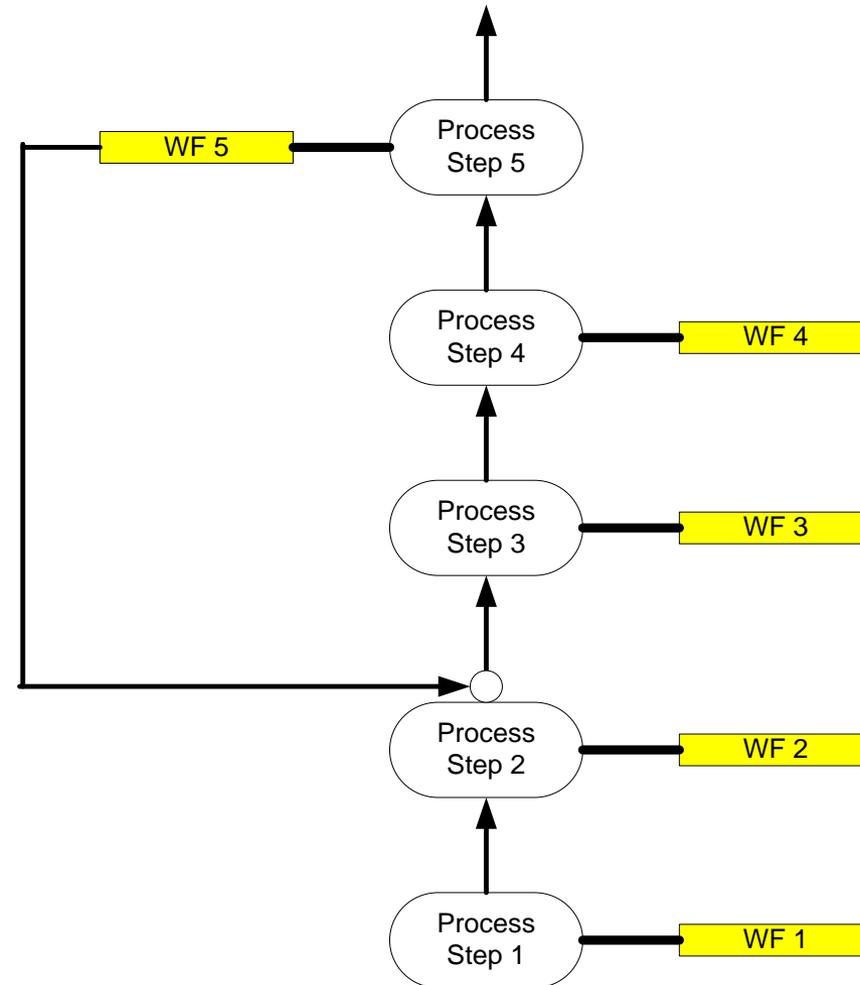
# MES Components: Specification Management (3/4)

## Definition of alternative flows



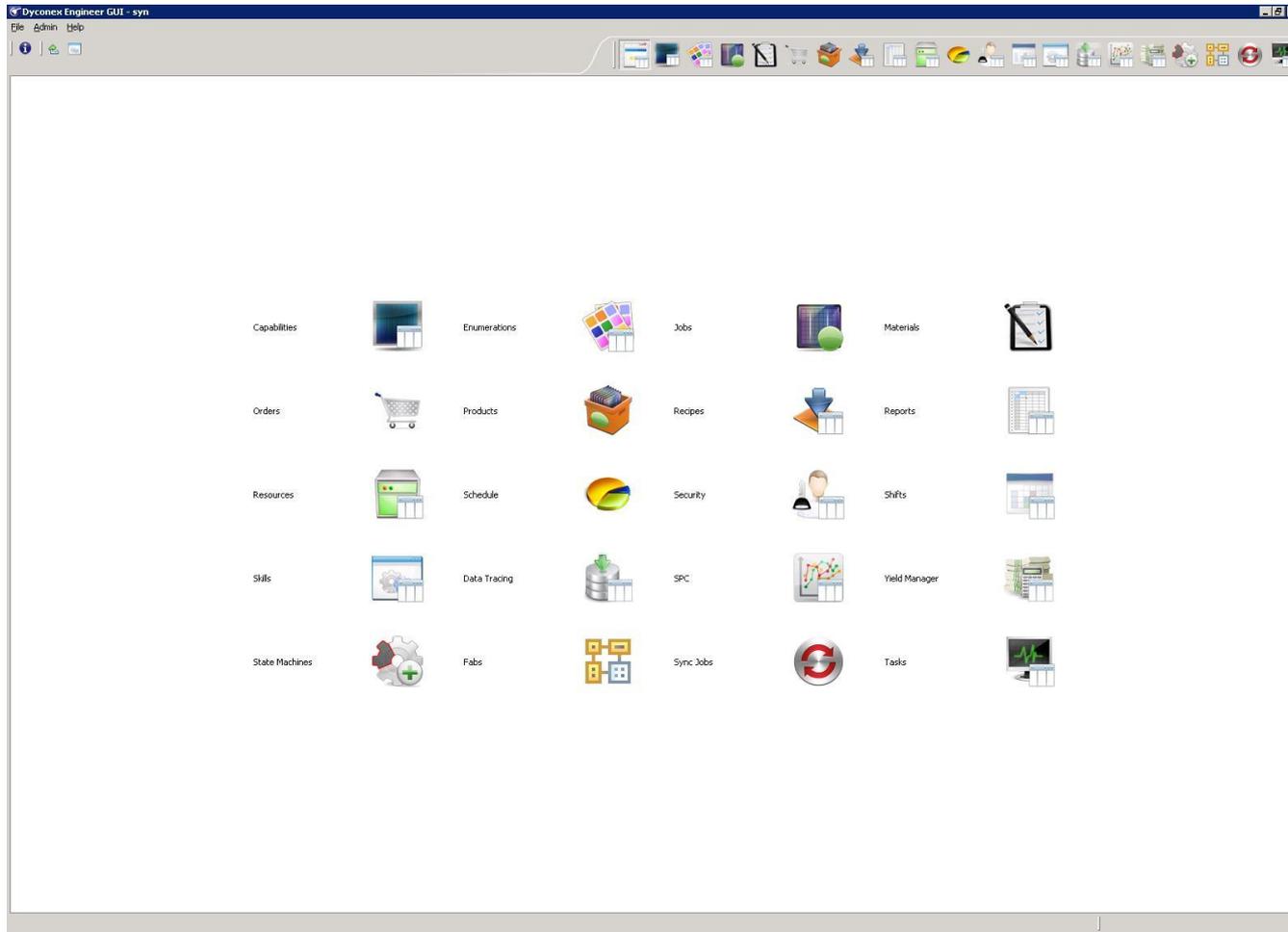
# MES Components: Specification Management (4/4)

## Definition of flows with rework



# GUI: Examples

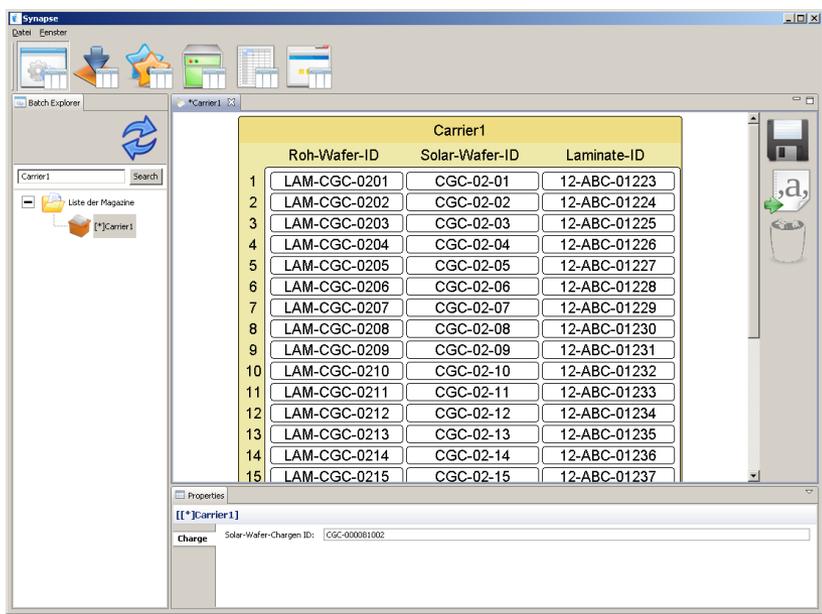
## Flexible configurable user interface with common look and feel (Eclipse-based)



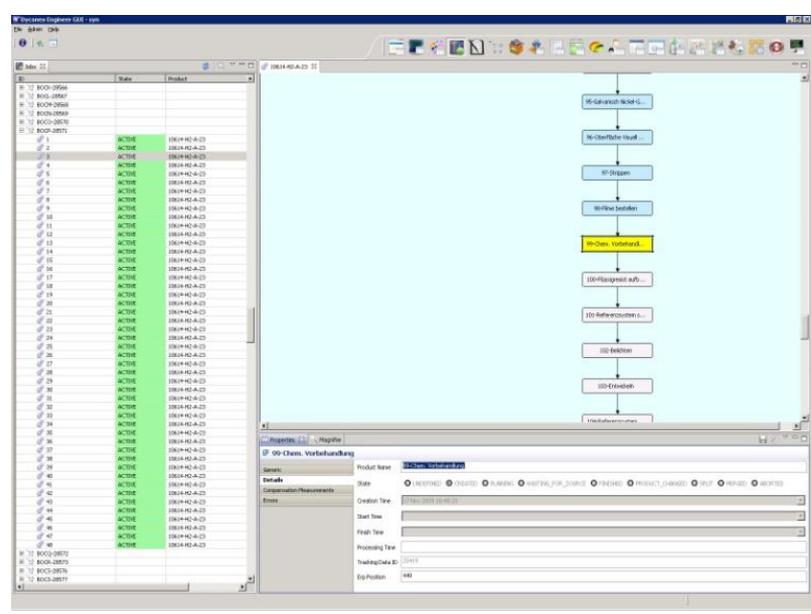
Start screen



# GUI: Examples



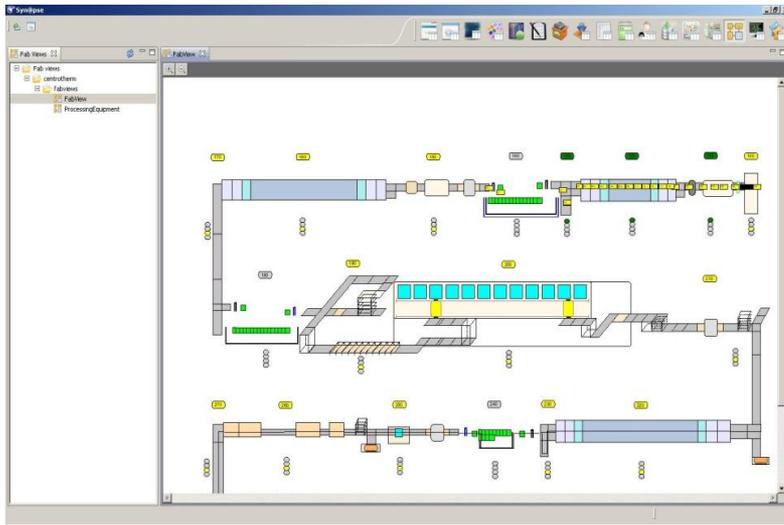
**Operator GUI** : Operator scans, e.g. using barcode reader, material or carrier and MES shows detailed information, e.g. content of carrier, processing status, etc.



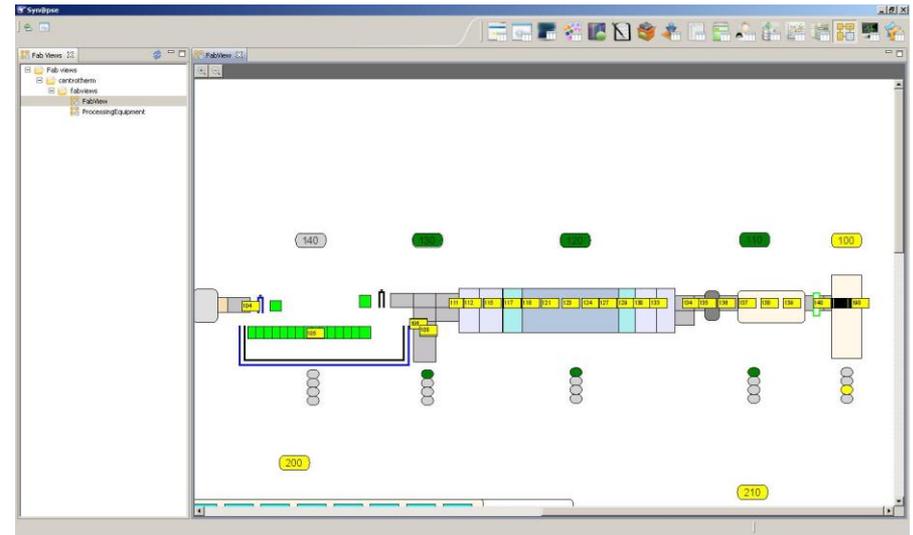
**Production Run**: Real-time event based progress monitoring of jobs, e.g. which process steps are already finished (blue), which one is currently in processing (yellow), which steps are still upfront (white)



# GUI: Examples



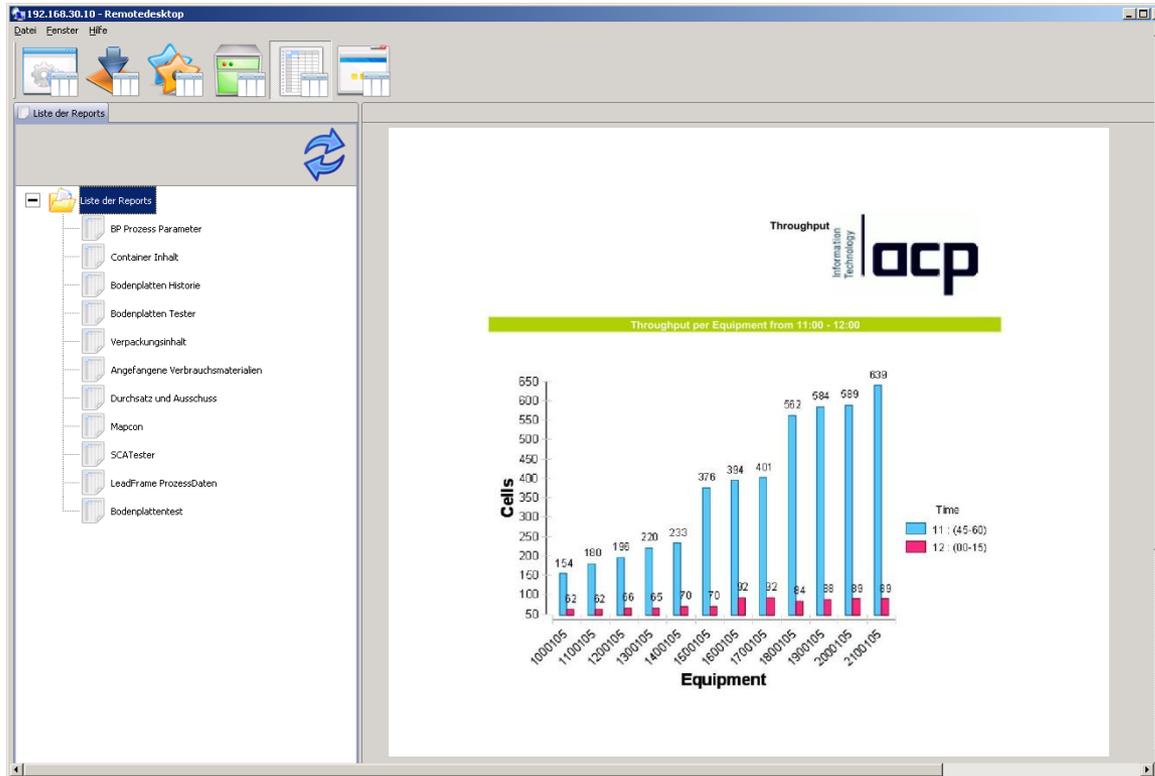
FabView



Fab view zoom with real time product movement



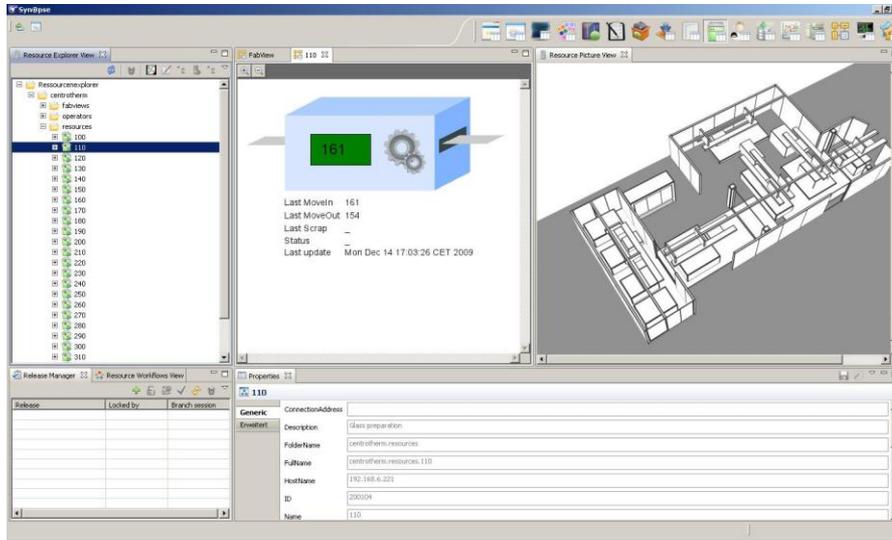
# GUI: Examples



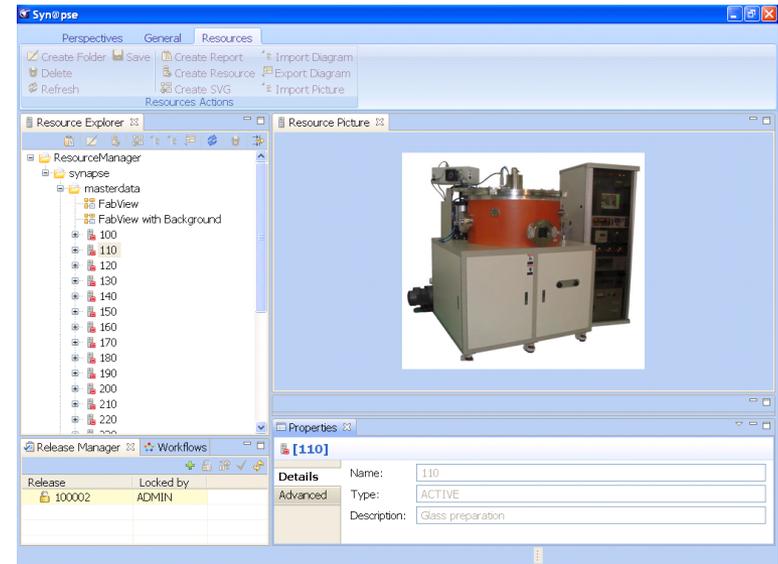
List of reports with a throughput example



# GUI: Examples



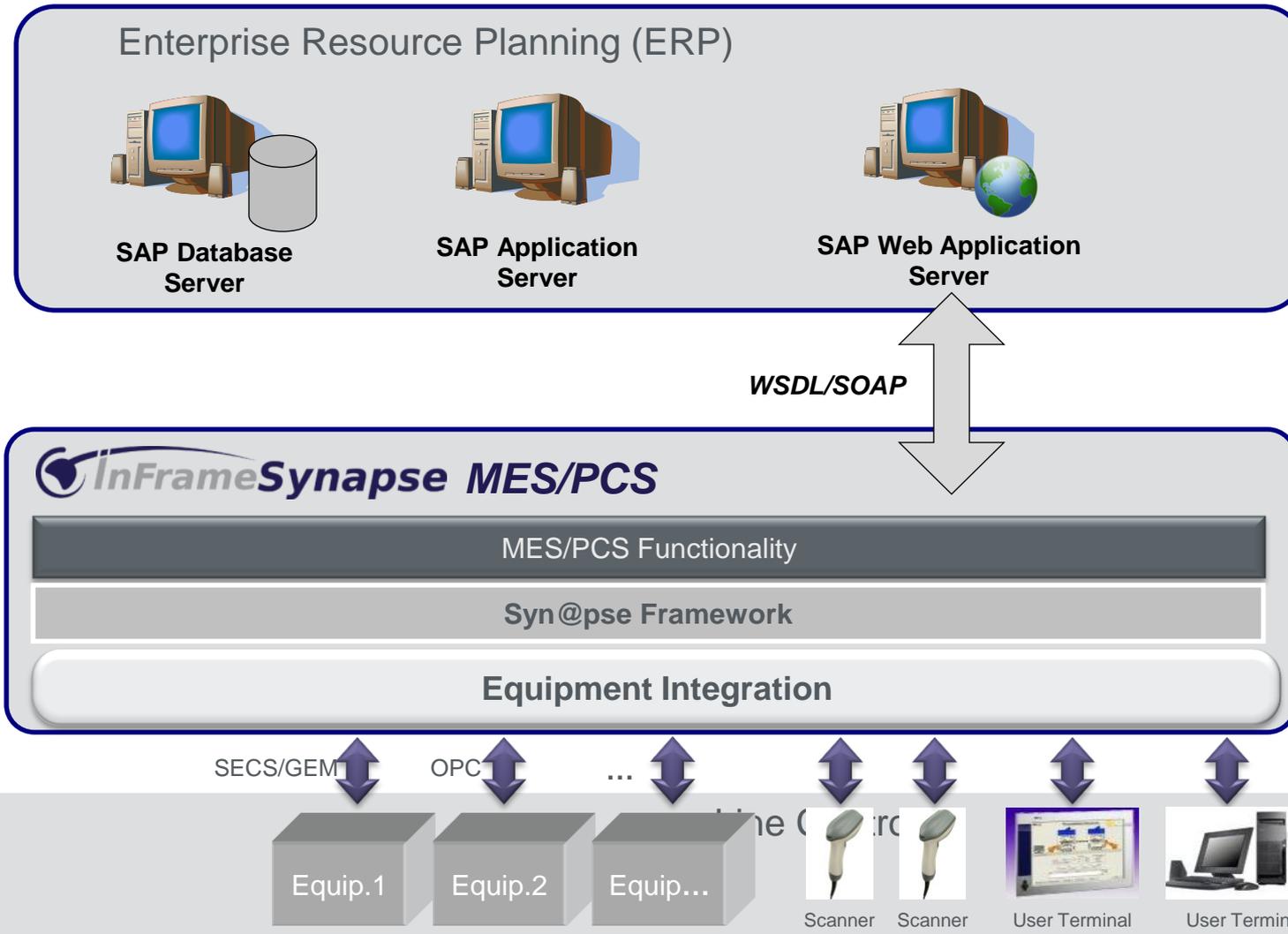
ToolState



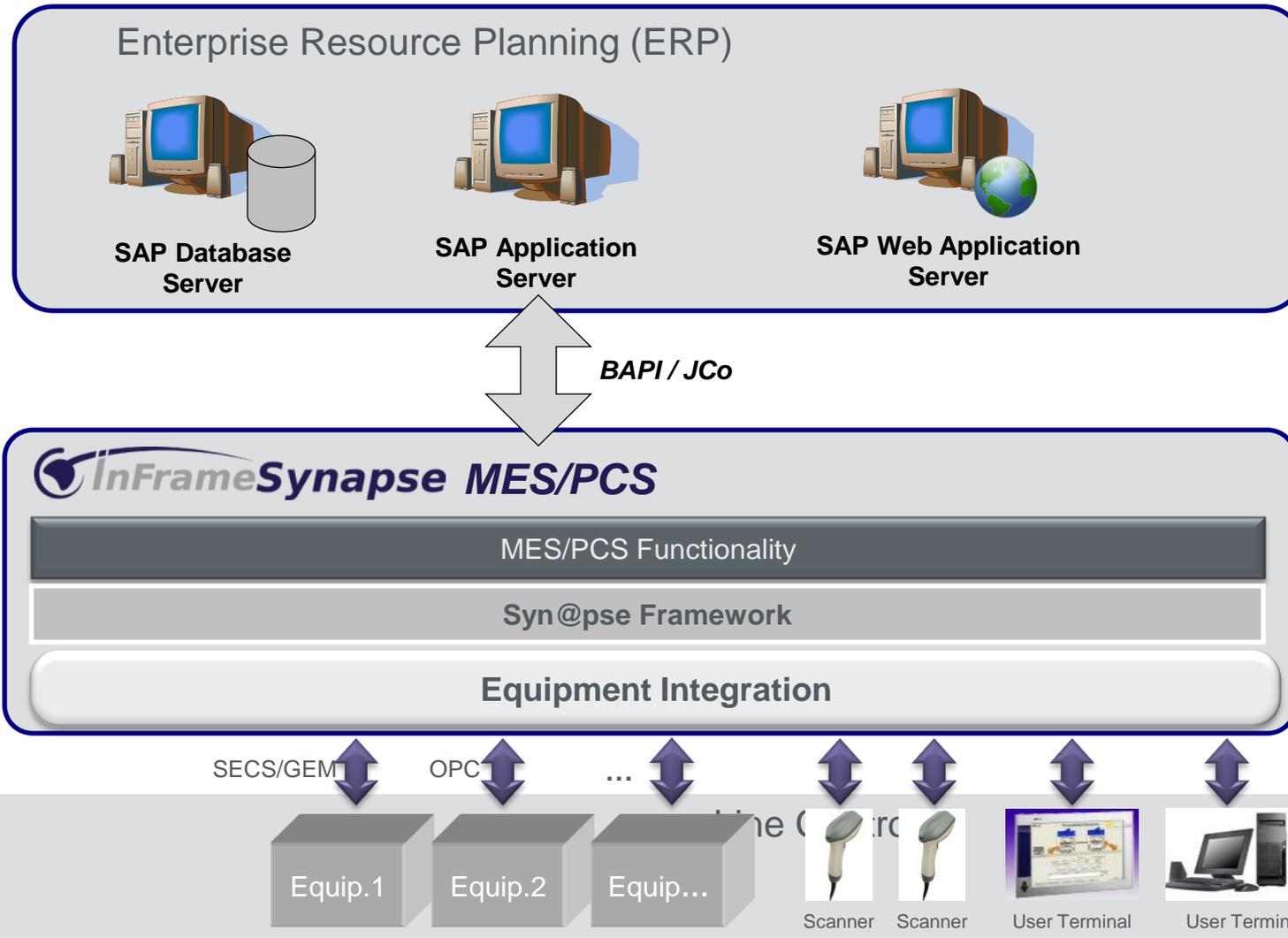
Resource Manager



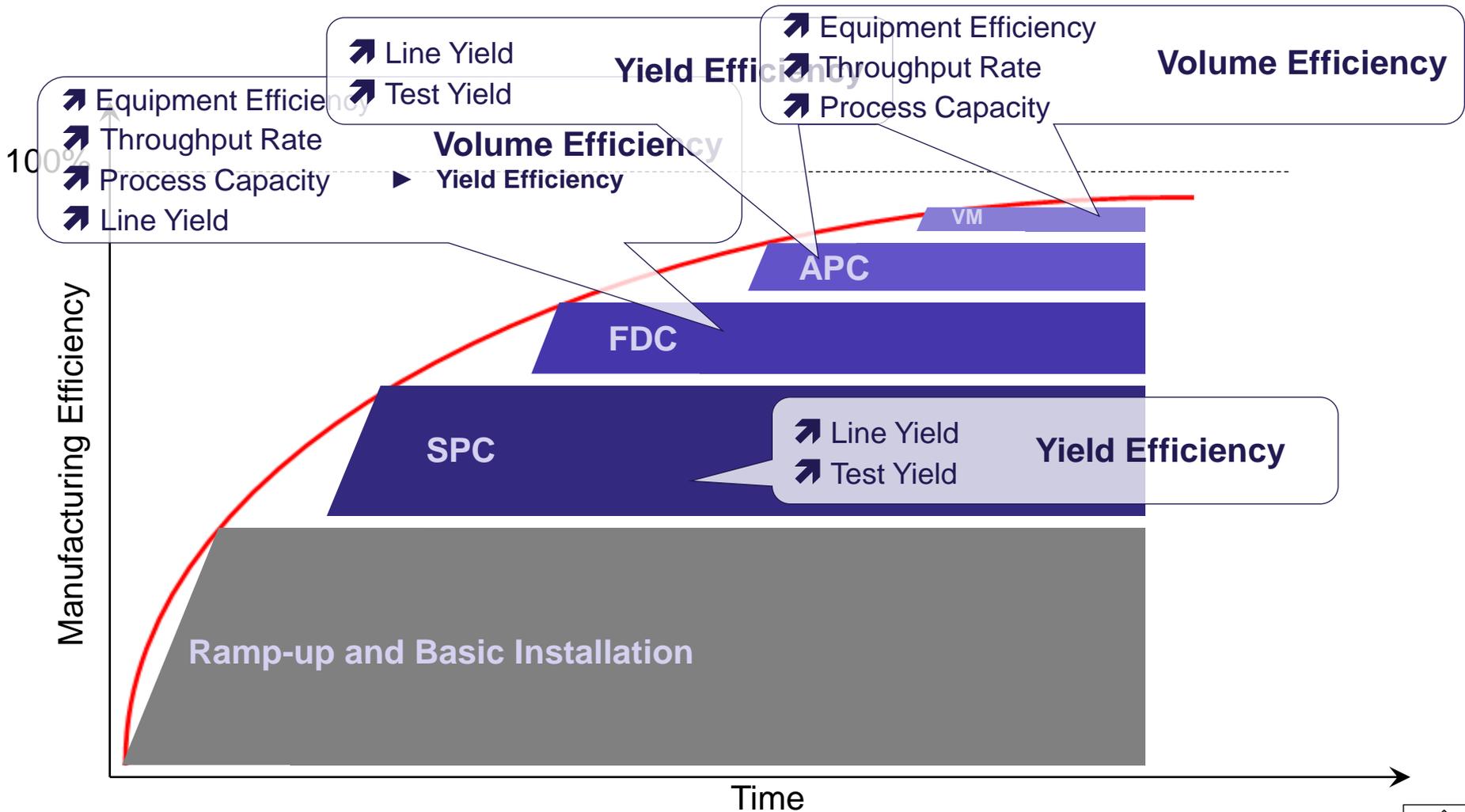
# System Overview (3a): SAP Connectivity Var. 1



# System Overview (3b): SAP Connectivity Var. 2



# Techniques to increase manufacturing efficiency

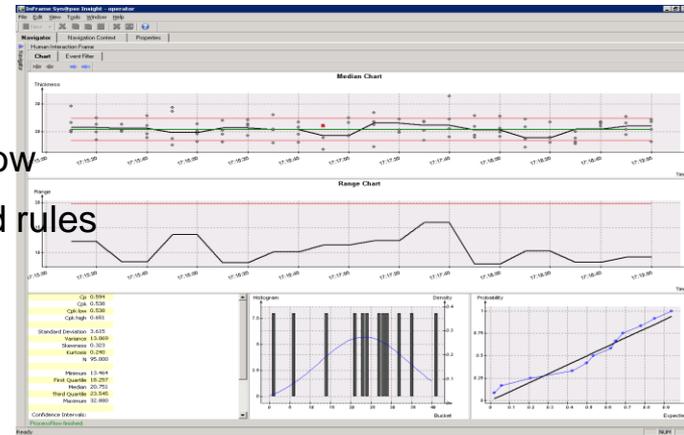


# PCS Components: Statistical Process Control (SPC)

## Customer Value:

### SPC allows to

- control defined process parameters within the process window
- use reaction rules like Western Electric or define customized rules
- online and offline support of control charts
- trigger automated Out of Control Action Plans (OCAPs) to be performed within the InFrame Synapse MES (or any other third-party system)
- configure measurement interval and definition of the SPC chart set up very comfortably fulfilling the VCN4.1 requirements



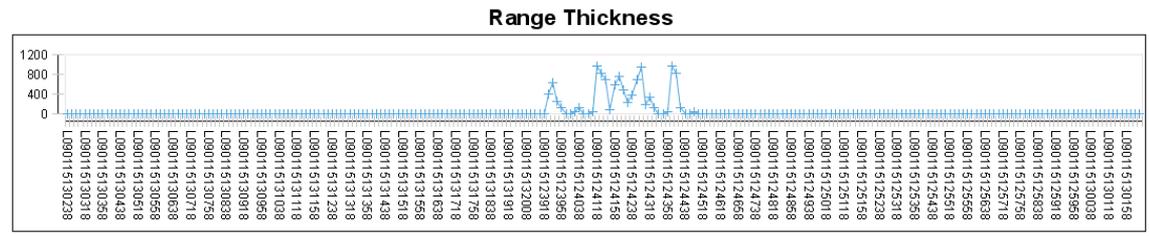
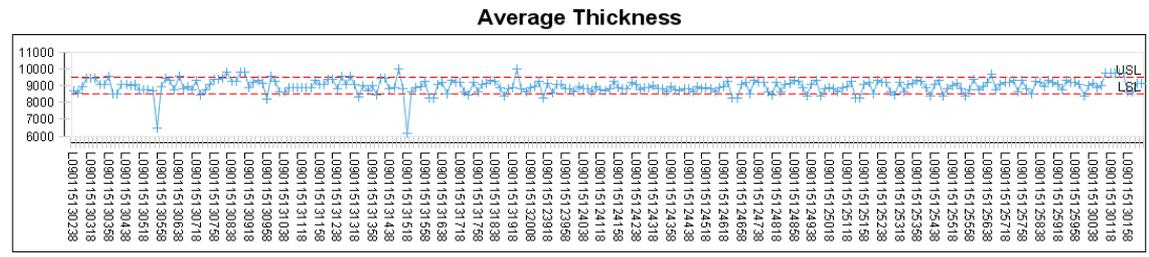
### Technical features:

- X-MR chart, XR chart, XR-median chart, Xs chart, ....
- Functions for definition of control charts
- Powerfull mathematical and statistical features line Cp, Cpk, SPC factors for limits and standard deviation (A2, d2, D3, D4, A3, c4, B3, B4) and statistical functions (process average, average range, etc.)



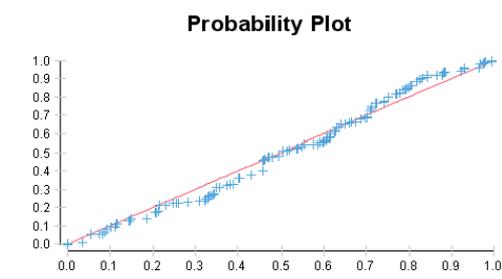
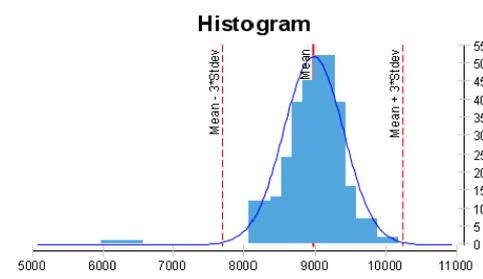
# Customizable web-based reporting

- Consistency of results due to identical calculation base
- Web-based reporting freeware
- One scenario for reporting and online SPC charts
- Interface to be used by any Third-Party Application



CP: 0.393186454206684  
 CPL: 0.364943754701331

CPK: 0.364943754701331  
 CPU: 0.421429153712037



# PCS Components: Process & Factory Diagnostics (1/2)

## Customer Value:

**Process & Factory Diagnostics provides diagnostics capabilities for traced off-line data based on following features:**

- Specification of drill-down paths (tree-based, table based and chart-based) e.g. drill-down from yield data, through process steps directly into the historical equipment data or online monitoring of the equipment)
- Visualization of data including powerful interactive configuration in conjunction with process context
- Correlation analyses to learn about the relationship between multiple process parameters
- Principle Component Analyses to learn about the strengths of relationships between process parameters and process characteristics

### Technical features:

- Self adapting tracing database making any future schema administration of the database unnecessary enhancing the standard tracing functionality of the MES
- Automatically adapting filtering based on the adaptive database schema.
- During Data Tracing the improvement of data quality and aggregation of data is performed based on flexible specified rules.

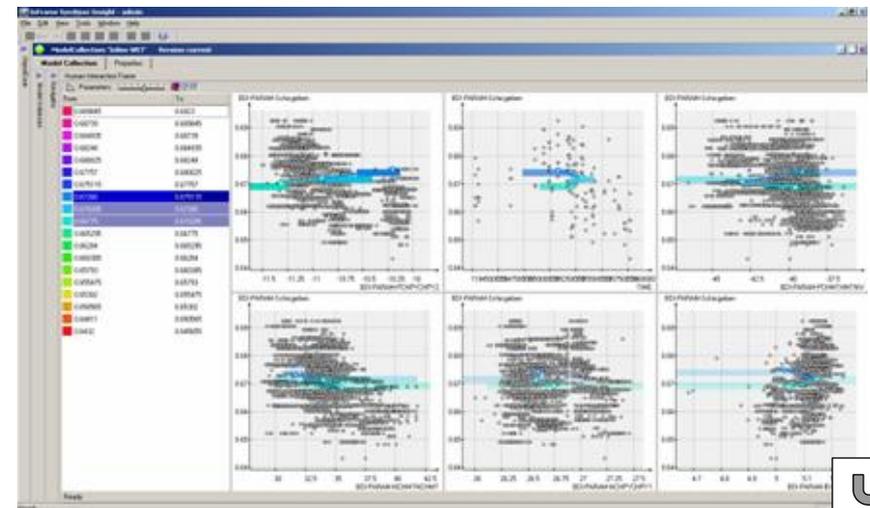
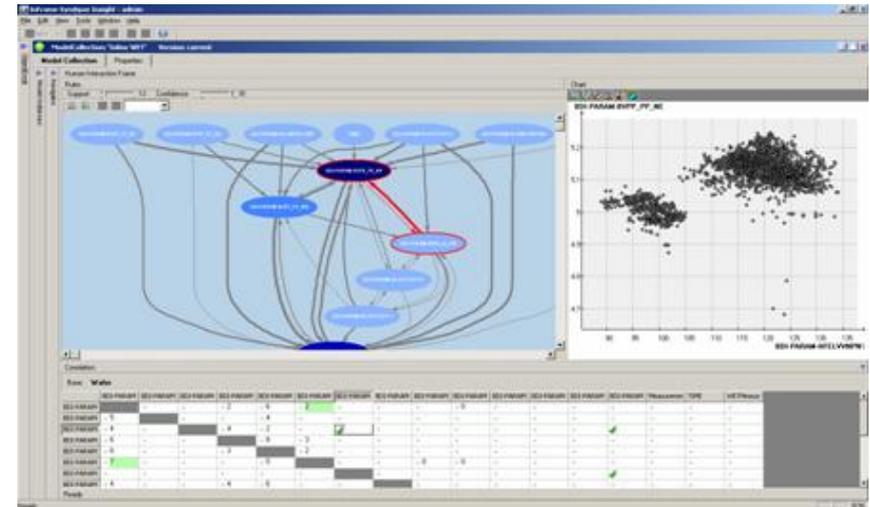


# PCS Components: Process & Factory Diagnostics (2/2)

## Correlation analysis

### Features:

- Interactive Correlation Editor
- Dependencies Graph
- Exploration of associations
  - between process data and quality measurements
  - between processes
- Prediction models: Integration of prediction into process monitoring



# PCS Components: Fault Detection & Classification (FDC)

## Customer Value:

FDC provides the following main functionalities:

- Flexible offline definition of univariate and multivariate FDC models
- Manual and automatically calculated univariate limits and multivariate limits (process tunnels)
- Powerful tools to specify process tunnels and end-point monitoring
- Automated notification in case of excursions
- Context-sensitive online monitoring of hundreds of equipment parameters simultaneously based on specified FDC models



## Technical features:

- Interpolation of sampled data based on linear interpolation, different kinds of splines and Fourier transformation.
- Powerful Visualization Charts for equipment data and alarms.



# PCS Components: Advanced Process Control (APC)

## Customer Value:

### APC provides the following main functionalities:

- off-the-shelf scenario including the required models in order to setup and execute Feed Forward / Feed Backward or Run-by-run controllers.
- Based on Design of Experiment (DoE) data (from inline-metrology, recipe setup) it is possible to calculate the functions of these controllers (controller setup).
- After the setup further on these controllers are applied if triggered by the appropriate InFrame Synapse MES modules in order to calculate the appropriate parameter adjustments.



### Technical features:

- It is possible to specify controllers with single input and multiple input parameters as well as single output and multiple output parameters.





# Thank you for your attention

Contact:

acp-IT AG

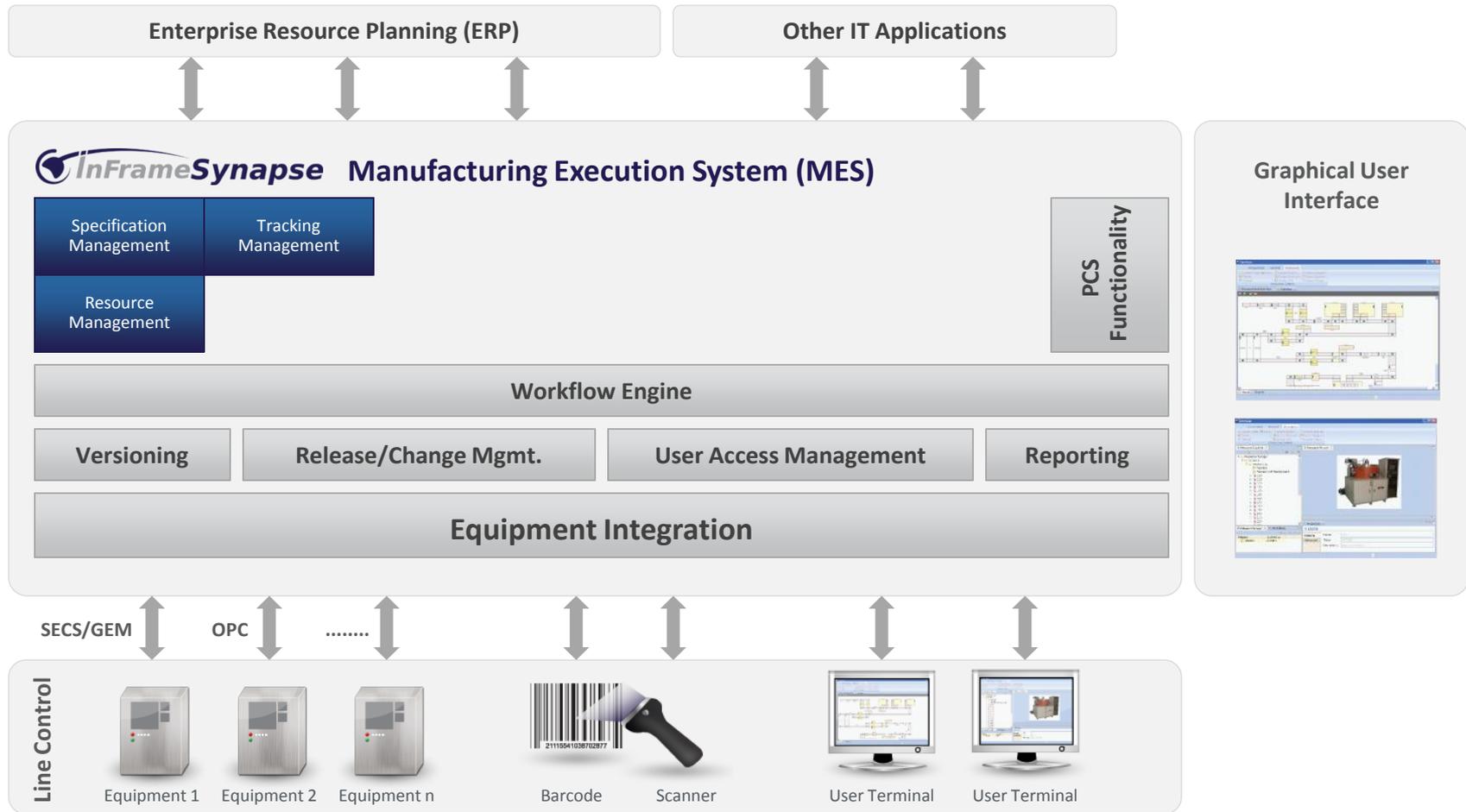
Handwerkstrasse 29, 70565 Stuttgart

Telefon +49 (0)711 782 40 89-0

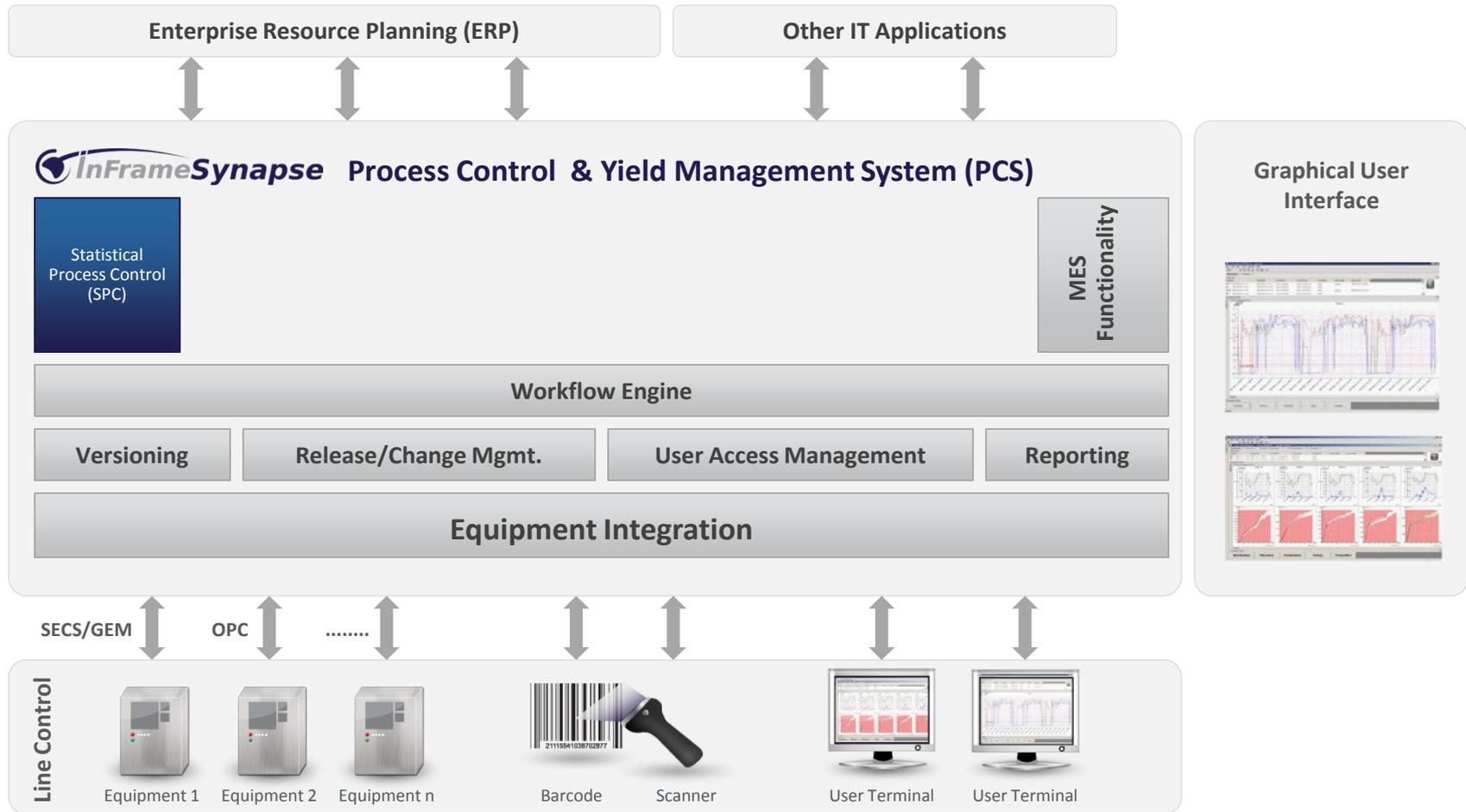
Telefax +49 (0)711 782 40 89-10

eMail [info@acp-IT.com](mailto:info@acp-IT.com)

# InFrame Synapse Manufacturing Execution System (MES)

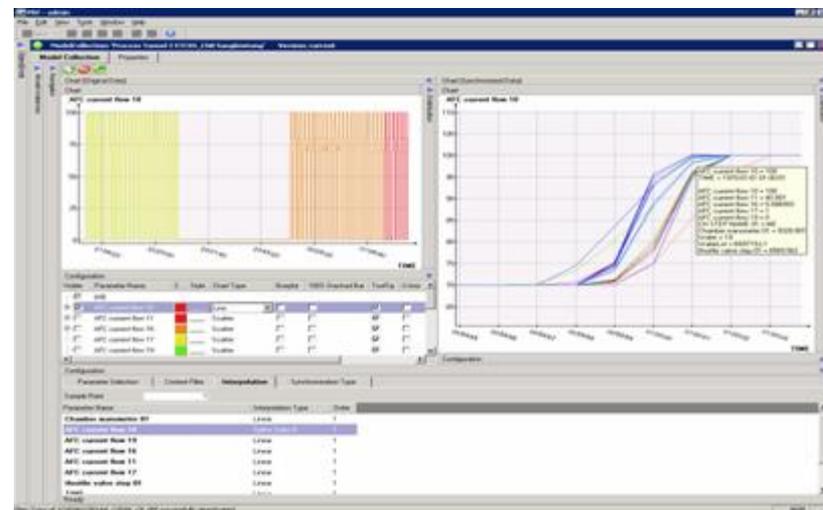
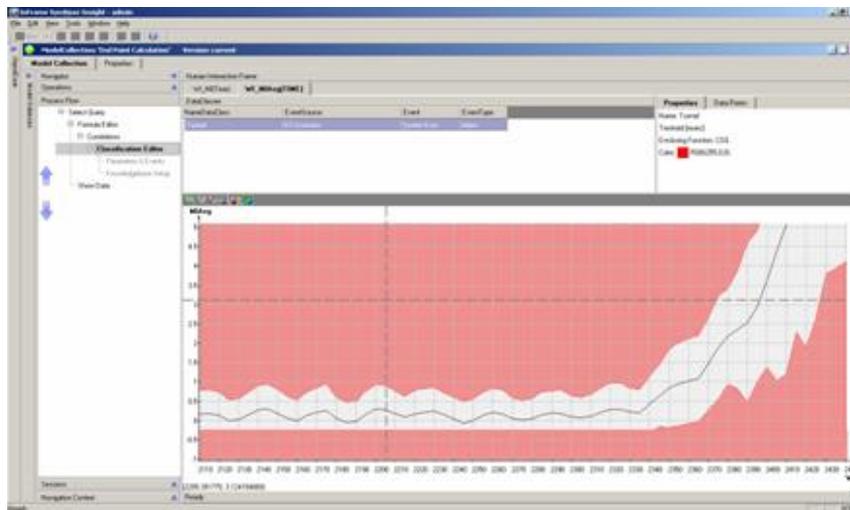
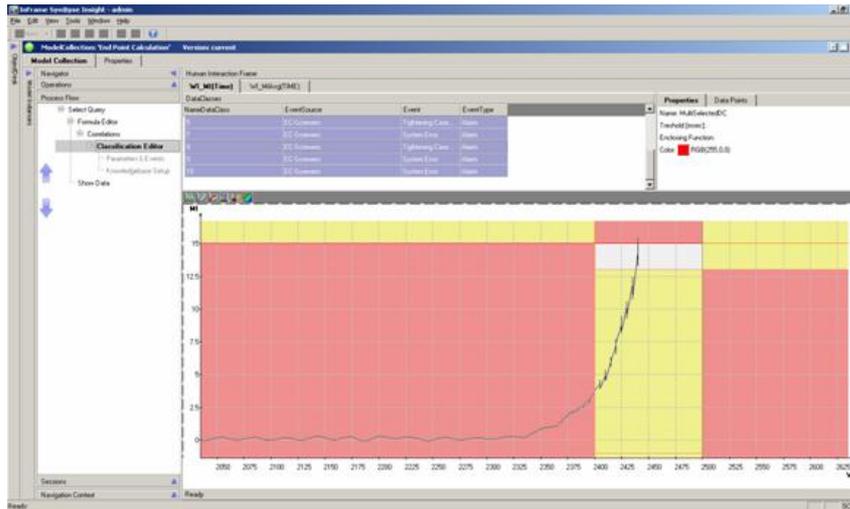


# InFrame Synapse Process Control System (PCS)

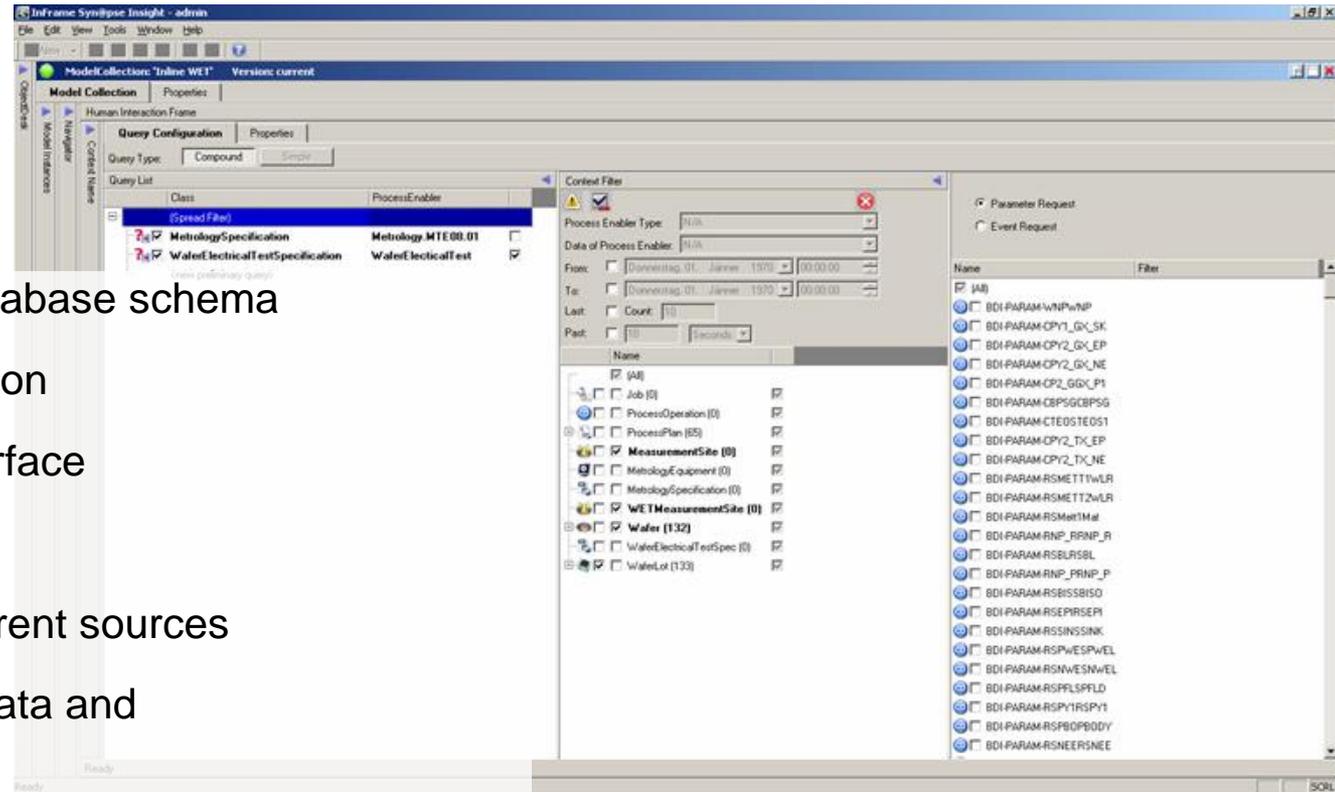


# Immediate detection of process excursion through online endpoint monitoring and process tunnels

- Customizable endpoint analysis
- Automated calculation of process tunnels
- Online monitoring of endpoints and process tunnels
- Automated notification in case of excursions



# Factory-wide collecting and filtering of process data and events



Automatically adapting database schema

→ No schema administration

Adaptive filtering user interface

compound filters

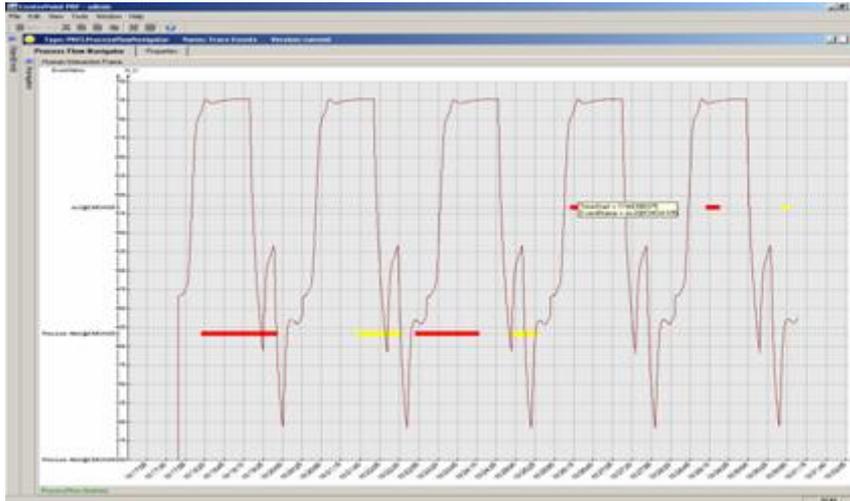
→ Combining data of different sources

Management of process data and process events

→ Merged with process context information



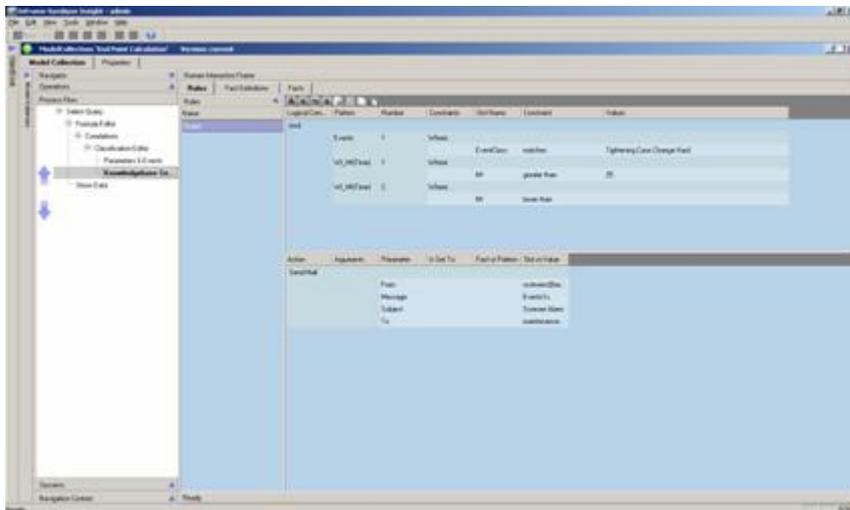
# Combined online parameter monitoring and event monitoring



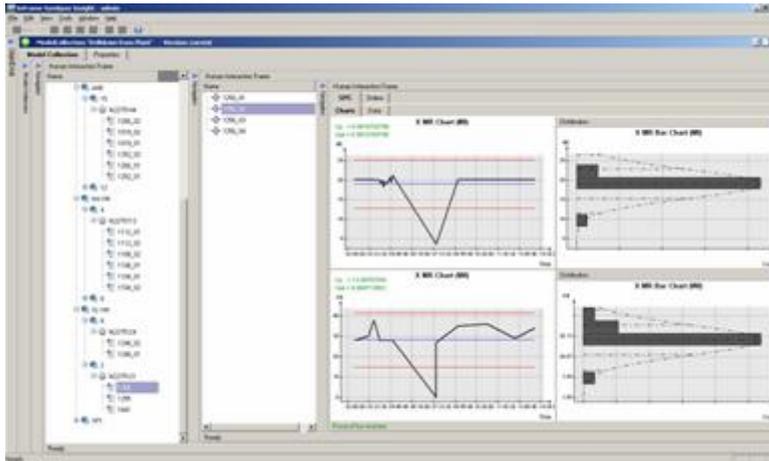
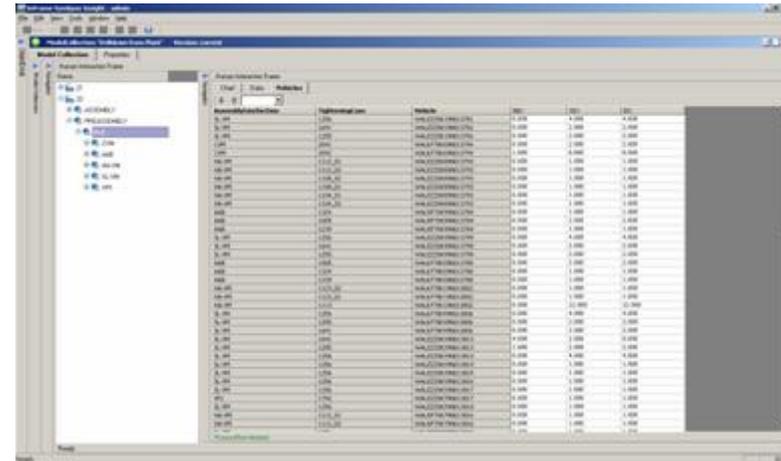
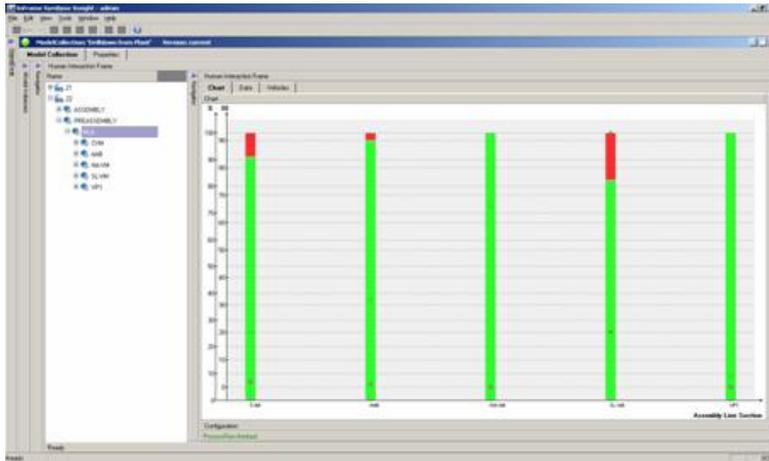
Combined visualization of events and parameteric data

Graphical Rule Editor

- combined conditions on parameteric data and events
- customizable automated actions in case of rule excursions



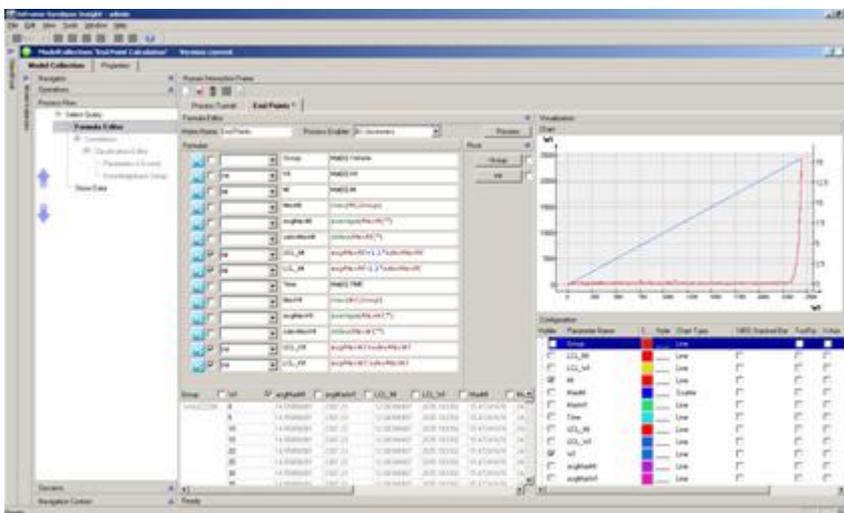
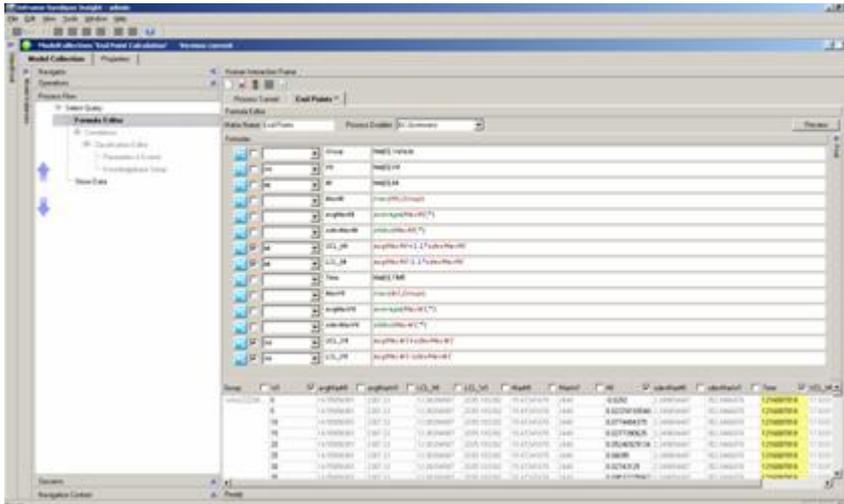
# Drill-Down from the factory to the single equipment



- customizable drill-down paths
- any combination of visualization elements
- coupling of online- and offline-data



# Fast adaption due to changing requirements



Interactive definition of mathematical and statistical models

Off-the-shelf libraries with mathematical and statistical models

Features for process monitoring and control

→ EWMA, Outlier-Filter, Cp, Cpk, ...

Derived (Virtual) parameters

Integration of context-specific process properties

Logical process model

Process abstraction from single equipment to whole Factory

