ABB

Modular Automation
How it's being used and how you can take advantage of it

Who should read this: Executives, technical directors, plant managers, operations managers, system designers, automation engineers, and maintenance personnel involved in greenfield process industries projects, or operating brownfield plants. Package unit suppliers, automation managers and skid vendors will also benefit from reading.

Shorter product life cycles are a major challenge
Many process industries producers, including biotech, chemicals, food and beverage, pharmaceuticals and more, are constantly challenged to stay competitive in the marketplace. One reason for this is that product life cycles have become much shorter, and "Time to Market" is now one of the most important distinguishers between success and failure of new products. The time required to move new products from the research stage in laboratories to large production plants must be as short as possible. To help meet these challenges, the use of modularization practices can provide many advantages.

Modularization is already widely used in plant construction
Modularization for the basic construction of new production sites is already widely applied. The use of standardized unit operations modules speeds up plant engineering, and also allows faster adoption if reconfigurations are needed to make new products. This is much faster and easier than the traditional approach for building a new process plant, which demands a huge engineering effort by experienced engineers. Many experienced engineers are part of an aging workforce which is nearing retirement. A lack of experienced engineers to replace them is generating further pressure to increase engineering efficiency.

Today, the design of an industrial process can be modularized based on process functions, such as reactors, filtration units, dosing systems, etc. When doing so, even the sizing and dimensions of equipment modules is considered to facilitate

transportation and easy integration into the overall process. Some key challenges facing process industries which modular production addresses are shown in Figure 1.

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Figure 01
Key challenges facing process industries which modular production

Automation is now closing the gap
But when it comes to automation, so far the process functions and process modules have only been partly automated, for instance, by using remote I/O boxes. Today, automation of process modules is not highly standardized, and integration of these modules into the overall automation system still requires a significant effort by both automation specialists and process equipment experts.

This is much different in the consumer products industry, where the "Smart Home" is developing daily through use of standardized, widely used technology. For example, the buyer of a new washing machine quickly connects it to the home's Wi-Fi network, and then easily controls it through a smart-phone app, based on numerous standardized services.

So why aren't we doing the same in the process industries? In fact, this is the aim of modular automation, and we are now starting to do it, by using Process Equipment Assemblies (PEAs), which are fully automated modules that can easily be integrated into the automation system. This could be a fully automated package unit or a skid-mounted module that is designed for reusability.

Modular Automation standards and solutions

Modular Automation is based on the standard Module Type Package (MTP), which is a protocol independent of any specific automation system. The MTP is defined by VDI/VDE/Namur guideline 2658 and serves as the key to building the "Smart Home" of the process industries.

As shown in Figure 2, the basic architecture of a modular automation system consists of PEAs at the operations level which communicate upward through the MTPs to the Process Orchestration Level (POL), which in turn manages overall process control. Communication between the modules and the overall automation system (at the POL), is done using the open architecture network OPC UA (Open Platform Communications, United Architecture.)
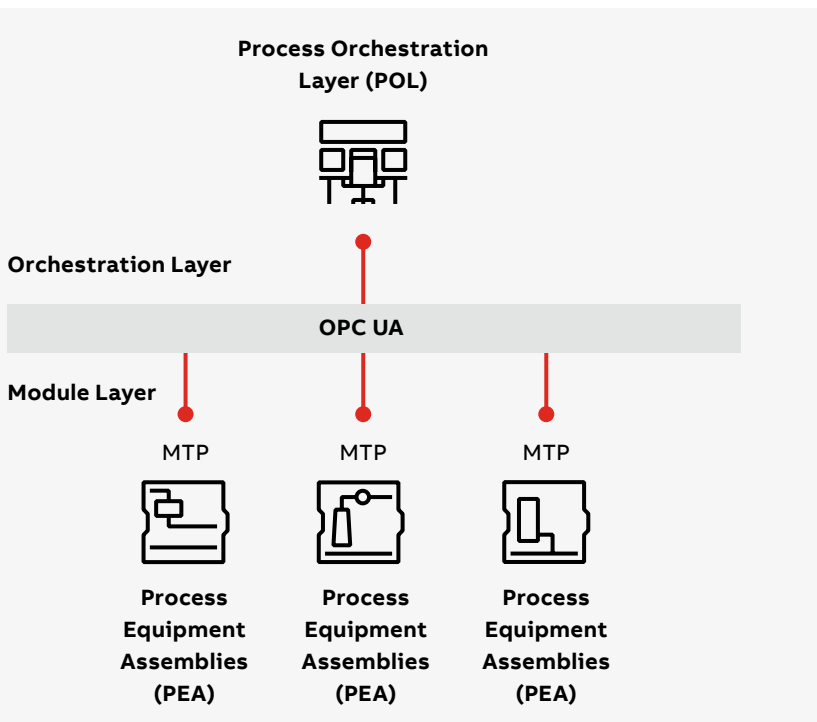
The MTP standard 2658 defines all aspects needed for "Plug-and-Produce" automation in process industries. The standard is divided into different sections, with one part for each of the key automation steps, as shown in Table 1.

2658-X	Title	2658-X	Title
1	Basic Concept	7	Alarm Management Models
2	HMI Concept	7.1	Alarm Management OPC UA
3	HMI Interfaces	8	Safety Concept
4	Process Control with Services	9	Safety Interfaces
4.2	OPC UA Method Interface	10	Diagnostics & Maintenance – PEA
4.3	Service Relations	11	Diagnostics & Maintenance – Plant
4.4	Cross Communications	12	PEA Qualification
5	Runtime Concept	14	MTP Certification Process

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Table 01
Aspects as specified in
VDI/VDE/NAMUR 2658

Not all sections of the standard are completed, but parts 1-4 are released, and users can implement them into real-world production sites today.

The MTP standard allows module builders to fully automate PEAs, and also pretest and prequalify PEAs. The MTP is used like a printer driver; it contains all key information such as system-independent process graphics (static and dynamic part), and all offered services, including their service parameters, if needed.

These MTP files can be transferred to the process or automation engineer, who then configures the overall process flow, based on the services and parameters. The orchestration system can communicate and control underlying PEAs using either a sequence running in a controller, a recipe from a batch system, or a workflow controlled by a Manufacturing Execution System.

A combination of different systems is possible as well, as presented in Figure 3. In addition, the graphical information can be automatically integrated into the POL's plant visualization system.
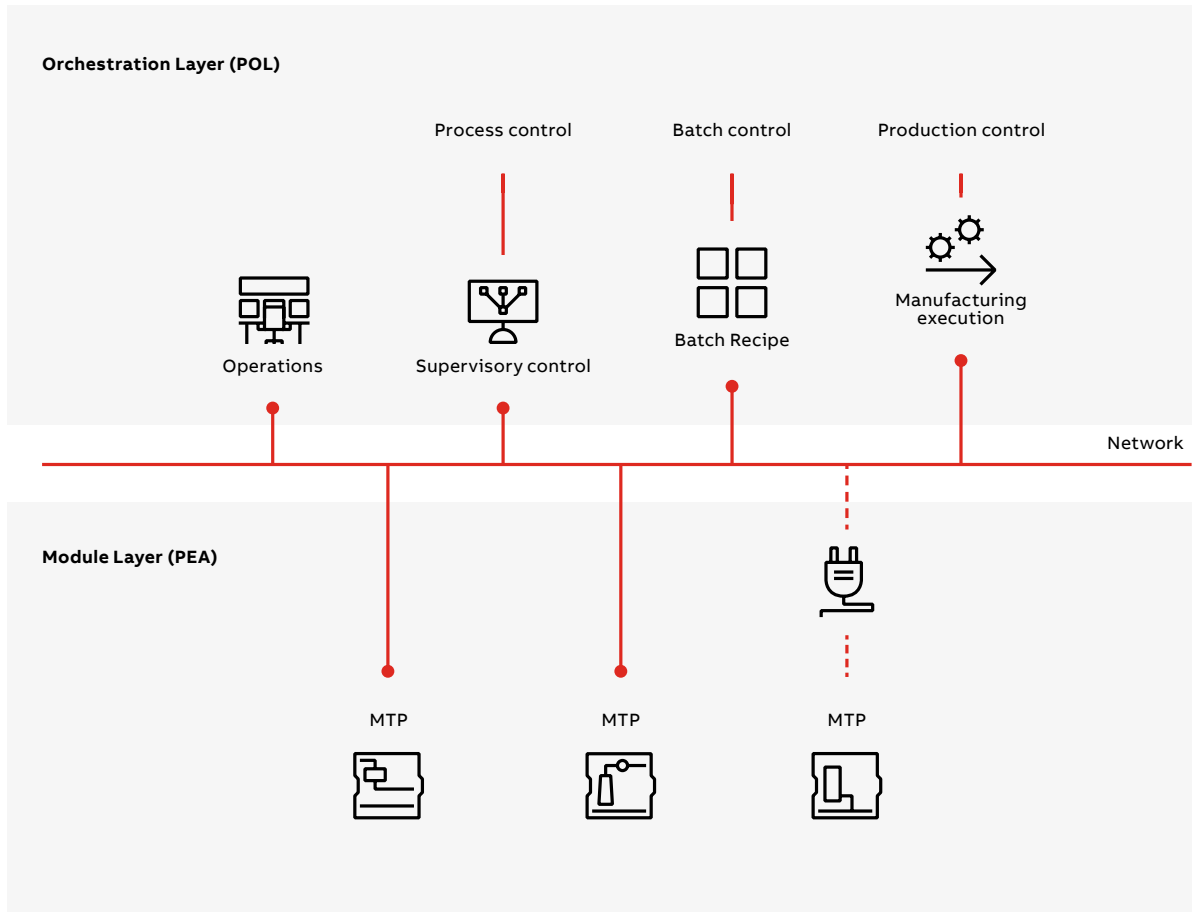

Process Orchestration Layer (POL)

Orchestration Layer

OPC UA

Module Layer

MTP   MTP   MTP

Process Equipment Assemblies (PEA)   **Process Equipment Assemblies (PEA)**   **Process Equipment Assemblies (PEA)**

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Figure 02
Rough architecture
of a modular
automation system

Orchestration Layer (POL)

Process control

Batch control

Production control

Operations

Supervisory control

Batch Recipe

Manufacturing execution

Network

Module Layer (PEA)

MTP

MTP

MTP

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Figure 03
Architecture using different orchestration systems as the POL

Key Benefits of Modular Automation

Users get faster Time-to-Market due to improved flexibility, efficiency and maintenance

Flexibility
- Modular automation allows companies to quickly adapt and expand their processes and systems in response to market changes. This makes new products much easier and faster to produce.
- Fast remodification of process flows based on re-parameterization and reconfiguration, instead of requiring application programming.
- Modules are POL automation-independent.
- PEAs act as a gray box instead of white box (no reengineering needed for integration). The gray box approach reduces complexity and hides unnecessary information.

- With modular automation, producers can easily increase or decrease production capacity as needed, based on market demand.

Efficiency
- By standardizing and automating processes, companies can increase production and engineering efficiency, and reduce costs.
- Smaller engineering efforts are needed for process configuration by avoiding application programming.
- Fully automated PEAs with defined services are fully tested and prequalified based on the services.
- Lower qualification and certification costs in regulated industries.

- Processes can be designed and pretested, based on the module services and without using the real hardware.
- Equipment builders can protect their intellectual property by using the gray-box approach provided by the MTP standard.
- No integration of the equipment function into a controller application is needed.
- Reduced factory acceptance testing (FAT) and commissioning time.

Maintenance
- Modular systems are often easier to maintain and repair, as individual modules can be replaced or updated without disrupting the entire system.

Up to 50% lower costs for engineering, testing, and commissioning
Until now, fairly few modular automation plants have been built, and therefore we don't have extensive benchmark figures regarding financial benefits. Nevertheless, analyses done by users and automation suppliers show reductions in investment costs for modular automation plants. A basic assumption is that the overall engineering effort and cost to build new production sites can be reduced by up to 50%.

This is certainly possible, considering that:
- The PEA modules come pretested and fully automated, so you only need to configure the overall process flow based on the appropriate services and parameters.
- Visualization of the module will be automatically imported from the MTP file, and users can then rapidly start commissioning.
- Factory acceptance testing simulation of the modules is much easier, reducing test efforts up to 25% since only sequence control of the services and interlocks must be checked, and no application programming must be tested.
- Commissioning time can be reduced up to 30% because extended I/O and loop checks are unnecessary.

Conditions are right for more extensive implementation of Modular Automation

Modular Automation, which today is being used in process industries on a small scale, is at the "tipping point" of much wider adoption. Key players in the value chain must now start collaborating, including:
- Module and equipment vendors
- Package unit suppliers and skid vendors
- Automation suppliers and system integrators, and most importantly
- Process industries producers

Module and equipment providers, including package unit suppliers and skid vendors, are today mostly supplying only partly automated modules, and therefore have limited knowledge about implementing the MTP standard. If they can deliver MTP-compliant modules, they will both differentiate their offering and protect their intellectual property.

Automation suppliers and system integrators must support equipment builders by implementing MTP. This is easy as the POLs allow a mixed automation structure, combining the traditional approach to implement modules with the new MTP-compliant modules, as shown in Figure 4 on the next page. This combination of MTPs in automation allows stepwise evolution and development of the process.

Process industries producers have the most to gain financially by adopting modular automation, and many are already working on the technology to receive the benefits. Executive leadership can play a key role by working to understand and encourage modular automation adoption. As a first step, when producers issue tenders, they should require their module builders to include the MTP standard on all new equipment.

How to get started

Producers can easily start with small steps, at low risk, based on the new MTP standard, and build upon that. A small pilot project – which is easy to do – will give an estimation of the key benefits your operations can get with modular automation, including a good idea of how big the financial benefits will be.
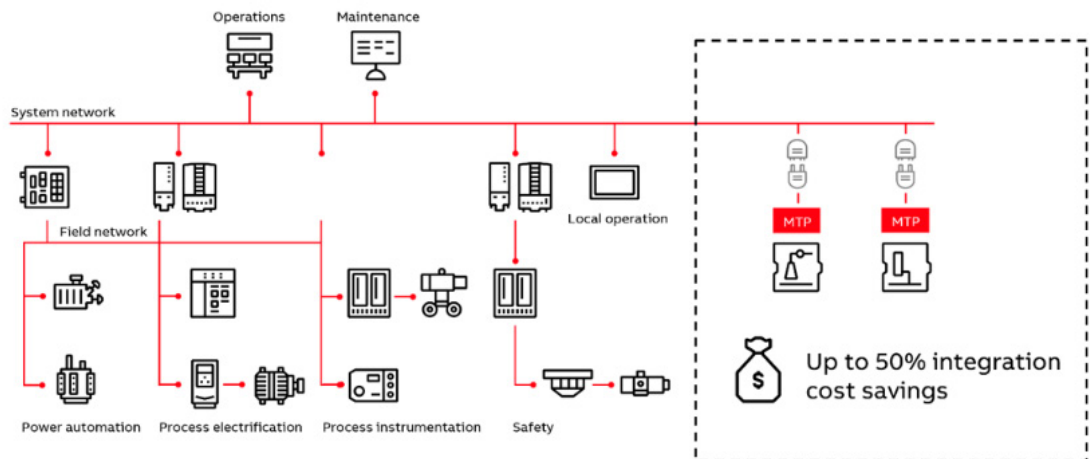

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Figure 04
Mixed automation structure of a plant, combining classical with MTP PEAs

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To discuss how a small pilot project might be set up, don't hesitate to contact us.

No matter where you are on your Modular Automation journey, now is a great time to move your company forward with it, to gain the benefits it offers.

The learn more about Modular Automation and ABB's capabilities to support you, scan this QR code.