Modularisierung in der Prozessindustrie

Prof. Dr.-Ing. Leonhard Urbas

VVD, 16.3.2018

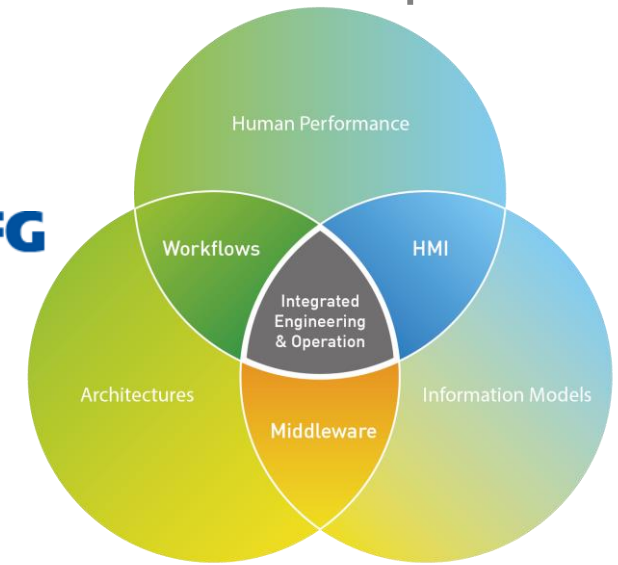
PROCESS CONTROL SYSTEMS
PROCESS SYSTEMS ENGINEERING

DRESDEN concept
Exzellenz aus Wissenschaft und Kultur

Research Topics Chair PCS & PSE Group

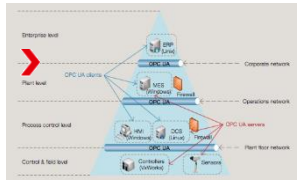
PROCESS CONTROL SYSTEMS | PROCESS SYSTEMS ENGINEERING

*Computer Aided **Integrated Engineering** of **Process Systems** in Multi-Disciplinary Teams*



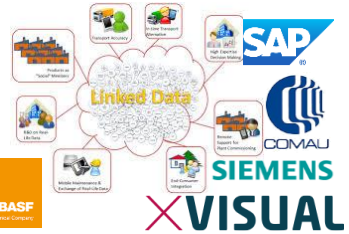
*Decision Support for **Commissioning, Operation, MRO** in Process Industries*

Semantic Real Time Integration

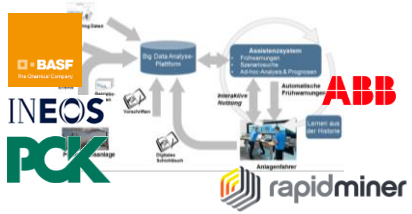


Plug-and-Produce Architectures

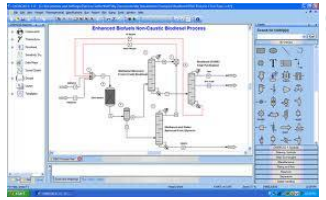
Digital Plant

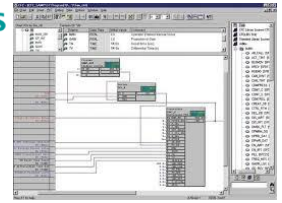


Smart Analytics



Information Modelling and Transformation





The challenge for manufacturing

(Steckenreiter, 2016)

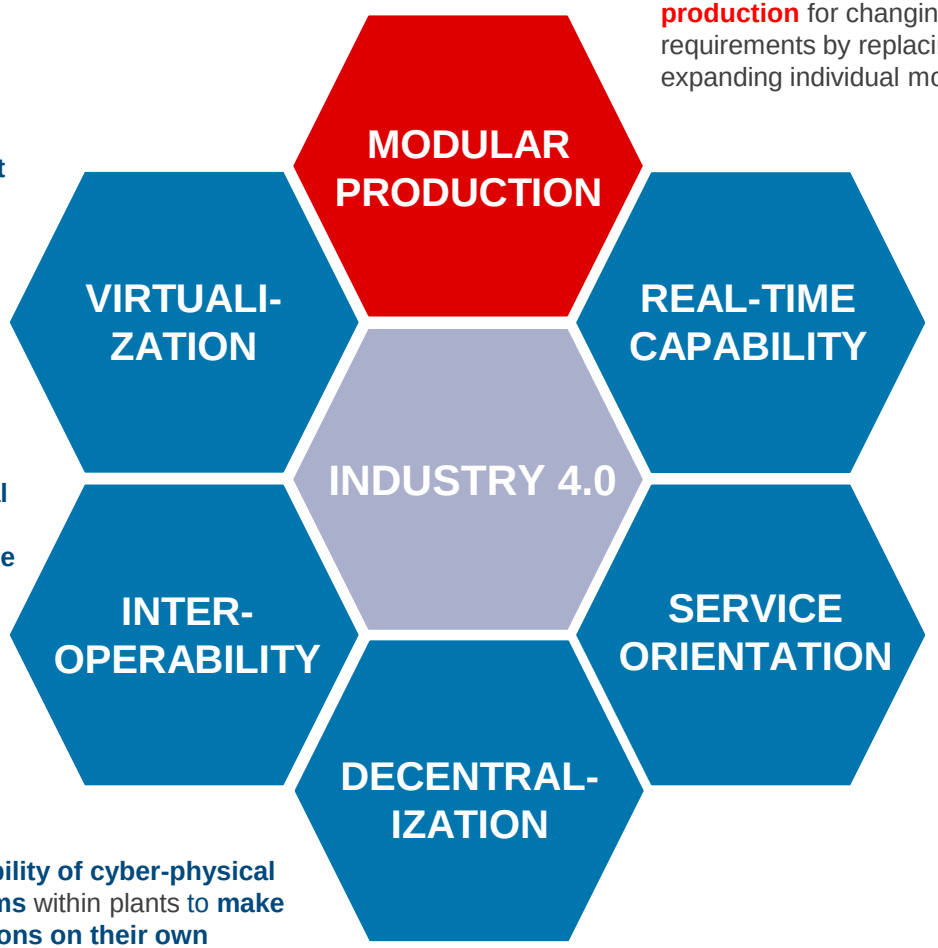
- **Local production**
  - Demand for regional/local production versus imported chemicals and drugs
- **Lower volumes**
  - More products with reduced volume per product- Customization
- **Higher volatility**
  - Lead time reduction to quickly address market demands
- **Higher productivity**
  - Economic pressure in manufacturing will become relevant in all segments

Manufacturing of the future: Think smaller, more flexible, yet cost competitive

Digitalization and Modularization

Flexible adaptation of smart production for changing requirements by replacing or expanding individual modules

A virtual copy of the plant which is created by linking sensor data (physical processes) with **virtual plant and simulation models**



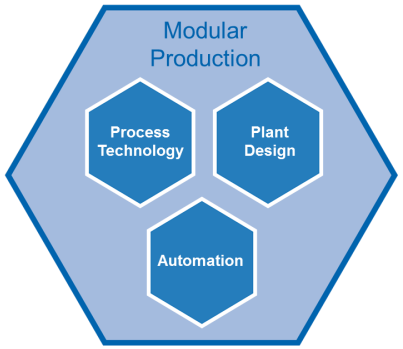
The **capability to collect and analyze data** and provide the derived insights sufficiently quick

The **ability of Cyber-Physical Systems**, humans and plants **to connect and communicate with each other.**

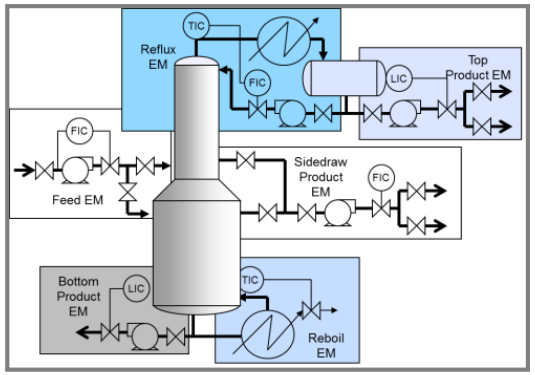
Offering of services (of cyber-physical systems, humans or plants) via the **Internet of Services**

The **ability of cyber-physical systems** within plants to **make decisions on their own**

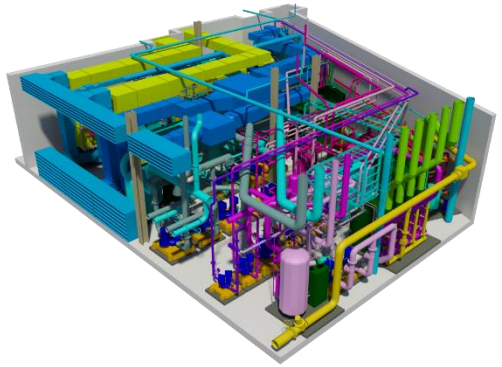
Faster time to market ?
Modularization in all disciplines of the asset value chain !!!



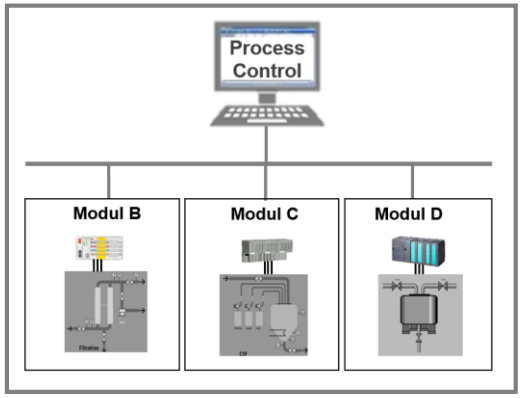
Process Technology



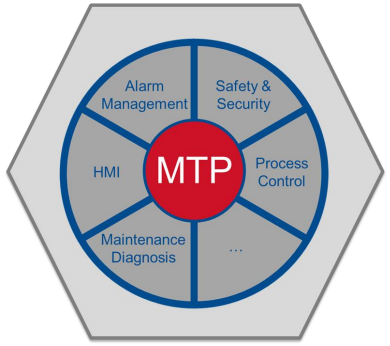
Plant Design



Automation



Process Module



Skid (Module)

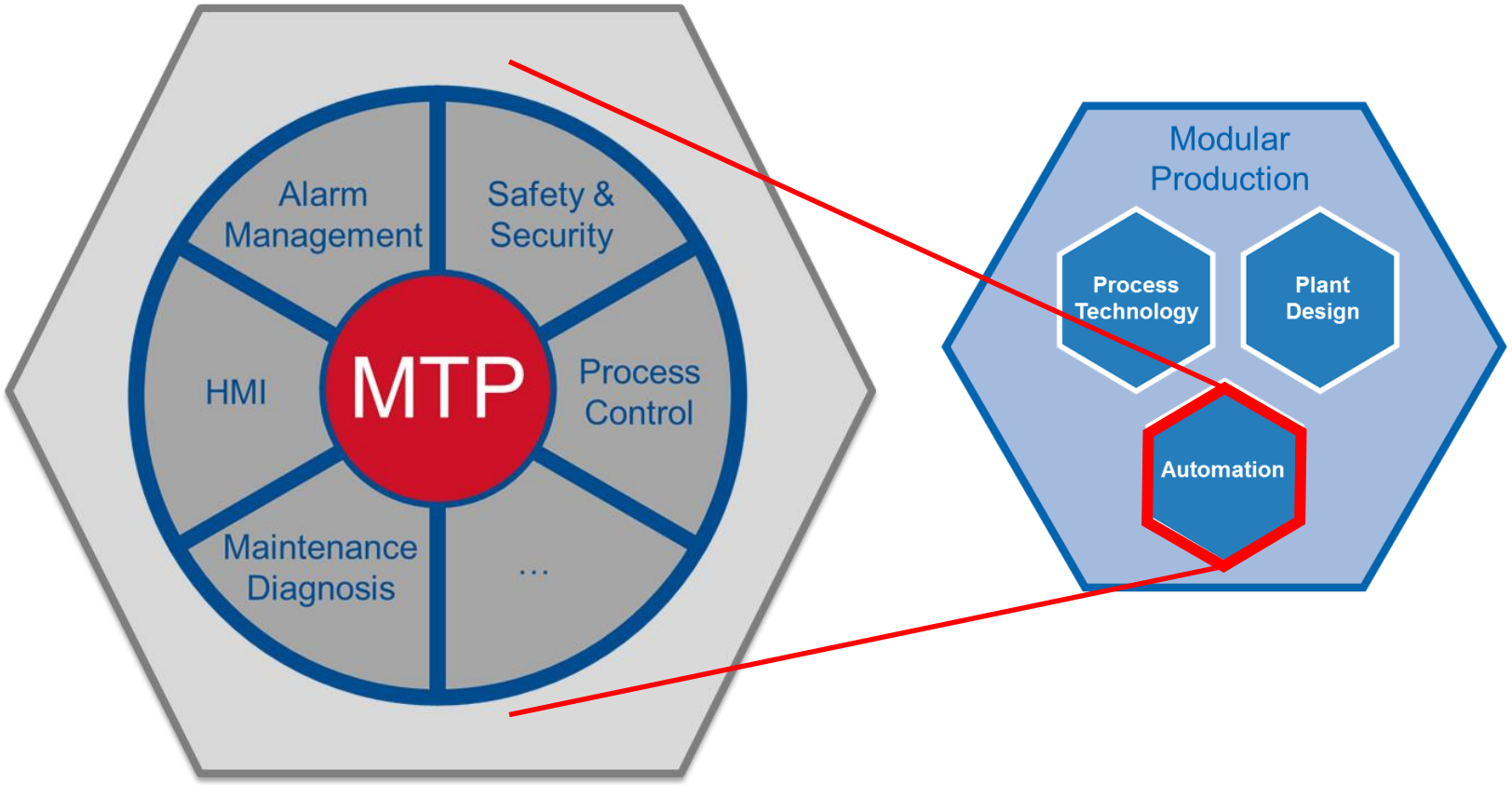
Production plant (Module)

Package Unit (Module)

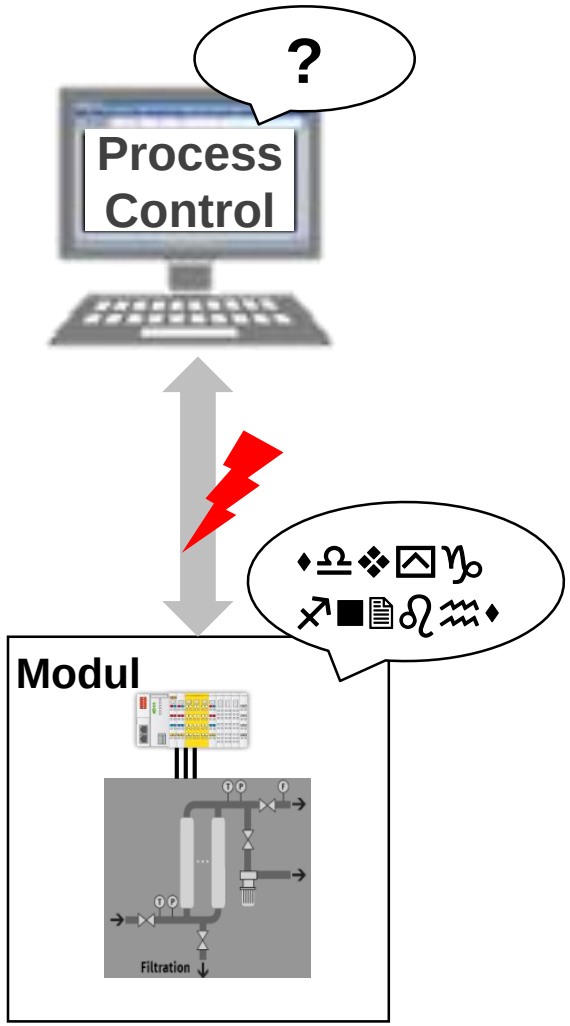
Modularization in Process Automation

Module Type Package (MTP)

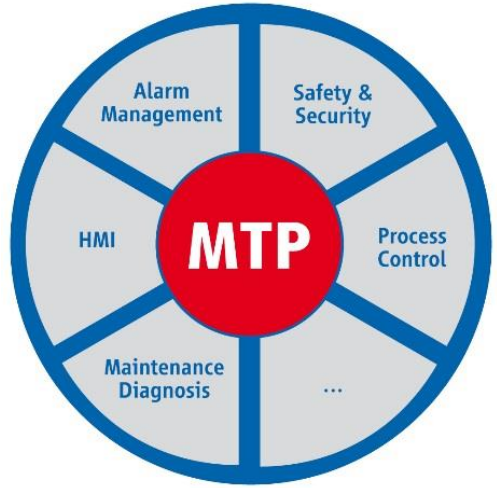
a standardized non-proprietary description of modules as enabler for **orchestration based plug-and-produce strategies**



Module Type Package

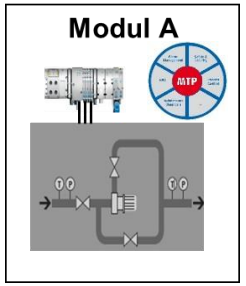


- a digital vendor-independent description of a single module
- contains all information to integrate a fully automated module in the Process Control Level
  - Communication technology
  - Operator interface (HMI)
  - Functionalities (Services) and their interfaces
  - Interfaces to diagnosis and maintenance information

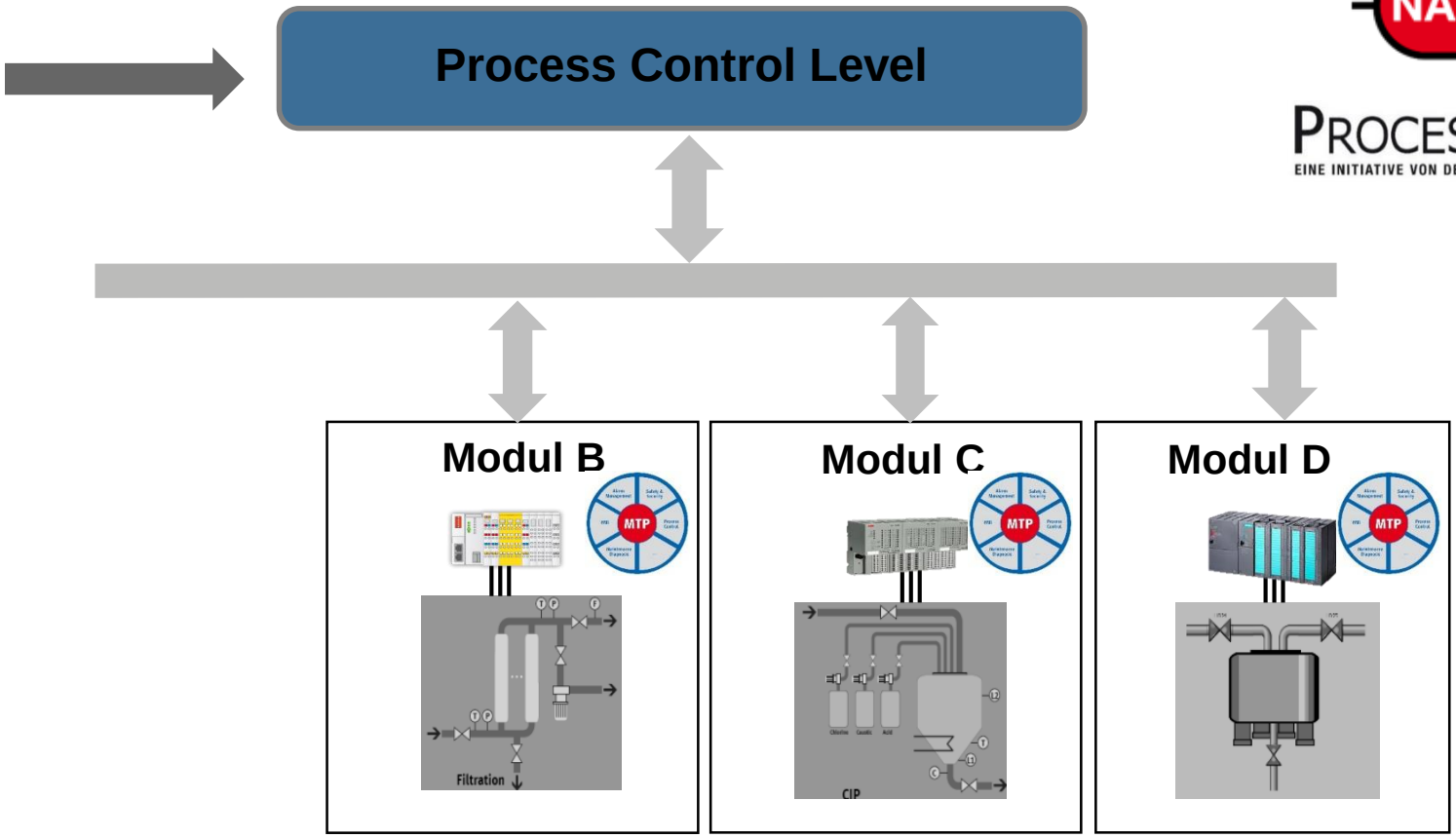


Modular Automation Principles

Module Engineering



Plant Engineering

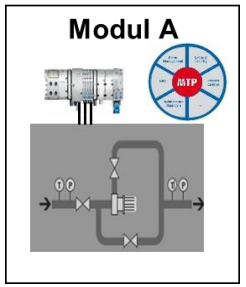


Modular Automation Principles

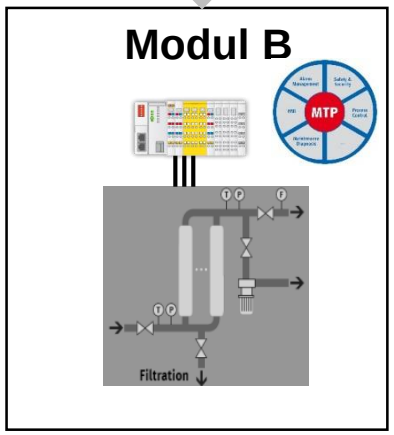
Module Engineering

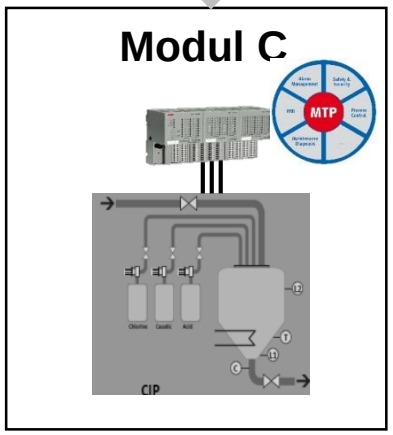
Plant Engineering

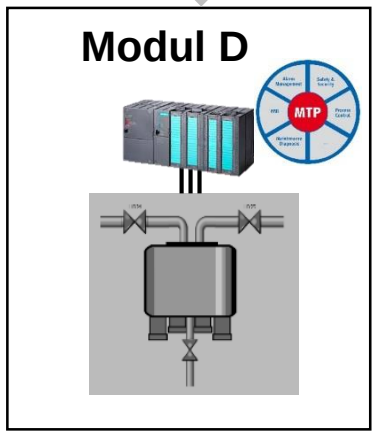
Import



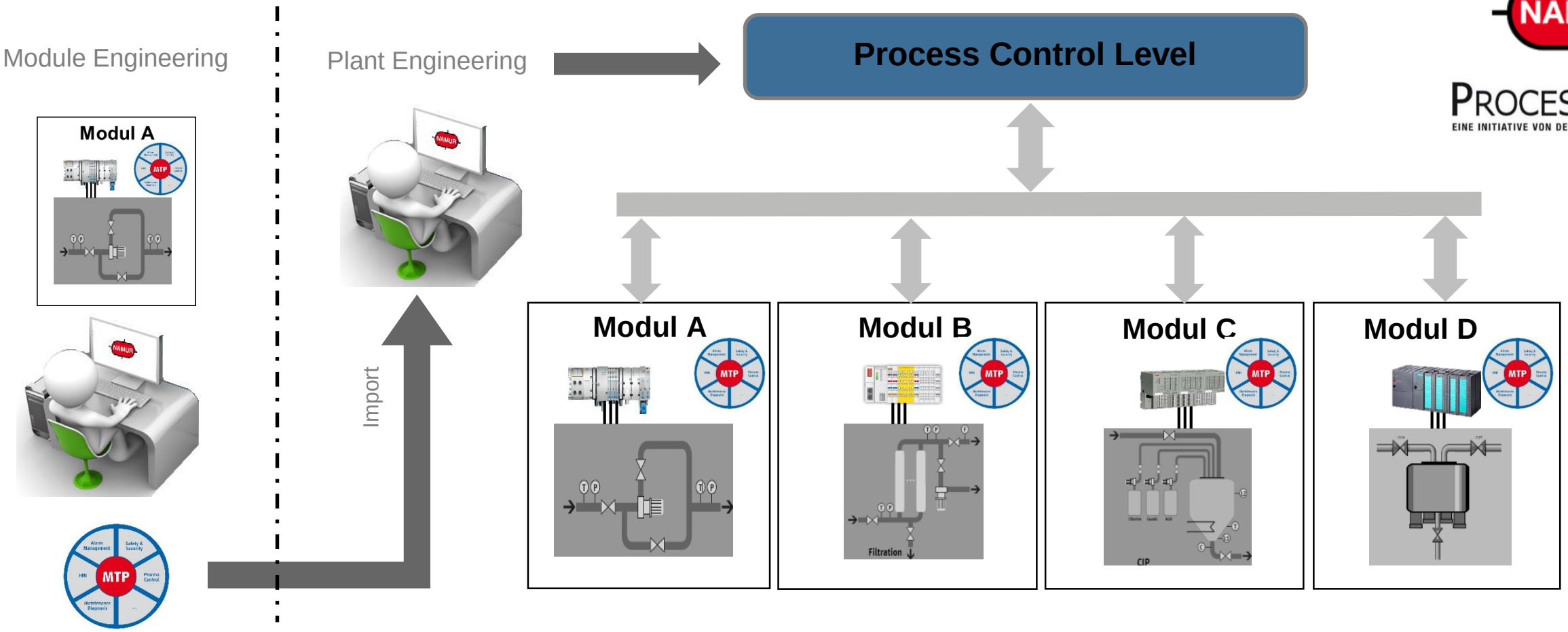
Process Control Level







Modular Automation Principles



MTP Project Members, Representatives

Automation/DCS/MES

EMERSON
YOKOGAWA
ProLeiT
Rockwell Automation
SIEMENS
werum SOFTWARE & SYSTEMS
ABB
Honeywell
optimize! softing
Schneider Electric
SAFETY NONSTOP
HIMA

Sensors / Actors

SAMSON
KROHNE
Endress+Hauser

Plant Owner / Operator

CLARIANT
BASF We create chemistry
EVONIK INDUSTRIES
BILFINGER
MERCK
SANOFI
invite
covestro
BAYER
LANXESS Energizing Chemistry

Controller / Remote I/O

STAHL
PHOENIX CONTACT
WAGO
PEPPERL+FUCHS
FESTO
TURCK
Weidmüller

Modul- / Plant Manufacturers

Finesse
GEA engineering for a better world
sartorius
AERZEN
AIR LIQUIDE GLOBAL E&C SOLUTIONS
Linde
Outotec
ZETA EVOLUTION OF TECHNOLOGY
spirotec
BIOENGINEERING

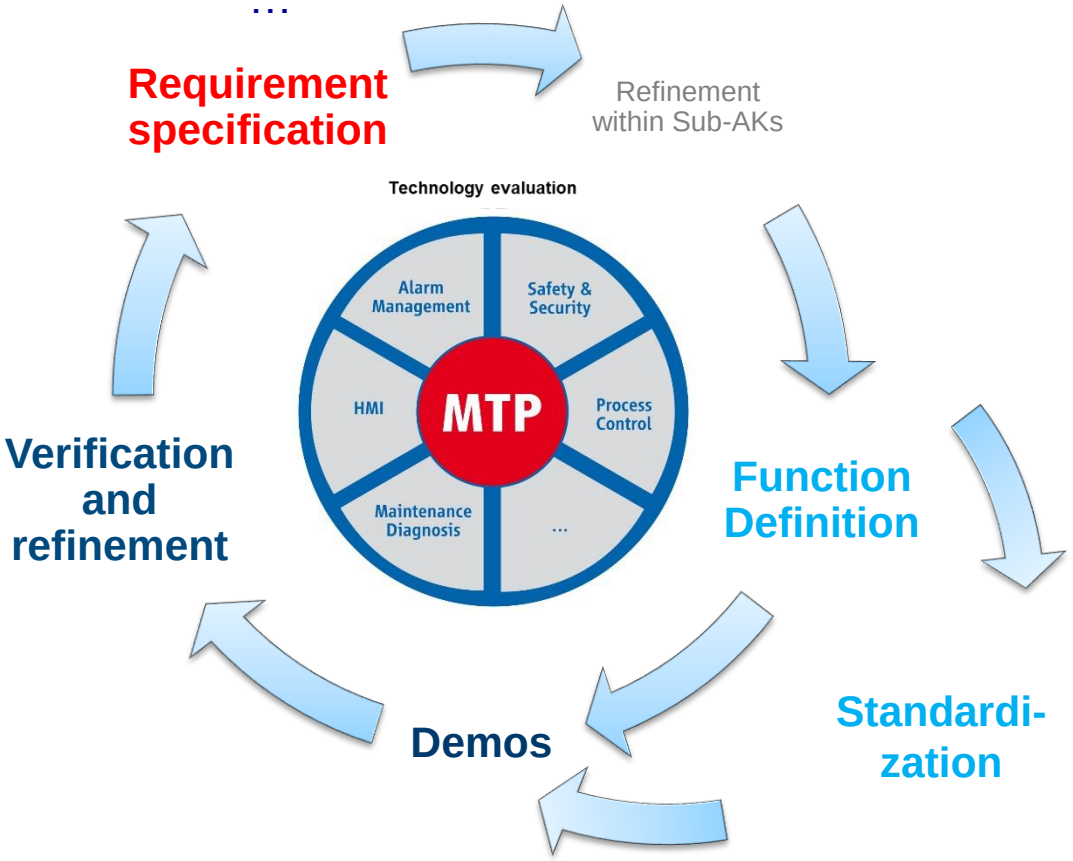
Universities / Associations

ZVEI: Die Elektroindustrie
NAMUR
PROCESSNET EINE INITIATIVE VON DECHEMA UND VDI-GVC
ISPE
TECHNISCHE UNIVERSITÄT DRESDEN
VDMA
HELMUT SCHMIDT UNIVERSITÄT Universität der Bundeswehr Hamburg
technische universität dortmund
RWTH RHEINISCH-WESTFÄLISCHE TECHNISCHE HOCHSCHULE AACHEN
DKE VDE DIN
VDI

ZVEI: Die Elektroindustrie
NAMUR
PROCESSNET EINE INITIATIVE VON DECHEMA UND VDI-GVC
ExxonMobil ?

Agile Approach of MTP Development

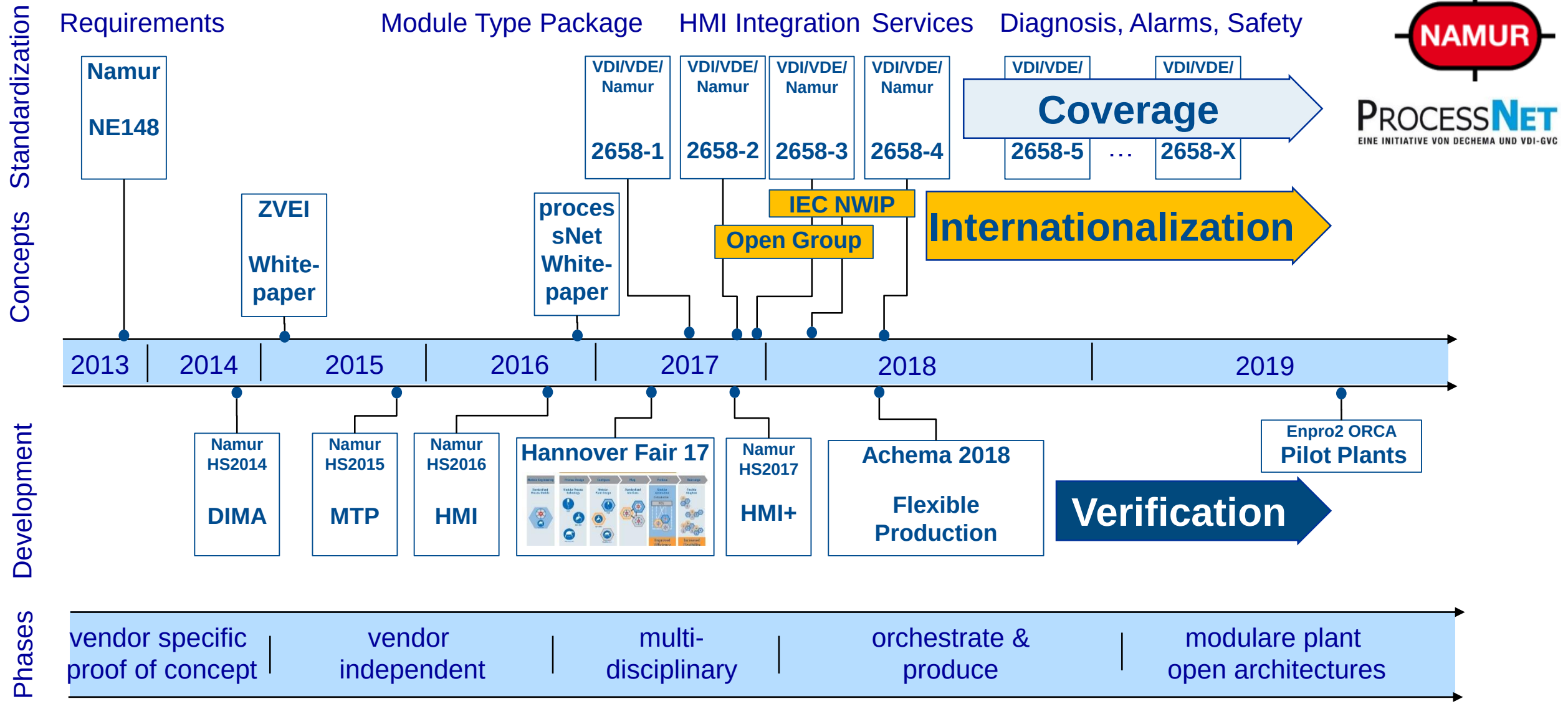
Iteration 1: MTP Architecture & Principles
Iteration 2: Human Machine Interface
Iteration 3: HMI Library
Iteration 4: Services
…



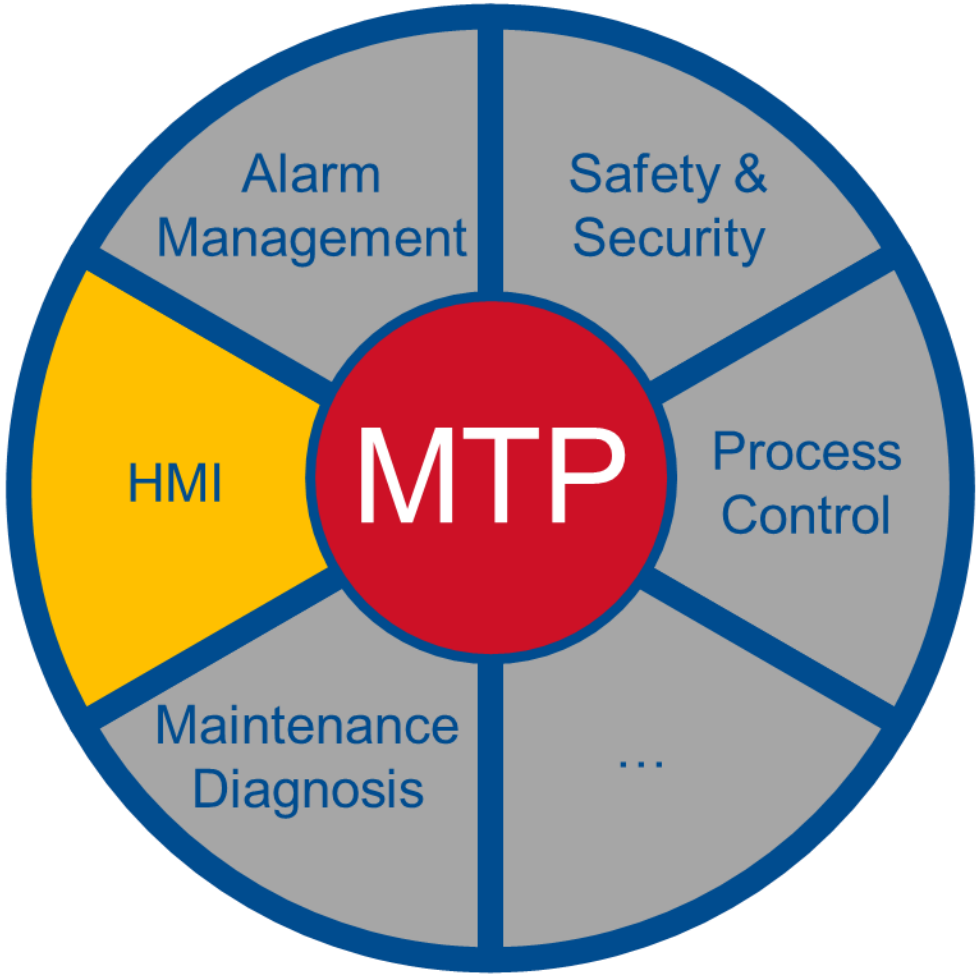
VDI/VDE/ Namur 2658-1
VDI/VDE/ Namur 2658-2
…

VDI/GVC 2776-1
…

Milestones & Strategies Module Type Package Specification and Standardization



MTP Slices: Human Machine Interface



Current Status HMI-Level

Harmonized view

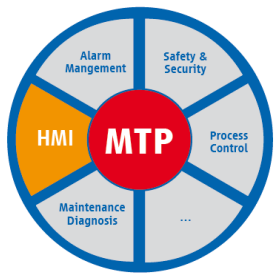
via customized libraries from the automation supplier!

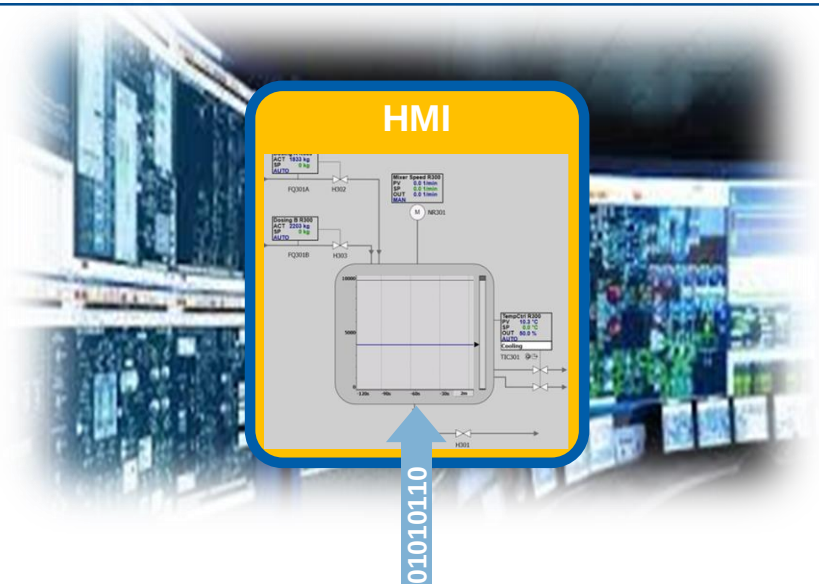
Formal description

Proprietary view of the modules

HMI
Process Control
DCS/PCS

HMI
PU's, SKID's

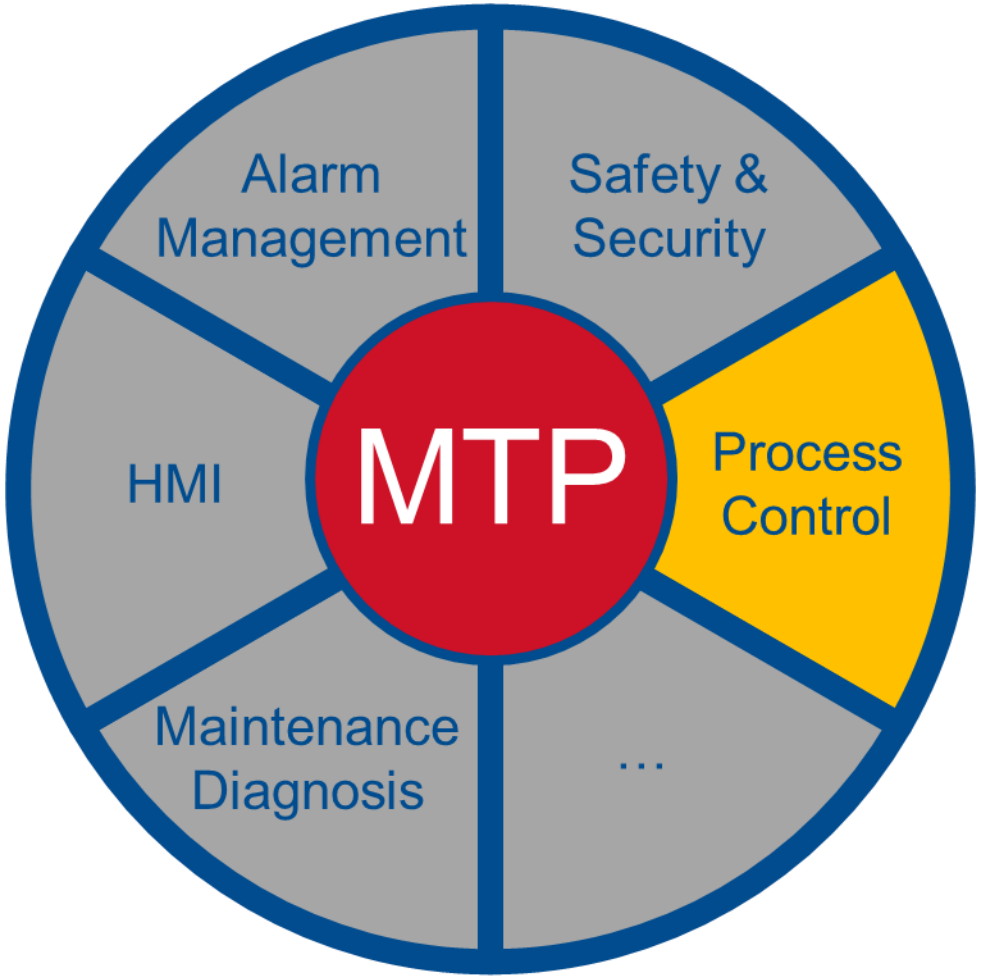




Production plant (Module)

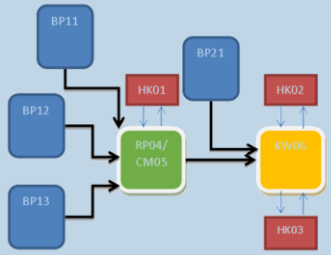
Package Unit (Module)

MTP Slices: Process Control



Current Status Process Orchestration

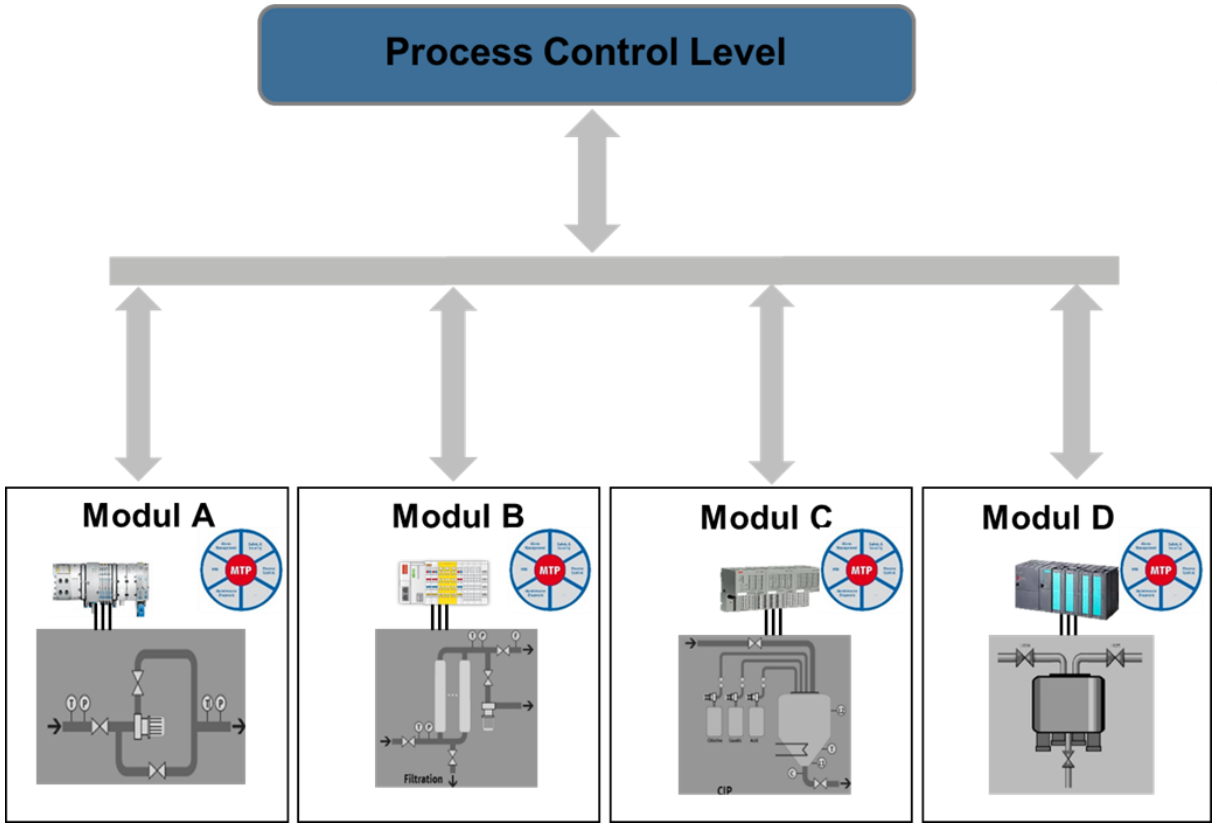
- **Orchestration of services:**



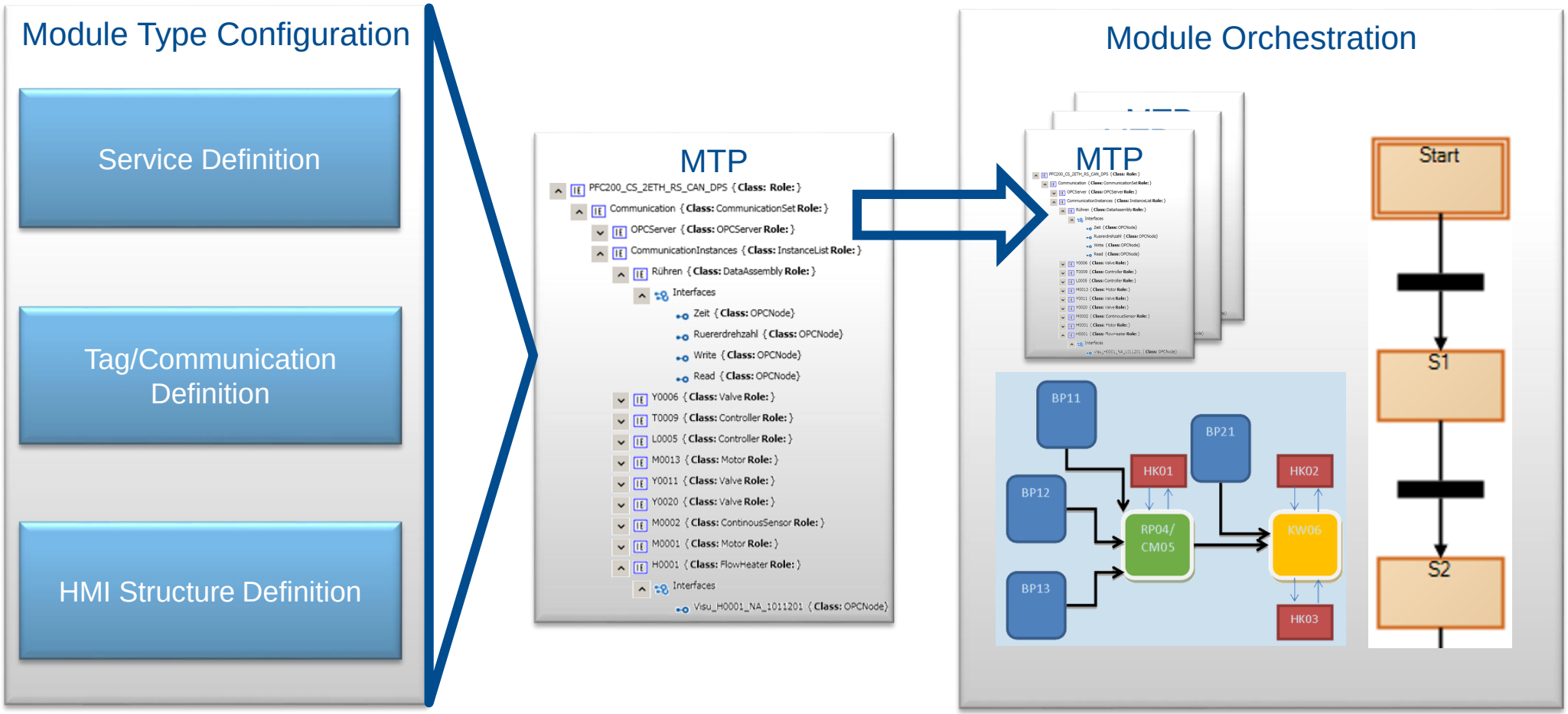
BPXX - Vorlagebehälter
RPXX - Rührreaktor
CMXX - kontinuierlicher Mischungsreaktor
KWXX - Destillation
HKXX - PUs für Heizen und Kühlen

- **Service oriented communication:**
  - Command (e.g. tempering)
  - Status (e.g. Run)
  - Service properties (e.g. temperature, limits)

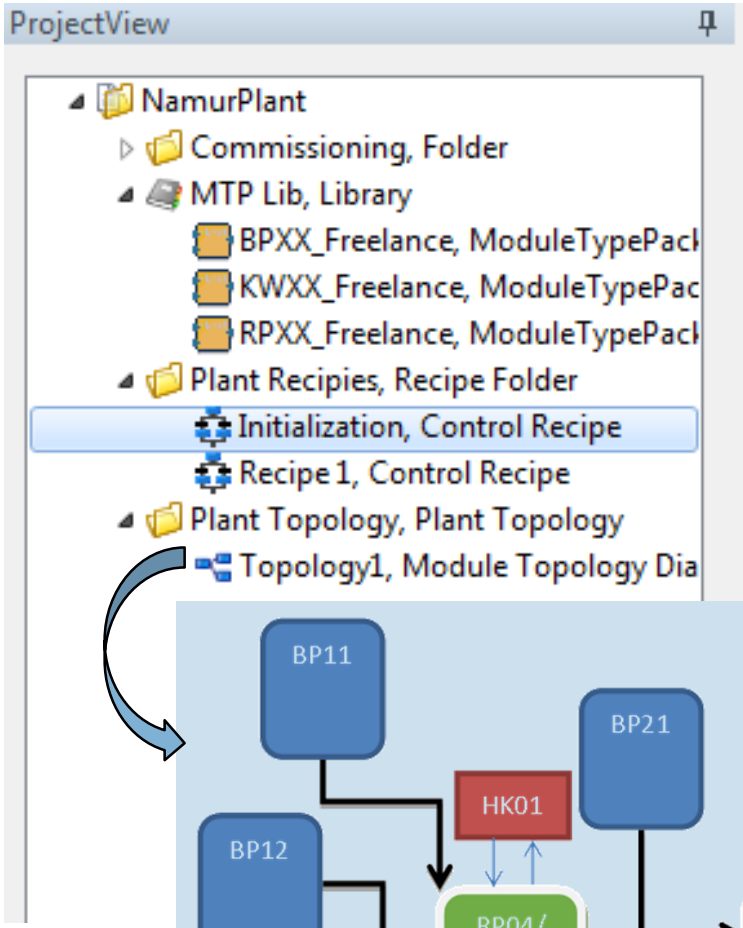
- **Services controlled by status model:**
  - State model IEC 61512 ed. 2

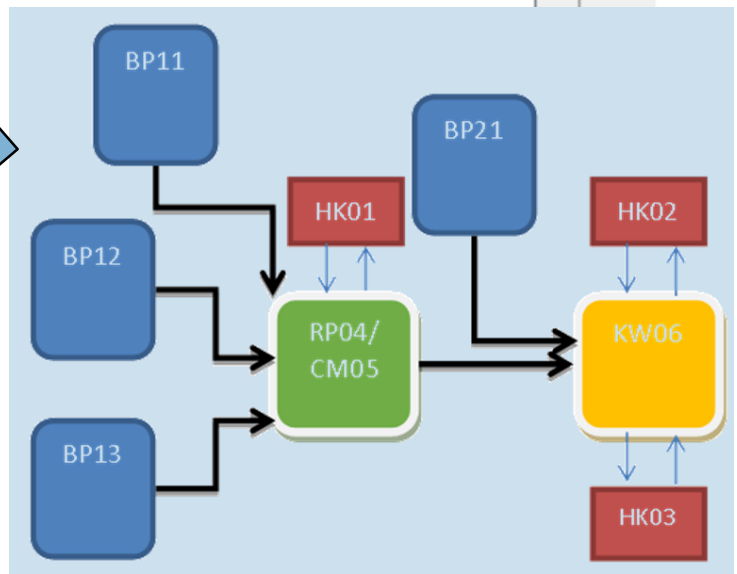


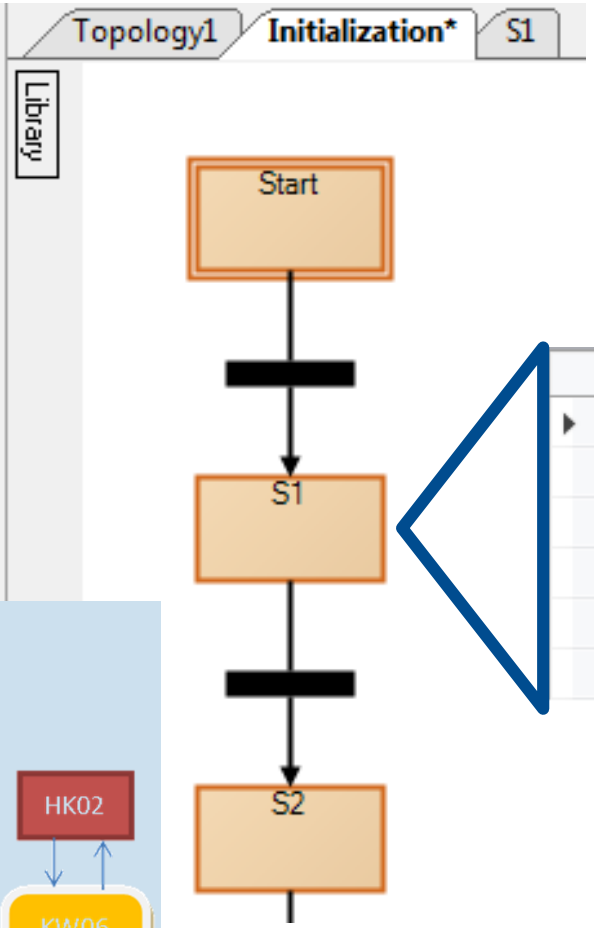
Current Status Process Orchestration



Example for Plant orchestration

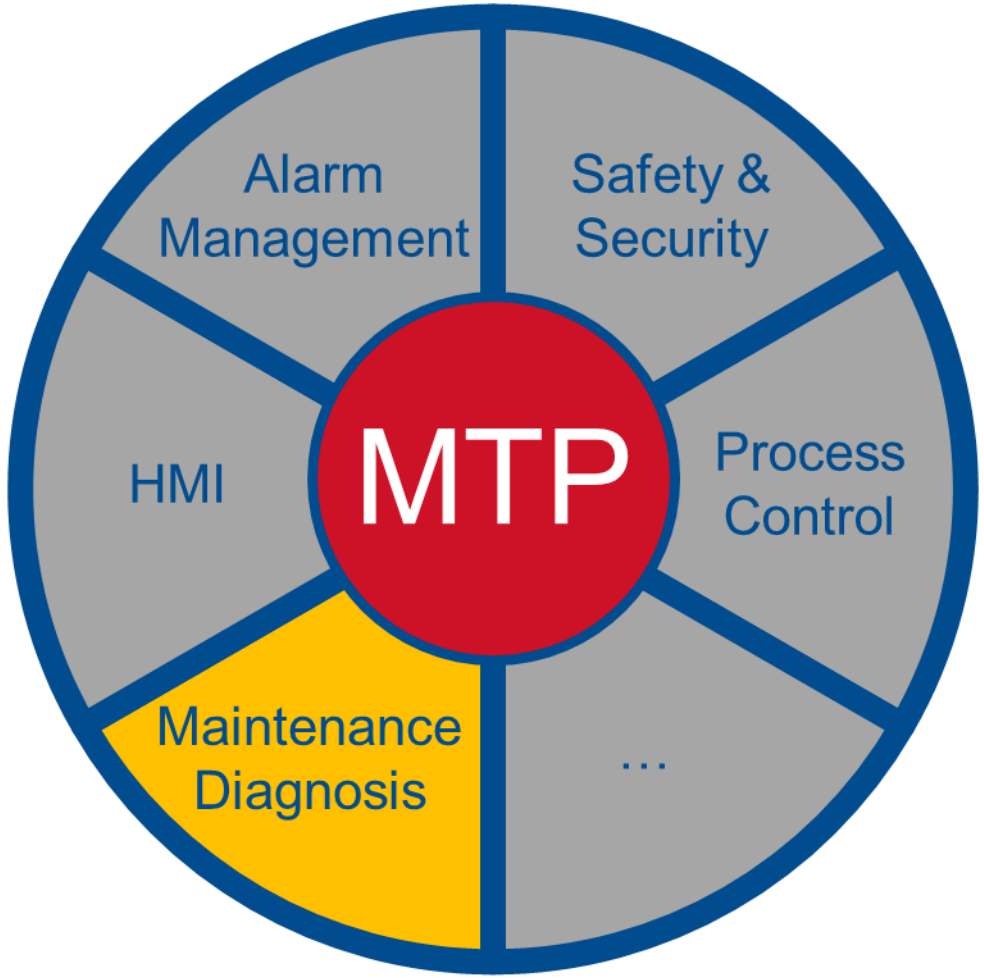






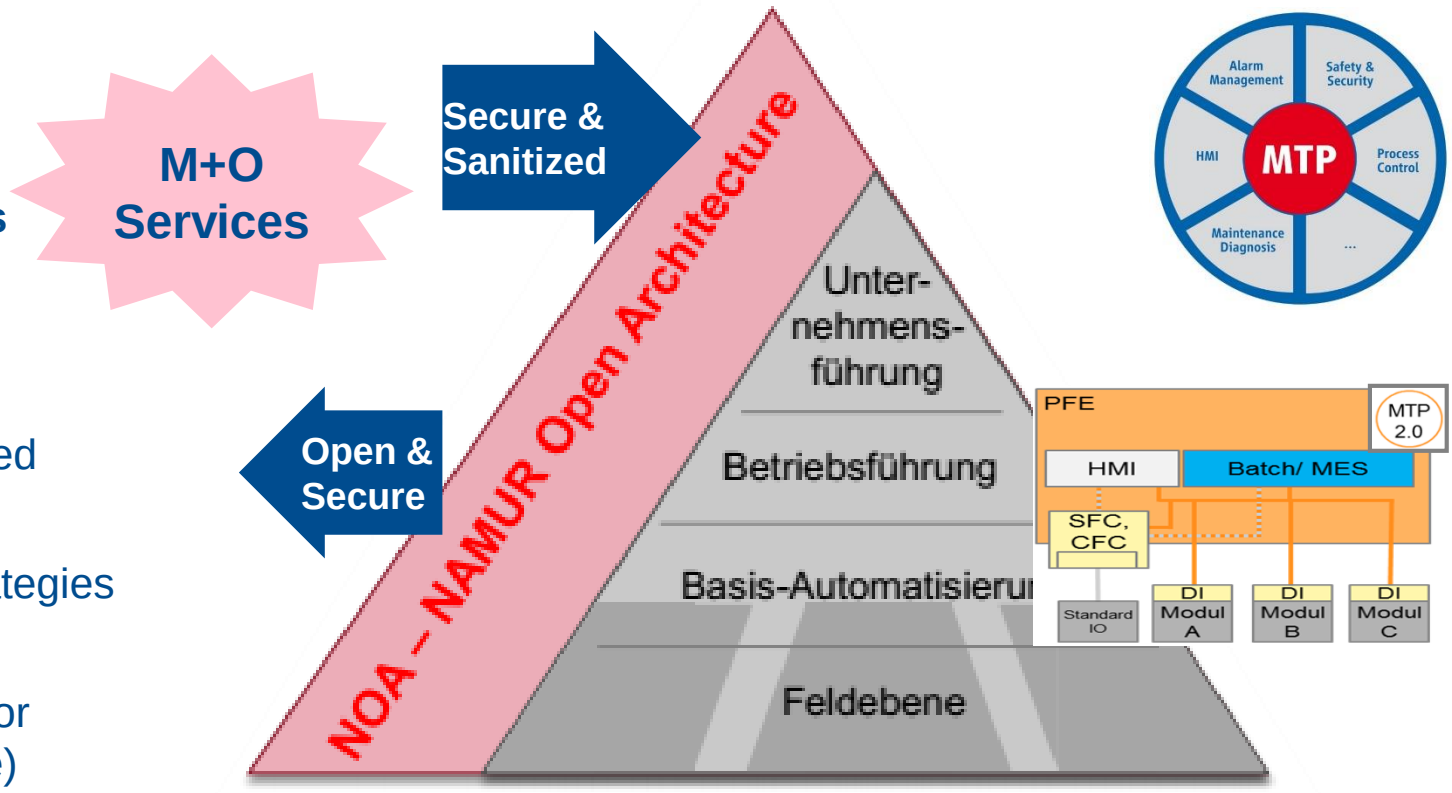
	Module	Module Type	Service	Command	Amount	Cycles	Temperature
▶	BP11	BPXX_Freelance	Discharge	Reset	50		
	BP12	BPXX_Freelance	Discharge	Reset	50		
	BP13	BPXX_Freelance	Discharge	Reset	50		
	RP04	RPXX_Freelance	Inert	Reset			50
	BP21	BPXX_Freelance	Discharge	Reset	50		
	KW06	KWXX_Freelance	Inert	Reset			

MTP Slices: Maintenance & Diagosis



Namur Open Architecture: A Candidate Technology for Secure Access to Modules for Diagnosis and Maintenance Services

- Namur Open Architecture (NOA)
  - Opens Automation Pyramid (Core Process Control) for “Industrie 4.0” applications (IT)
  - Does NOT affect **Core Process Control**
- Module Type Package (MTP)
  - Modules and PFE live within **Core Process Control**
- MTP & NOA
  - MTP may provide **semantics** for NOA-based Services
  - MTP may publish NOA related Access Strategies for **Verfication of Request**
  - NOA may provide a **secure service loop** for services on all levels (PFE, Module, Device)



Demonstrator Achema 2018 - Schema

Plant Control Level

Module Control Level

Modular Process Equipment Assemblies

modular / functional Equipment

ABB

Siemens

TU Dresden Dash Board

P+F Tablets

P+F Tablets

P+F Tablets

P+F Tablets

WAGO

Siemens

Embedded

P2O-Lab Feed

Merck Reactor

PLC.next

Samson Flowunit

Huber Temp

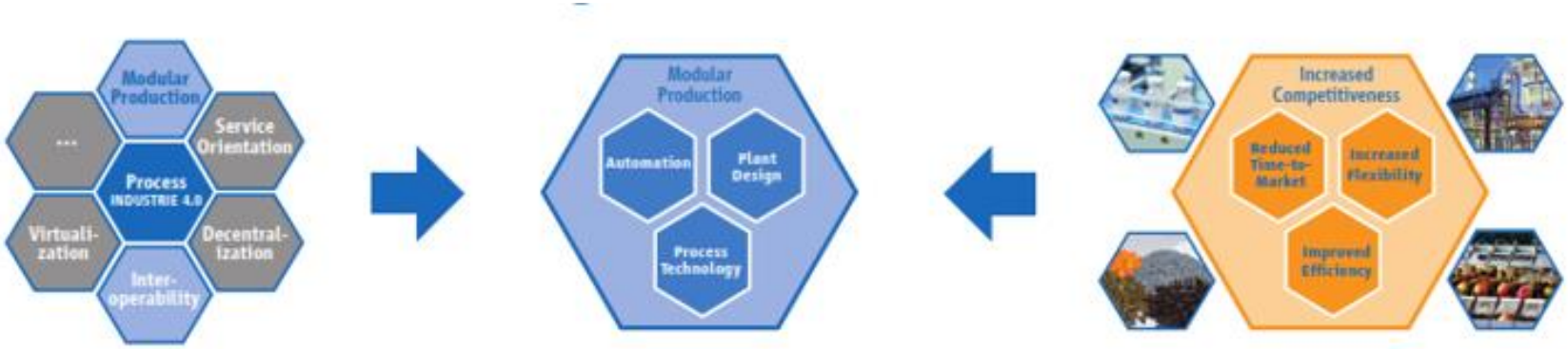
Demonstrator Achema 2018 - Orchestration

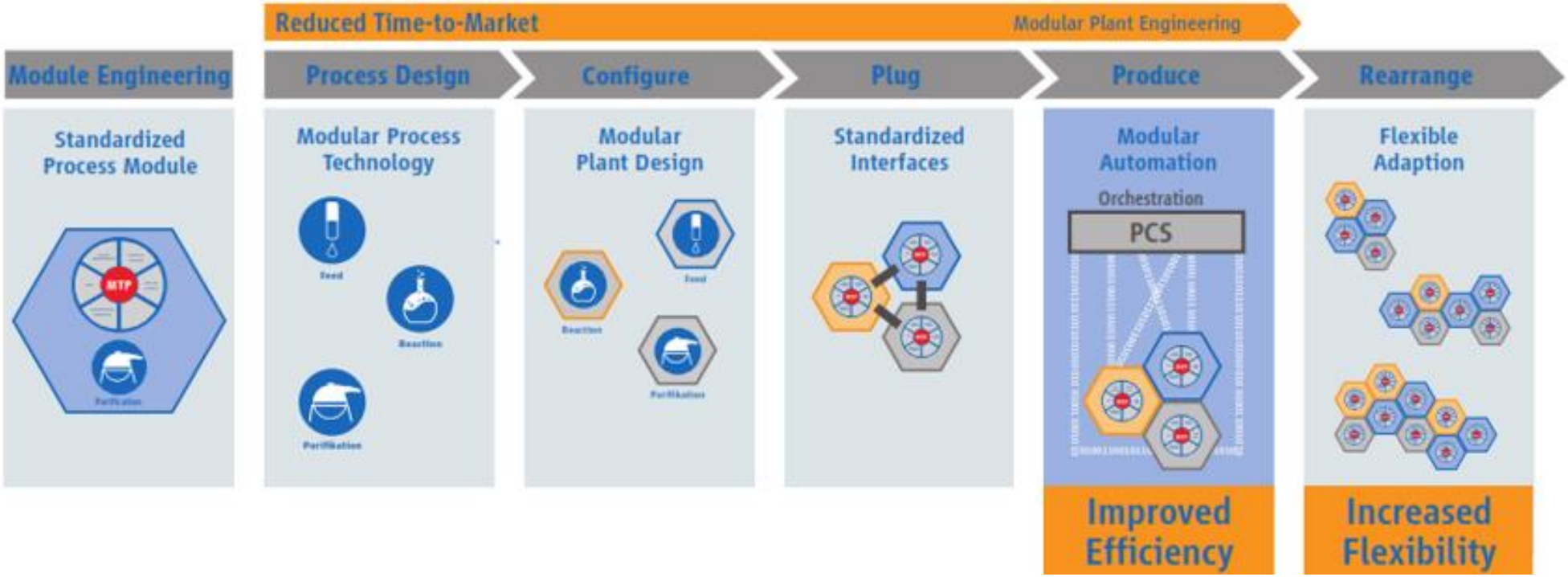
Describe your process as a sequence of phases (a la isa 106) based on the modules‘ services

Modul	Service	Vorlegen	Reagieren	Ruhen	Aufheizen	Abfüllen
	Vorlegen	V = 10 l, t=AFAP				
Dosiermodul	Dosieren		F = 1 l/min			
	Nachfüllen					
	Rühren	n = 100 Upm	n = 200 Upm			
Reaktormodul	Begasen		F = 0,01 l/min			
	Entleeren					F= MAX l/min
Heiz/Kühlmodul	Temperieren		dt = -10°C/min, Tt=4°C	T=4°C	dt = +10°C/min, Tt=20°C	

Recipe can be manually derived for batch control systems or as SFC or generated automatically (research)

Summary


Modular Production
Service Orientation
Decentral-ization
Inter-operability
Virtuali-zation
...
Process
INDUSTRIE 4.0
Modular Production
Automation
Plant Design
Process Technology
Increased Competitiveness
Reduced Time-to-Market
Increased Flexibility
Improved Efficiency


Reduced Time-to-Market
Modular Plant Engineering
Module Engineering
Process Design
Configure
Plug
Produce
Rearrange
Standardized Process Module
MTP
Modular Process Technology
Feed
Reaction
Purification
Modular Plant Design
Standardized Interfaces
Modular Automation
Orchestration
PCS
Flexible Adaption
Improved Efficiency
Increased Flexibility

Working Groups (Teamwork Namur & ZVEI)

Technology evaluation, ongoing

WG 1.12.1
Members: ZVEI, Namur

Alarm management

WG 2.9.1
Members: ZVEI, Namur

HMI

WG 2.9.1
Members: ZVEI, Namur

Condition based Process control

WG 2.3.1 (AK 2.4.1)
Members: ZVEI, Namur

Diagnosis / Maintenance

WG 2.6.1 -> AK 4.13.1
Members: ZVEI, Namur