

NAMUR - Interessengemeinschaft
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AK POSITION

Process Orchestration – Harmonising the Integration of Modular Equipment

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AK POSITION reflects the experience gathered by the members of the joint NAMUR/ZVEI 2.4.1. and has been agreed within the Working Group. This document does not enjoy the same degree of consensus as a NAMUR Recommendation or NAMUR Worksheet. By publishing an AK POSITION, the Working Group can almost immediately inform interested readers of their own experience.

Process Orchestration – unleash the potential of modular production: harmonising the integration of modular equipment is key.

Until today, the state-of-the-art integration of equipment into production systems has typically been handled by system integrators using individual black boxes from multiple equipment vendors in order to build “static” production systems. Modular plants today require a more harmonised approach of integrating the required modular equipment: *Process Orchestration*.

Module Type Package (MTP) enables an intelligent integration by clearly defining self-contained, service-oriented assets. The focus of the MTP-standardisation highly depends on the modules of automated modular plants – also called Process Equipment Assembly (PEA) – which always represent physical equipment whereas a single MTP definition represents its type. The combination of a Process Equipment Assembly (PEA) with a Module Type Package (MTP) can be called a “smart module”.

Such smart modules require a corresponding flexible orchestration to combine several modules or services into a sensible composition of a modular plant. *Process Orchestration* will thus enable modular production based on the MTP concept: It handles several PEAs and their actions in order to plug and unplug PEAs into the *Process Orchestration Layer* (POL). This POL is a necessity as it ensures simplified integration and production traceability while introducing modularity and flexibility for production including vendor independence from POL and PEA suppliers.

The commonly used definition *automation layer* will be part of the *Process Orchestration* as it combines the PEA spanning logic and the PEA overarching interlocking/ arbitration of the fully encapsulated modules in order to provide an overall automation of a modular plant.

Process Orchestration in a nutshell

In the same way an orchestra turns musician, notes and instruments into a symphony *Process Orchestration* turns the cacophony of unrelated, non-standardised black boxes of current modular process automation into a symphony of well-known, standardised harmonised, interoperable components. When comparing *Process Orchestration* of a modular plant with a musical orchestra arranging musicians, notes and instruments into playing a symphony, the composer would be represented by the team consisting of the product designer and the process engineer, who define the new product and its production process. The whole composition would be the underlying master recipe. The orchestration of musicians and instruments represents the modularised topology of the available process equipment assemblies (PEAs) of the production plant – each fulfilling specific tasks and providing specific functions. The score of the symphony translates to the scheduled sequence of production orders produced in the orchestrated plant.

The core of the process orchestration layer and its plant operators is represented by the conductor who orchestrates all the musicians and their instruments representing all the available process equipment assemblies (PEAs) in the plant.

The conductor’s baton keeping the orchestra in check is the beat of the information bus of the modularised environment. To stay in the metaphor, the single musical instrument is equivalent to the physical equipment of a PEA. The individual musician act as the control CPU of each PEA. The melody of an instrument played by the musician is the single service provided by the PEA in the orchestrated plant.

Even if all the musicians had their notes and instruments and knew what to play and when to play it, a high-quality symphony would not be possible without a conductor. *Process Orchestration* coordinates the separate PEA services according to the master recipe to ensure consistency and quality of production and timing.

The following picture gives an idea of the reference architecture we envision for process orchestration.

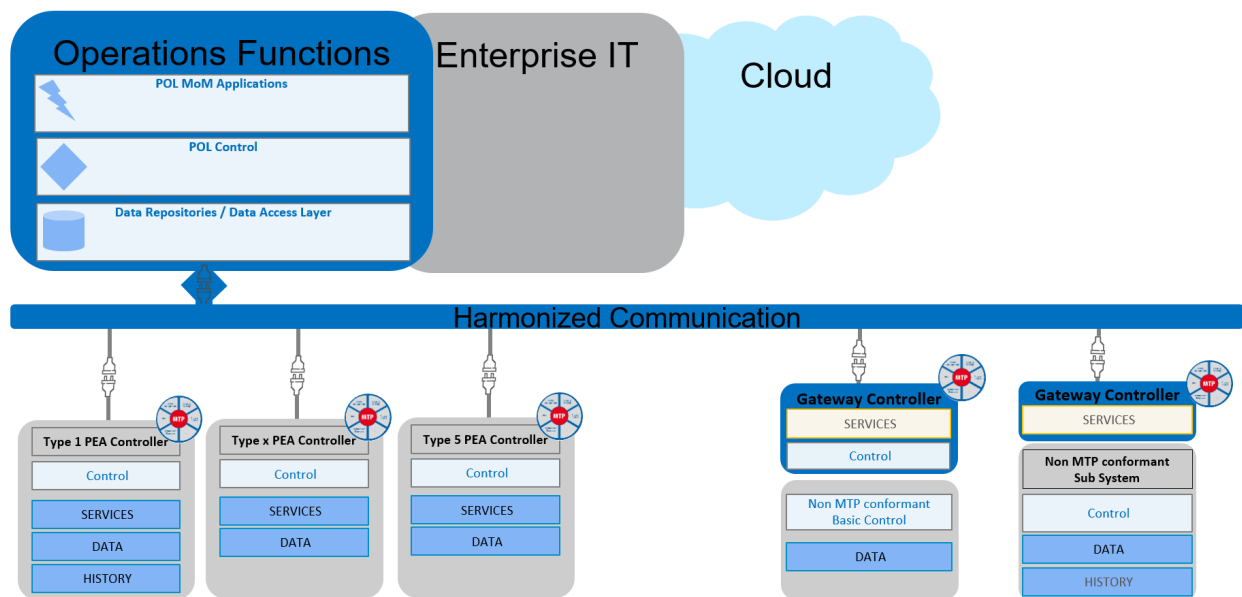


Figure 1: Reference Architecture of Process Orchestration - Source WG 2.4.1

State of Process Orchestration today

The concept of the Module Type Package is standardised in VDI/VDE/NAMUR 2658 and IEC 63280 and further standards are under development. The first commercial products are available providing modular plants with standardised MTPs.

Process Orchestration exists as a term and as a much-discussed concept. Both, suppliers and industrial partners through their respective organisation NAMUR and ZVEI strive for a harmonised applicable solution. In order to achieve this solution, NAMUR and ZVEI joined forces in the now renamed working group 2.4.1 “Process Orchestration”.

All results of the discussion in the working group 2.4.1 covering MTP will be used to extend the VDI/VDE/NAMUR 2658. The core goal of the working group is to develop a joint NAMUR-ZVEI recommendation on the POL as a starting point for further standardisation.

Next step: Gaining industrial experience and developing a standard

The working group follows two distinct paths: The development of a usable standard from an industrial perspective and the support of early adopters to gain tangible industrial experience. To achieve a sensible standard the implementation of solutions at early adopters is important as this provides valuable data and understanding for the development of a standard.

The major tasks of the working group are thus:

- Collecting the basic requirements for orchestration based on practical use cases.
- Supporting detailed plug and unplug capabilities in order to allow flexible production.
- Identifying the impact of POL on the existing system landscape in the process industry.
- Sketching out a modular POL to represent the single version of truth for any system in the automation pyramid, for example an upper layer system like the Enterprise Resource Planning (ERP).
- Supporting early adaptors of modularised environments in the process industry.
- Harmonising and standardising interfaces of PEA and POL and provide access of POL data to any other system.

Life cycle of modular production environments – implementing optimised processes utilising modular resources with the POL

Future modular production environments require the design, the implementation and the wide adoption of new flexible automation and information technologies over the whole life cycle of the production environment. A fully service-oriented infrastructure of modules with encapsulated functionalities will hereby be combined with a similarly flexible POLs. The following major aspects of the life cycle of modular production environments are important for developing an adequate solution:

- The **Engineering Phase** consists of designing, implementing, simulating and commissioning an orchestrated production environment.
In the life cycle of a production plant, the term “orchestration” is used in the engineering phase – an early stage in the life cycle – to describe the planning of the interconnection of PEAs to form a meaningful processing plant. This includes a topology, a sequence and interlocks, the overarching logic, parameters, name definition and versioning. This phase is finished with a commissioning of the PEA. This commissioning might be virtual, i.e. it might be performed and tested in a virtual environment. The engineering is concluded by uploading the plant topology with MTP information into the orchestration and by the assignment of real PEAs for the future operation of the production plant.
- In the **Runtime Phase**, the term “orchestration” covers the management of resources as well as the automated and manual execution of individual functional services provided by the PEAs. This task resides in the POL of a modular production system. It includes the functionality of Manufacturing Operations Management (MOM) as well as process control and operations. Examples include the definition of executable master recipes, error and exception handling, and module-overarching functionality. The communication between PEA and POL is preferably based on the harmonised standard OPC UA (Open Platform Communications Unified Architecture) for numeric values and the well-defined data interfaces as specified by MTP.

Our position

Modular plants require a more harmonised method of integrating the required modular equipment: *Process Orchestration*. It will enable modular production based on the MTP concept handling PEAs in the *Process Orchestration Layer* (POL). This POL is needed to simplify integration and production traceability while introducing modularity and flexibility in a vendor independent way.

Currently we are gathering the requirements for *Process Orchestration* in detail for process control, for MOM and for the special requirements of the regulated industry. Our results will be available to NAMUR and ZVEI members and will be shared with the technical committee GMA FA 5.16 for PEA/MTP. MTP related results will be transferred into the VDI/VDE/NAMUR 2658 standard.

The working group will hereafter suggest the standardisation and modularisation of POL functions in international technical committees.

By designing use cases with requirements and solution concepts and by turning these into practical industrial pilots and implementation projects this working group can serve as a catalyst for operators and suppliers of systems for modular production in the entire process industry as well as in discrete manufacturing using and adhering to the existing standards IEC 61512 (ISA-88) and IEC 62264 (ISA-95) as the basis of the work.

Technical topics and caretakers

The NAMUR working group 2.4.1 “Process Orchestration” joined forces with the NAMUR working group 2.3.1 “Batch Control”. The purpose of this co-operation is to jointly continue the work on the already defined requirements for MTP and Process Orchestration.

In sub-teams this working group deals with the topics “POL functional requirements for MOM and Process Control”, “Plug and unplug requirements of process equipment assemblies (PEA)”, “Technical and communication integration and data modelling aspects” as well as “Definition of validation scope derived by operational requirements in regulated industry for modular production”.

We drive an international standard for modular production through the co-operation with further working groups:

- ZVEI – Joined Workforce as part of WG 2.4.1
- BioPhorum – Automation “Plug & Play” team
- OPA F- Open Process Automation™ Forum
- ENPRO 2.0 Initiative – ORCA Project “Efficient orchestration of modular plants”