White Paper
October 2021

Smart Commissioning

Smart Commissioning is a technology-enabled approach for streamlining the commissioning of field instrumentation connected to a DeltaV™ Distributed Control System (DCS) or Safety Instrumented System (SIS). It significantly reduces the effort and time for commissioning HART devices by automating most of the associated tasks involved. The benefits of Smart Commissioning extend beyond the site work; it changes the way automation projects are executed.

Some of the functionality enabling Smart Commissioning became available starting with DeltaV v13 and it was greatly improved in DeltaV v14. This whitepaper describes the Smart Commissioning features for HART devices as in DeltaV v14.LTS (or later).

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The Smart Approach for Device Commissioning

While automation expenditures are only a small portion of the overall project cost, any delay in the commissioning of the automation system can cost millions of dollars. Smart Commissioning drastically reduces time and effort in commissioning HART devices by taking full advantage of the intelligence of those devices. Traditional commissioning practices seldom use HART communications. Smart Commissioning leverages the HART protocol to automate the device commissioning process. There are four main tasks on the Smart Commissioning approach:

1. **Automatic Device Identification.** Devices are identified by the device tag. The wiring or channel position is no longer relevant for device identification purposes. It does not matter if the device was pre-tagged by the vendor or tagged on site before mechanical completion, if there is a tag in the device, the device can be automatically identified.
2. **Automatic binding to control or safety logic.** Once the device has been identified is automatically bound to the right control strategy based on the device tag. Even if the device tag was already bound to a control strategy, it is verified that everything is place for the use of the device within DeltaV, for example, it is confirmed the CHARM is assigned to the right controller.
3. **Automatic device configuration.** Smart instruments have dozens or even hundreds of parameters to configure. While it could be possible to order devices pre-configured, this approach would delay the procurement of field devices. In addition, there is always late changes to be applied. Automatic configuration allows for efficient device configuration based on pre-defined configuration templates.
4. **Automatic loop test.** Devices are tested using HART commands to set the device output and the response verified all the way to the control or safety logic.

Since the above tasks are automatically executed by the system, documentation is readily available. Another significant difference between Smart Commissioning and traditionally practices is the parallel execution of multiple devices instead of one device at a time.

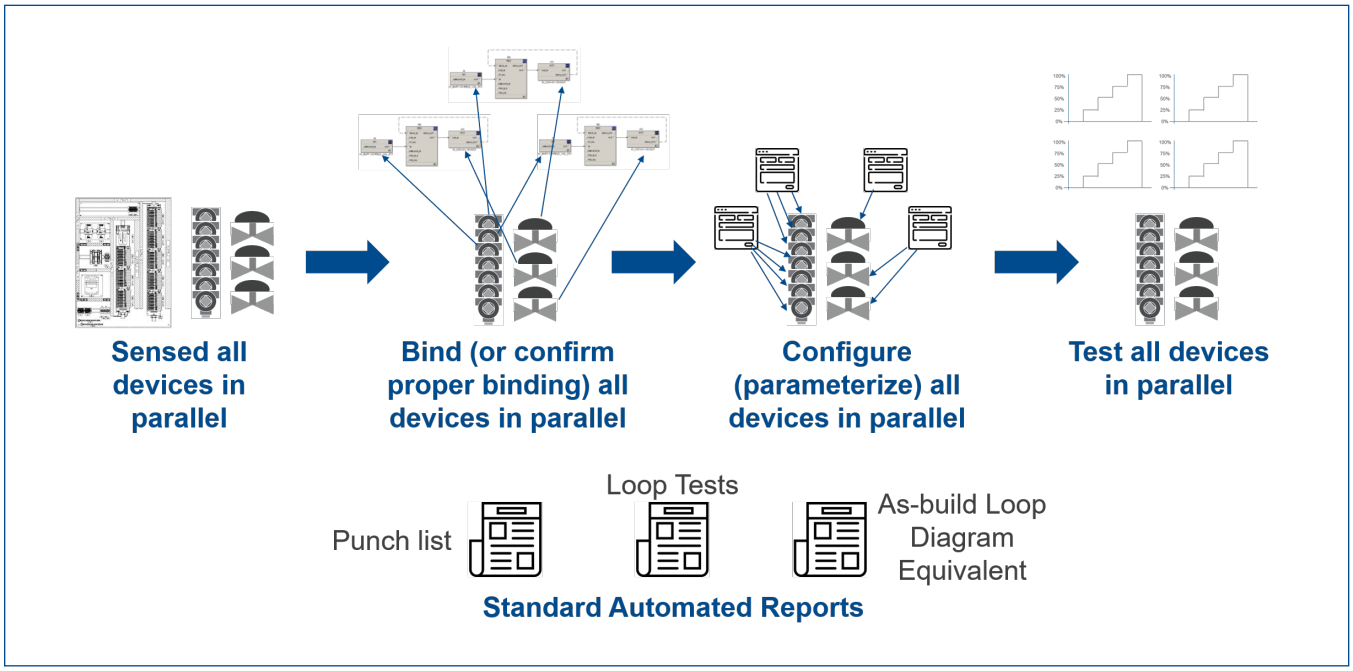

Figure 1. Automated Commissioning Workflow.

Smart Commissioning not only reduces the time and effort for commissioning field devices, it complements and leverages other DeltaV functionality to change the way automation projects are executed. Electronic marshalling enables to fully decouple the I/O physical design from the software design (e.g. control strategies). As illustrated in figure 2, engineering tasks, field installation tasks, and procurement of field devices can all be performed in parallel. Once the engineering phase has been completed, Smart Commissioning brings software and hardware together during the on-site phase of the project. The following sections describe some of the benefits from electronic marshalling and how electronic marshalling relates to the late binding concept.

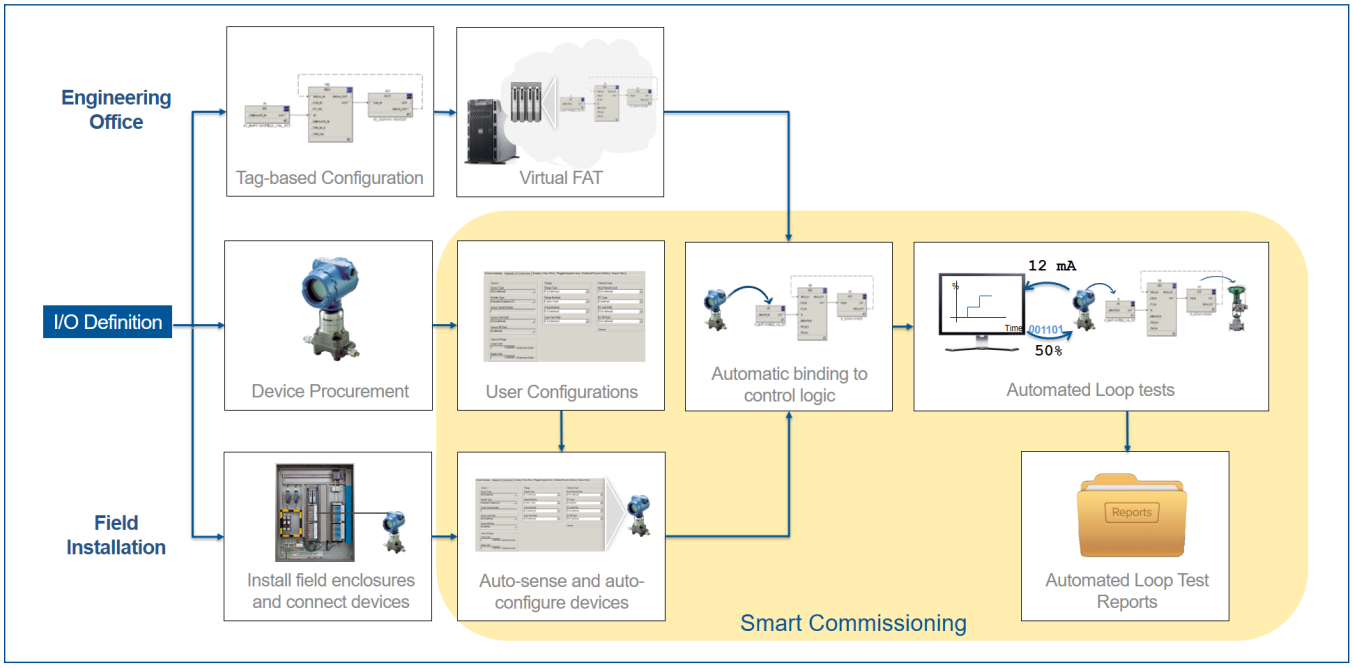

Figure 2. Project Execution with Smart Commissioning (I/O relevant tasks).

Decoupling the I/O Physical Design

Electronic Marshalling enables control and safety logic configuration to proceed independently from the design and installation of the physical I/O and field instrumentation. There are three key features of DeltaV DCS (or DeltaV SIS) that enables the decoupling of the physical I/O design from the control strategy (or safety logic) design:

1. **Control strategies and safety logic can be configured using just the Device Signal Tags (DST)**, eliminating the need to define the physical location of the I/O during the configuration phase. DeltaV DSTs are unique identifiers for device signal references. As soon as the initial process design is available, typically on a Piping and Instrumentation Diagram (P&ID) and/or on an instrument index, the project team can start configuring control strategies based only on the DSTs. Each I/O function block is linked to a DST that is not yet assigned to any particular I/O channel. In a traditional configuration approach, I/O references within the control strategies are bound to specific channels creating unnecessary dependencies in the project schedule. DeltaV v14 provides the ability to configure HART devices and the associated CHARM properties even before the specific CHARM location is known.

2. **Electronic Marshalling provides an unprecedented flexibility** in both control system I/O topology and SIS I/O topology. Each individual channel is characterized for the requirements of the field device via a single channel component called a CHARacterization Module (CHARM). DeltaV Electronic Marshalling helps reduce overall system costs by eliminating internal cabinet cross wiring, reducing overall footprint, simplifying I/O channel assignments, and reducing Factory Authorized Testing activities.

3. Fully decoupling software and hardware is only possible if **control and safety logic can be tested without the need of hardware** and independently of the physical I/O design. Virtualization capabilities enable testing of both control and safety logic without physical control hardware present. Simulation by DST rather than by the physical channel location maintains the independence between software and hardware.

Installation of Field Enclosures

While the system configuration is being done at the project office, and the field devices are being specified and procured by the engineering firm, field installation activities can also be executed in parallel. Thanks to the flexibility provided by Electronic Marshalling, the quantities of standard I/O enclosures can be determined based only on the expected I/O quantity per location without knowing what type of I/O will be connected. Specifically, Configure-To-Order (CTO) field enclosures can be procured and sent to the site for installation early in the design cycle. The use of standard field enclosures eliminates custom cabinet design thereby reducing engineering labor and shortening the schedule. However, the use of CTO cabinets is not required to receive the benefits of Smart Commissioning.

Based on the physical location of the field enclosures, field devices can be associated with a given enclosure. Not spending time on detailed design for multicore cables is a considerable time saver as well as the elimination of loop drawings. Thanks to the broad range of I/O types, practically all field devices can be connected to the DeltaV CHARacterization Module (CHARM) I/O subsystem without the need of external components. A large variety of signal types (e.g. RTD, T/C, 120VAC, etc.) can all be used within the same field enclosure. The installer only needs to select the proper CHARM and terminal block, based on the signal type. All this field work can be done without any information about the logical I/O assignment within the control strategies. One key feature of Electronic Marshalling is the ability for the DeltaV controllers to utilize I/O from many CHARM I/O Card (CIOC), which further simplifies design consideration for allocating devices to field enclosures. In DeltaV SIS, all inputs are directly available to any CHARM Smart Logic Solver (CSLS) within the same safety network which greatly simplify device allocation.

Once all the CHARMs have been installed, the next step is to auto-sense the CHARMs. Each CHARM is automatically identified by the DeltaV system with no need for the user to define the type for each I/O channel. DeltaV v14 introduces the ability to specify user-defined CHARM templates, allowing users to define all the properties for each CHARM type practically eliminating manual configuration of CHARMS. This feature not only reduces effort but also reduces errors during CHARM configuration. Field devices can be terminated either before or after auto-sensing CHARMs.

Once the CHARMS have been auto-sensed, HART field devices can automatically be identified. Another key improvement introduced in DeltaV 14 is the auto-sensing of multiple devices at the same time. Users are able to select a CIOC or CSLS and initiate the auto-sense of all HART devices connected.

Late Binding

Decoupling software and hardware has great benefits in project schedule but it could introduce complications unless there is an efficient way to bring the software and hardware together. In DeltaV, when controls strategy and safety logic are merged with the physical I/O designs, the logical signal references are automatically bound to the physical I/O references without any additional intervention by the user.

Late binding delays the assignment of the physical I/O references until the field devices are installed and commissioned on site. The device and CHARM configuration performed prior the assignment to a physical I/O reference is preserved once the late binding has been completed.

DeltaV allows late binding for all type of signals based on the instrument tag. For HART devices, the binding of I/O references is performed automatically once the device is connected to a physical I/O channel and has been discovered by DeltaV system. For other type of signals, the user could manually allocate the proper DST based on the connected device either using drag and drop functionality or bulk edit capabilities.

Automatic Late Binding of HART Devices

DeltaV can auto-sense HART devices and extract relevant device information. This information includes the manufacturer, type, and revision, as well as the tag and description unique to each device. If the discovered field device tag matches a configured I/O reference within the system, the proper I/O function block is automatically bound to the right field device.

Smart Commissioning Without Late Binding

While late binding provides great benefits in terms of flexibility, **Smart Commissioning can be performed without doing late binding.** If a device placeholder is already allocated to a given CHARM, the device placeholder is automatically reconciled automatically with the field device during the binding process. The next section describes the three main approaches for reconciling device placeholders and field devices.

Handling Tags Within HART Instruments

The approach for automatically identifying field devices and binding them with control strategies is based on the ability of reconciling the field device tag to the device reference within the DeltaV system. There are three main approaches for handling tags within HART instruments:

- **Field device is the tag master** (Emerson recommended approach). In this approach, the field device tag becomes the DST under the CHARM and all I/O references to the DST are bound to the field device. Any existing DST will be overridden by the device field tag.
- **System is the tag master**. In this approach, the DeltaV DST will be written to the field device tag regardless if the device was previously tagged or not
- **Hybrid approach**. In this third option, the field device tag is compare with the DST and user can decide how to deal with conflicts. The recommended option is to only proceed if the field device tag matches the DST and send devices to the punch list when the tags do not match.

Field Device is the Tag Master (Emerson recommended approach)

In this approach, HART devices are either pre-tagged at the factory or tagged on-site before/after device installation depending on the characteristic of the field device. Specialized devices such as control or safety valves are normally pre-tagged at the factory. Generic field devices can be purchased in bulk and installed in any applicable location, being tagged in place. The generic field device approach simplifies warehousing and management of instruments during construction since there is no need to track individually tagged devices.

Regardless of when the field device is tagged, the tag in the device is uploaded during the commissioning process into the system and used to bind device reference to control and safety logic. When the I/O channel senses a field device the tag in the field device becomes the channel DST. The advantages of this approach are:

- Field devices can be connected to any CHARM of the proper type. Smart field devices are automatically detected based on their tag. Checking the wire to confirm what smart device is connected to the right I/O channel is no longer needed. The right channel is any channel of the proper type.
- There is no need to pre-configure the DST under CHARMs since the DST is generated from the field device tag and bound to the proper control or safety logic automatically. There is no even need to pre-configure the CHARM, as CHARMs will be automatically sense as part of the process for sensing field devices.

There are two options in DeltaV v14 for using field device tags:

- Use of the device short-tag (8-character tag) – In this case, the device short-tag becomes the CHARM DST.
- Use of an up to 16-character tag automatically extracted from the HART long tag (up to 32-character) - The extracted tag becomes the CHARM DST. DeltaV provides an expression editor to define the extraction rule for extracting the 16-character tag from the HART long tag. HART long tag is only available on HART 7 devices. To extend Smart Commissioning to HART 5 devices, DeltaV provide an option to use the standard message field as replacement of the HART long tag. A extracted tag could be generated from the message field in the same as in generated from HART long tags. If device tags (either HART long tag or message field) are 16 characters or less, then there is no need to define an extraction rules as device tags could use directly.

System is the Tag Master (alternate tagging approach)

Emerson realizes that changing work practices sometimes takes time, especially when there are multiple companies involved, with this in mind, Smart Commissioning can support other approaches for handling tags.

In this alternate approach, field devices are not pre-tagged before delivery to site. Instead, the device tag is written by the DeltaV system to the field instrument based on the DST name configured on the I/O channel. When the HART field device is autosensed, the DST is written to the device and the device information (manufacturer, type, and revision) is uploaded to the DeltaV system. In this approach, field device tags are limited to the first 8-characters of the DST.

While this approach also allows devices to be purchased in bulk and installed in any applicable location. The disadvantage is that CHARMs must be configured with the DST of the appropriate device which reduces some flexibility. This approach could be utilized when I/O design is fully completed before starting the system configuration.

Hybrid (second alternate tagging approach)

This approach is a combination of the first two options. Devices are pre-tagged at the factory or on-site before installation, **and** the CHARM channels are also configured with the proper DST. When the channel is auto-sensed, the DST name should agree with the field device tag, confirming that the proper device has been installed in the proper location. Any discrepancies can be resolved on the spot and corrected in either the device or the channel configuration. A tag extraction rule could be defined to handle device tags longer than 16 characters.

This approach could be utilized on modernization projects where the device tags are known as well as the specific location for each device.

Smart Commissioning supports all of these approaches, so the user can select the method that best fits the specific project.

Automatic Configuration of HART devices

One of the activities that demand the highest manpower effort during instrument commissioning is the configuration and setup of individual field devices. Traditionally, this is done one device at a time using either AMS Device Manager or a hand-held communicator. As intelligent field devices become more complex, the number of parameters that must be configured increases dramatically, resulting in a corresponding increase in the amount of configuration time required and the risk of errors. In addition, manual device configuration makes difficult to establish and maintain consistency throughout the plant areas or insuring an “approved” configuration is reliably loaded on each field device.

The phrase “define once, use many times” describes a more efficient method of configuring HART devices using AMS Device Manager Bulk Transfer. The AMS Device Manager Bulk Transfer process consists of four major elements:

1. **User Configuration Development** - The first element is the development of standardized User Configurations (AMS device templates) that define the specific configuration of a particular device class. Each of these User Configurations (device templates) is associated with a particular manufacturer, type and revision. There can be multiple User Configurations

for each manufacturer, type, and revision that reflects the different ways that the device might be used (e.g. different applications for the same device type). User Configurations can be created well ahead of the installation of field devices, and used as the configuration standard beyond the project timeline and across different sites. User Configurations define all the common attributes among many devices. Certain unique information such as the instrument range can still be defined on an instrument-by-instrument basis.

2. **Device Mapping** - Once the User Configurations have been developed, the next step is the mapping of individual devices to a particular User Configuration and unique attributes (e.g. instrument range). This is done in an Excel file and loaded into AMS Device Manager with the Bulk Transfer Utility. This concludes the pre-site activities associated with device configuration via AMS Device Manager. Please consult the section “Planning for Smart Commissioning” for an explanation of other pre-site activities.
3. **Configuration Transfer** - When a device is auto-sensed on site and a valid User Configuration mapping exists, the User Configuration can automatically be sent to the device. Alternatively, multiple devices can be selected and their User Configurations will be transferred with the Bulk Transfer Utility. DeltaV v14 provides the ability to initiate the configuration transfer as part of the commissioning process and select which devices will be configured through the Bulk Transfer Utility. The DeltaV Device Commissioner is fully integrated with AMS Device Manager and configuration transfer can be initiate from this DeltaV software application.
4. **Device Verification** - Reporting tools provided with the Bulk Transfer Utility and the AMS QuickCheck Snap-On can be used to validate that transmitter configurations match the User Configurations.

Bulk transfer of device configurations using the AMS Device Manager Bulk Transfer functionality has been shown to **reduce instrument configuration activities by more than 75%**. This offers significant opportunity to reduce the overall commissioning schedule, leading to earlier start-ups. For additional information on how to streamline device configuration please consult the **AMS Device Manager whitepaper** about Streamline Device Commissioning.

Automated Loop Tests

Once the device tag has been bound with the control strategies and the field devices have been properly configured, a final loop test is generally required. This is designed to test the entire loop from the transmitter to the output of the associated function block, so the range of the process variable is validated to be accurate in the process control graphics and faceplates. This has traditionally been done using two technicians; one in the field and the other at the DCS console. The field technician would simulate an analog value at the transmitter and the console technician would check the corresponding value at the DCS. This approach is time consuming and manpower intensive.

Computer-assisted loop tests have been used in previous versions of DeltaV producing considerable manpower savings (more than 50%). **DeltaV v14 introduces fully automated loop tests** which lead to even greater manpower savings. **Estimated time savings on loop tests are around 75%.**

With automated loop testing, a single technician at a DeltaV workstation can remotely initiate an automatic loop test for either a single HART device or multiple devices. The DeltaV system will check the function block output to confirm proper operation of the entire loop. This verification includes lower and upper ranges as well as engineering units. The automated loop test functionality will force the transmitter to go through a series of pre-configured outputs and automatically confirm the proper value based on pre-defined expected values.

On-demand Reports

DeltaV v14 provides detailed reports for the loop test results indicating whether a field device passed the test, failed the test, or the test has not been performed yet. Test reports include the results of each test step (expected vs. actual test value) as well as device details (model, manufacturer, revision, and module reference). Other reports are also available, including list of auto-sensed devices, list of devices configured through AMS Bulk Transfer, and an issue list or punch list (e.g. detected devices not referenced by a control module, devices without an User Configuration, or devices that failed the loop test.

Safety Instrumented Systems

Smart instruments have been used in safety instrumented systems (SIS) due to their advanced diagnostics. For more information about using HART in DeltaV SIS, please consult the HART Capabilities **whitepaper**. DeltaV v14 provides the same level of Smart Commissioning functionality for HART devices connected to DeltaV SIS with Electronic Marshalling:

- Tag-based configuration.
- Testing of safety logic in a virtual environment. Management of change functionality allows to easily identify and manage configuration modification via a Cyclic Redundancy Check (CRC) for each SIS modules. DeltaV v14 introduces a new CRC that is not affected by the location of the I/O which facilitates the verification that safety logic did not change after the late binding. The existing module CRC is still available and it will flag any change in the SIS module.
- Automatic late binding or automatic device verification. The HART identification tag within the instrument can be automatically compared with the tag defined at the I/O channel to confirm the device is connected to the right terminals.
- Automatic configuration of HART devices through the AMS Bulk Transfer functionality which not only reduces time and effort, but increases consistency, eliminates manual errors, and facilitates de use of advanced diagnostics.
- Automated loop tests for input devices.

*Wireless*HART Devices

The following functionality is available for *Wireless*HART devices connected to the Wireless I/O card (WIOC):

- Tag-based configuration
- Testing of control logic in a virtual environment
- Automatic late binding
- Automatic configuration of *Wireless*HART devices through the AMS bulk transfer functionality
- Automated tests via DeltaV Device Commissioner

Smart Commissioning Software Applications

DeltaV v14 introduces two new software applications to support Smart Commissioning. The first application, I/O Studio, is intended to support the preparation phase. The second application, DeltaV Device Commissioner, is intended to support the field work.

1. **I/O Studio** – This application enables you to fully define I/O details—both CHARMs configuration and device information—even before the physical design is completed, which fully decouples software and hardware design.

   DeltaV I/O Studio is fully integrated with DeltaV Explorer and lets you define and apply pre-configured settings for both CHARMs properties and HART device properties, reducing configuration time considerably. The pre-configured settings for HART devices can even be applied automatically once a device has been auto-sensed.

   Using DeltaV I/O Studio, you can pre-define the settings for the DeltaV Device Commissioner application, and perform “one-click” commissioning for HART devices.

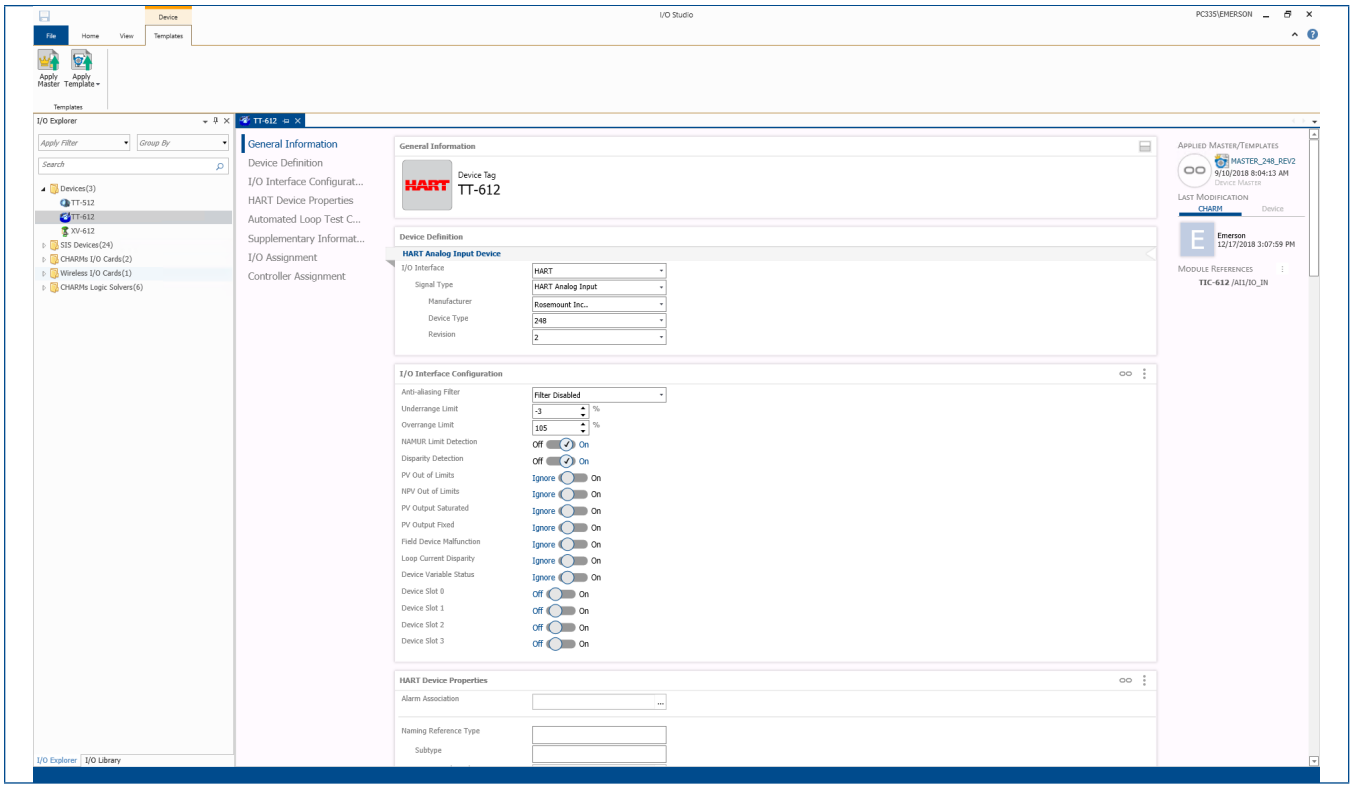

Figure 3. I/O Studio.

2. **DeltaV Device Commissioner** – This is the software application for performing commissioning work. Once all the settings have been defined, the user simply need to select the nodes and start the commissioning process. No other work is required. The traditional task-intensive commissioning process is a thing of the past.

   Any device with a commissioning issue is sent to a punch list so the user can investigate and troubleshoot. Once the proper correction has been done, the user just need to re-start the commissioning process for the affected devices.

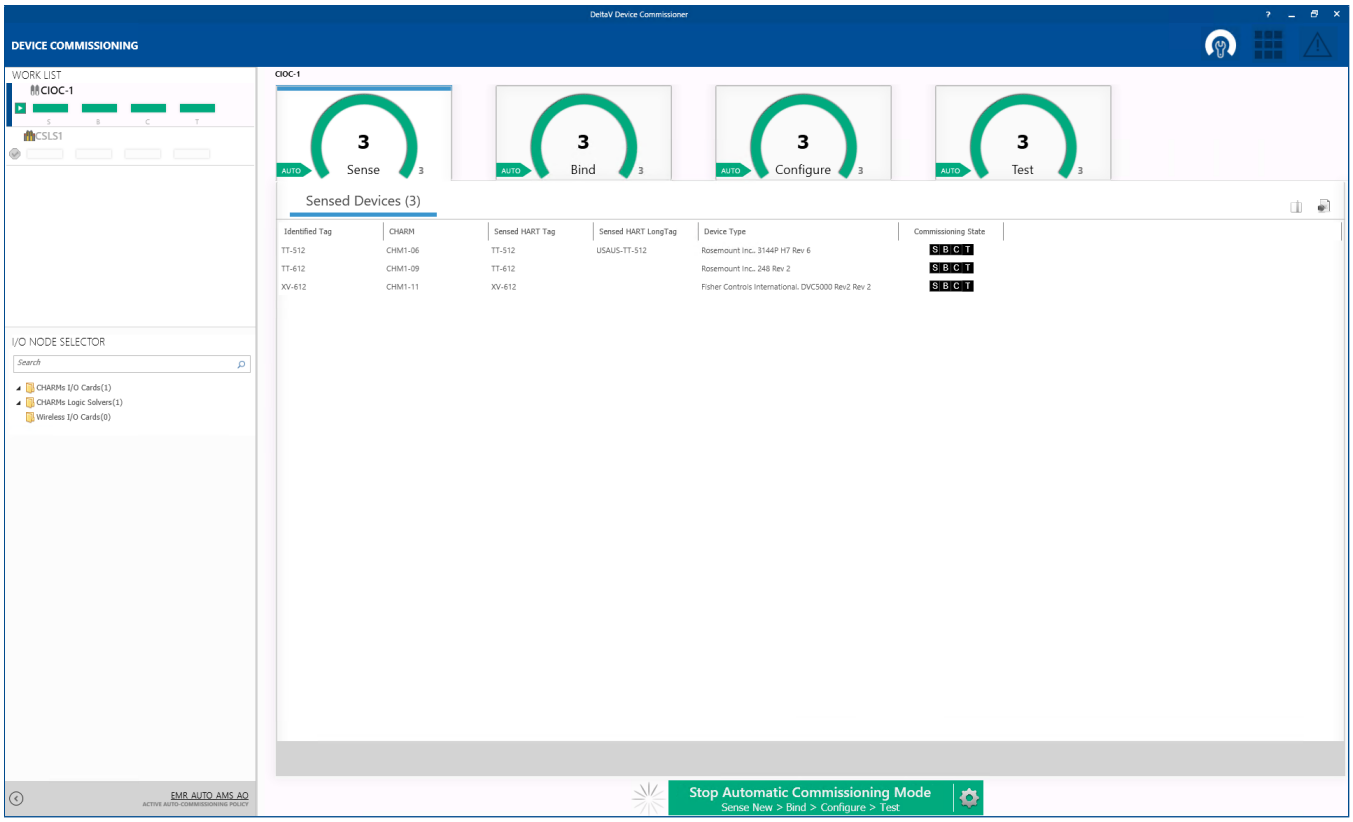

Figure 4. DeltaV Device Commissioner.

Detailed Workflows for Commissioning HART devices

This section describes the most common workflows for commissioning of HART devices. For each workflow, the following information is presented: assumptions, the required tasks prior the on-site work, and the overall sequence of activities. The main difference among the different workflows is how the field device tag is reconciled to the device signal tag (DST) in DeltaV. As previously explained in the ‘Handling Tags Within HART Instruments’ section, there are three main methods for reconciling the tags associated with devices. These three approaches are summarized in the figure below. However, once the tags have been reconciled, the rest of the commissioning workflow is practically the same.

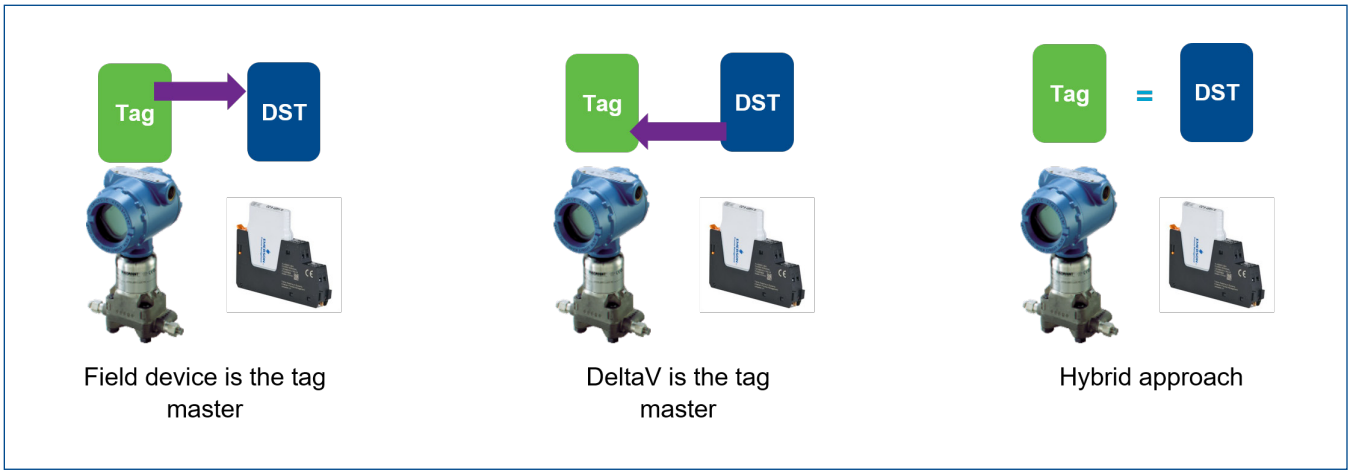

Figure 5. Options for Tag Handling.

Emerson's Recommended Workflow – Field device is the tag master

Assumptions:

- HART devices have been pre-tagged at either the factory or before/during installation.
- Configuration of control and/or safety logic have been completed and tested. Configuration of control strategies and safety logic only include DST references rather than assignments to specific I/O channels.

Required Activities Prior On-site Work:

- Commissioning policy is set so the field device tag will become the DeltaV DST during the auto-sensed process.
- The DST generation policy is defined if the tag read from the field device needs to be processed to match the DST reference.
- AMS Device Manager User Configurations have been created and mapped to device tags. If field devices are properly configured, then there would be no need to create User Configurations. In this case, the commissioning policy must be set to skip device configuration.
- Loop test templates have been defined and assigned to the proper device placeholders. The test templates specify the number of steps as well as step increments (e.g. 5-point tests consisting of 0, 25, 50, 75, and 100 percent of the process variable).
- Expected values for the automated loop tests have been defined and entered (in I/O Studio) via bulk edit for each placeholder.

Recommended Workflow - Field device is the Tag Master:

Device Installation and Wiring	Devices are installed and verified to ensure the right device is installed in the right process connection and there is no issues in the installation or connection to the process (mechanical completion). Device is wired to the proper field enclosure as defined in a device allocation list per field enclosure. Installer selects the proper terminal block and CHARM based on the device list for the enclosure. Devices are wired per a typical wiring diagram.
Starting Automatic Process for the given I/O node (CIOC, CSLS or WIOC)	User launches the DeltaV Device Commissioner, selects the proper node(s), and start the commissioning process. From here all the rest of the tasks are performed automatically by the commissioning application.
Auto-sensing CHARMS	The DeltaV system identifies the type for each CHARM. CHARMs configuration templates are applied once devices are bound which eliminates manual CHARM configuration.
Auto-Sensing HART Devices	HART devices are auto-sensed and tags are reconciled per the commissioning policy (in this case, the device tag becomes the DeltaV DST). All device references are automatically bound to the control strategies.
Bulk Device Configuration	The DeltaV Device Commissioner initiates the AMS bulk transfer for automatic device configuration.
Automatic Loop Tests	The new DeltaV loop test functionality is used to generate device signals in step increments (e.g. 0, 25, 50, and 100 percent of the process variable). The system automatically verifies that appropriate indication is correct at each test point based on the defined expected results. A single technician can set and check functionality from a DeltaV workstation. DeltaV automatically documents the loop checks steps and provide the ability to generate commissioning reports.

Alternate Workflow 1 – DeltaV is the Tag Master

While Emerson recommend the workflow above, Smart Commissioning is flexible enough to accommodate other workflows.

Assumptions:

- The HART devices tag is ignored on this workflow. Typically, this means that devices were not tagged prior to connecting to control system. It also possible that devices were not consistently tagged, and a decision was made to use the DST from the control or safety system.
- Configuration has been completed and tested prior to shipment to site. Configuration of control strategies includes DST references assigned to specific I/O channels.

Required Activities Prior On-site Work:

- Commissioning policy is set so the DeltaV DST will become the field device tag during the auto-sensed process.
- AMS Device Manager User Configurations have been created and mapped to device tags. If field devices are properly configured, then there would be no need to create User Configurations. In this case, the commissioning policy must be set to skip device configuration.
- Loop test templates have been defined and assigned to the proper device placeholders. The test templates specify the number of steps as well as step increments (e.g. 5-point tests consisting of 0, 25, 50, 75, and 100 percent of the process variable).
- Expected values for the automated loop tests have been defined and entered (in I/O Studio) via bulk edit for each placeholder.

Alternate workflow 1 - DeltaV is the Tag Master

Device Installation and Wiring	Devices are installed and verified that right device is installed in the right process connection and there is no issues in the installation or connection to the process (mechanical completion). If generic devices are used, this means that the device is from the right class. The device is wired to the proper I/O CHARM, based on the cable schedule. Installer selects the proper terminal block and CHARM based on cable schedule. Device is wired per a typical wiring diagram.
Starting Automatic Process for the given I/O node (CIOC, CSLS or WIOC)	User launches the DeltaV Device Commissioner, selects the proper node(s), and start the commissioning process.
Auto-sensing HART devices	HART devices are auto-sensed and tags are reconciled per the commissioning policy (in this case, the DeltaV DST becomes the field device tag). All device references bound to the control strategies are preserved.
Bulk Device Configuration	Same as Emerson's recommended workflow.
Automatic Loop Tests	Same as Emerson's recommended workflow.

Alternate Workflow 2 – Hybrid

This workflow could be utilized during modernization and retrofit projects where both device tag and device location are known. This workflow is also similar to traditional work practices.

Assumptions:

- HART devices have a tag that needs to be preserved.
- Configuration has been completed and tested prior to shipment to site. Configuration of control strategies includes DST references assigned to specific I/O channels.

Required Activities Prior On-site Work:

- Commissioning policy is set to only proceed if the DeltaV DST matches the field device tag. HART devices have been pre-tagged either at the factory or before/during installation.
- The DST generation policy is defined (optional). A tag extraction policy is only needed is the field device tag must be processed to match the DeltaV DST.
- AMS Device Manager User Configurations have been created and mapped to device tags. If field devices are properly configured, then there would be no need to create User Configurations. In this case, the commissioning policy must be set to skip device configuration.
- Loop test templates have been defined and assigned to the proper device placeholders. The test templates specify the number of steps as well as step increments (e.g. 5-point tests consisting of 0, 25, 50, 75, and 100 percent of the process variable).
- Expected values for the automated loop tests have been defined and entered (in I/O Studio) or via bulk edit for each placeholder.

Alternate Workflow 2 - Hybrid

Device Installation and Wiring	Devices are installed and verified that right device is installed in right process connection and there is no issues in the installation or connection to the process (mechanical completion). The device is wired to the proper I/O CHARM, based on the cable schedule. Installer selects the proper terminal block and CHARM based on cable schedule. Device is wired per a typical wiring diagram.
Auto-sensing HART devices	HART devices are auto-sensed and tags are reconciled per the commissioning policy. In this case, the commissioning process will proceed for all devices where the DST matches the device tag, any discrepancy will be flagged and will require user intervention.
Bulk Device Configuration	Same as recommended workflow.
Automatic Loop Tests	Same as recommended workflow.

Planning for Smart Commissioning

Traditionally, device commissioning is mainly considered as field work and not much preparation is involved. Most commissioning tasks are left to the on-site phase and any unexpected delay has a significant impact on the critical path of the project. The Smart Commissioning approach either eliminates or automates on-site tasks by developing a defined execution plan supported by the use of the Smart Commissioning tools. While the preparation effort increases, this effectively removes work from the critical path. The result is a shorter and more efficient execution phase that leads to a shorter overall process.

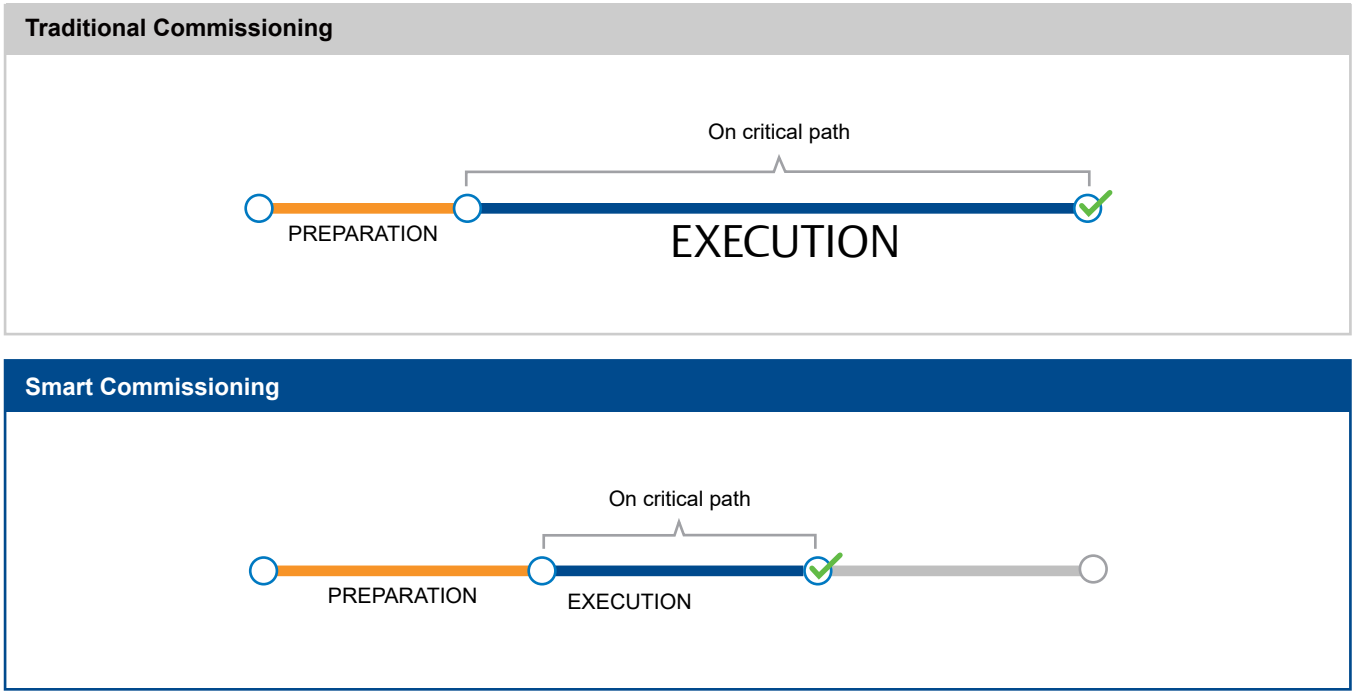

Figure 6. Workflow for Device Commissioning.

Standardization

A key aspect in improving efficiency is standardization. The Smart Commissioning software application enables the standardization of device configuration as well as the standardization on the commissioning workflow.

Standardization of configuration is related to creating templates for the I/O configuration, the device alarm settings and loop test procedures (loop test templates). The intent is to create off-line templates that could be applied to multiple devices during the execution phase.

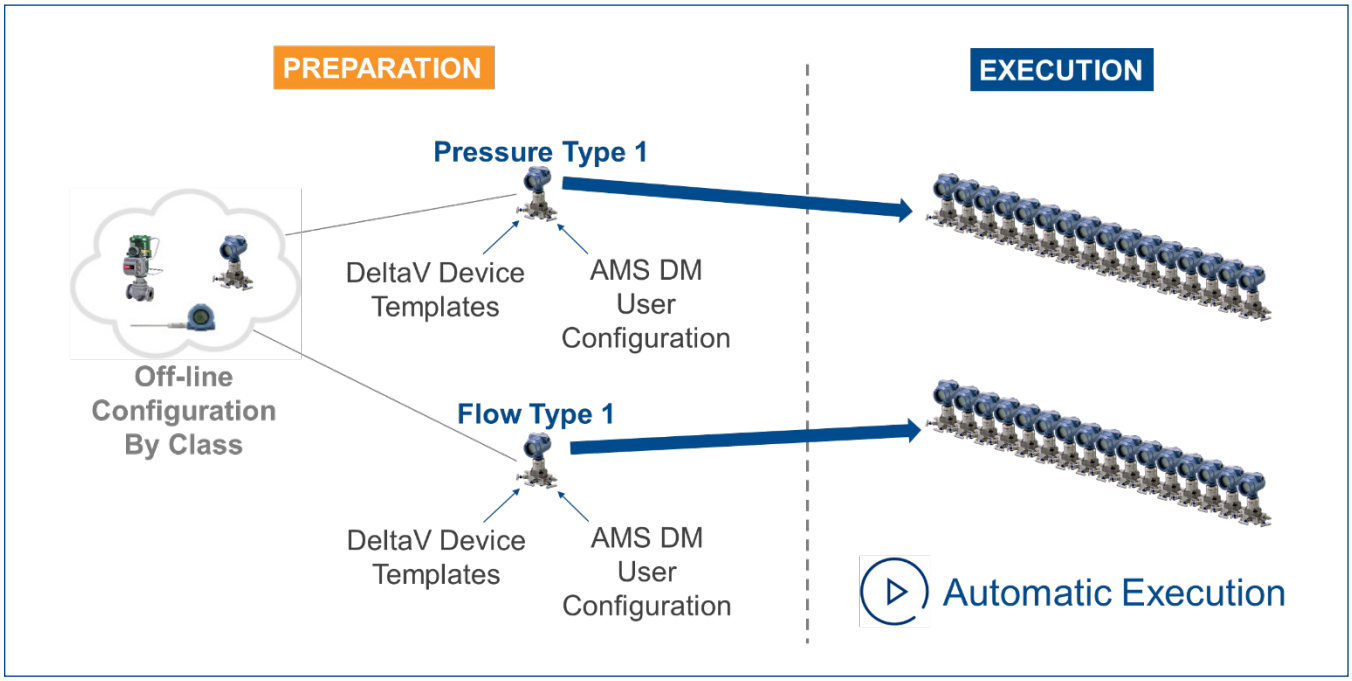

Figure 7. Template Approach for Commissioning.

Auto Commissioning Policies

The standardization on workflow is related to defining the proper work practices for maximum efficiency, among other things, the workflow development includes defining the device tagging approach and the loop test approach among other work practices. The Auto Commissioning Policy defines the way to perform sensing, binding, configuration and testing of HART devices. For example, the commissioning policy can be set to:

- Sensing only new devices, instead of all devices under a given I/O node. The option for sensing only new devices is the preferred selection. Typically, field devices do not become available at once but in increments. The user can perform Smart Commissioning on all the devices available at that time and then some days later, perform Smart Commissioning only on the recently added devices.
- Define how the field device tag would be reconciled with the system DST.
- Exclude output devices from the automatic loop test, so output devices can be loop tested at a specific time to allow for coordination with personnel in the field (if necessary, the work practices at the facility).

The commissioning policy also defines what to do on a conflict. For example, what would happen if the device tag has invalid characters or if the device information does not match the device placeholder. The goal is that during execution, the user does not need to answer prompts or take decisions. DeltaV supports multiple Auto Commissioning Policies but only one can be selected at a time. One of the multiple policies must be set as the default policy which would be automatically loaded when the DeltaV Device Commissioner is launched. The user can select a different policy before executing the commissioning process.

Project Considerations

There are multiple decisions to make based on the project requirements and work practices. Some of considerations for planning Smart Commissioning are:

- Determining the tagging approach including whether a DST Generation Policy is needed or not.
- Decide whether DeltaV device placeholder configuration will be based on master/templates or individually bulk edited. While standardization has multiple benefits, it is not required to create templates and masters. Smart Commissioning still can deliver benefits even without templates and masters.
- Establish whether control strategies will refer to assigned I/O references, unassigned I/O references, allocated devices, or unallocated devices.
- Evaluate if field device configuration (i.e. parameters within the field device) is needed. If yes, determine whether it will be performed using AMS Device Manager User Configurations or not.

The above considerations are very important as they define the required tasks before the on-site work as well as the execution approach.

Main Configuration Activities During the Project Phase

Smart Commissioning requires preparation prior the on-site work, the following configuration tasks are required before the execution phase:

- Configure device placeholders if not using system defaults. There are different options for configuring device placeholders within DeltaV. One option is to fully configure unallocated devices which enables defining all settings (e.g. alarm configuration) for each device placeholder before the I/O location is known. Unallocated devices can be created based on templates or masters to simplify the device management as templates/masters provide a central location for easily implementing changes. Another option for device placeholder configuration is to use the system defaults (including device alarm conditions), in this approach there is no need to configure templates or masters.
- Expected values for automatic loop tests have been entered for each device placeholder. User-defined imports in DeltaV Explorer (bulk edit) can be used to enter the expected values. This can be done on either allocated or unallocated device placeholders.
- If desired loop test settings are different than system defaults, create and assign Automatic Loop Test templates as appropriate. The default settings for loop test include among other things five test points (0%, 25%, 50%, 7% and 100%).
- Set the DST Generation rules in DeltaV Explorer (if needed). These DST generation rules are only needed if:
  - It is desired to use an alternate field device tag (i.e. message field for HART 5 devices and HART long tag for HART 7 device).
  - The alternate field device tags (message field or HART long tag) are longer than 16 characters.
  - It is necessary to perform some string replacement (e.g. handling a “-” as “_” within the field device tag).

- Create and map AMS Device Manager User Configurations (if needed). Creating User Configurations is only required if field devices will be configured (i.e. parameterized) via pre-defined configuration templates during the on-site activities.

  Creating these device configuration templates involves:

  - Group devices in classes defined by device type and application. An User Configuration is needed per device type (manufacturer, model, and revision). The same device type could have multiple User Configurations for different applications. For example, a pressure transmitter could be used for flow or level measurements. The user could create different User Configurations for those applications. Only one User Configuration can be associated with a given field device.
  - Decide what parameters from the configuration template will be applied to the device instances. User has full control on what parameters from the template will be applied to the device instances.
  - Determine if certain parameters such as instrument ranges are needed on a device-by-device basis. Certain parameters (e.g. device description) can be applied along the User Configuration. The User Configuration defines all the common parameters across all the device instances while other parameters (outside the template definition) can be applied to specific devices.
  - Create a device mapping table to associate each template (User Configuration) to device tags. This association is done via an excel file that is uploaded to AMS Device Manager.
- Develop commissioning policies. The commissioning policies define the specific commissioning workflow as well as the rules for managing conflicts during the commissioning process.

In addition of the configuration activities described above, some other installation tasks are required, please consult the previous section about the different workflows for details.

On-site Execution of Smart Commissioning

The on-site work is extremely simplified due to the planning phase. **Smart Commissioning provides positive results only after proper planning and preparation**. It is strongly recommended to either involve subject matter experts early during the planning phase or ensure all personal involved with Smart Commissioning planning is adequately trained. Below is a step-by-step description of the on-site work:

1. User launches the DeltaV Device Commissioner and acquire a given node (e.g. CIOC). The default commissioning policy is automatically selected. The user only needs to change the commissioning policy if a different workflow is required for the selected node(s).
2. The user clicks a button to initiate the commissioning process for all devices connected at that time and walk away to work on other tasks. Since the process is fully automatic, there is no need to interact with the system. Conflicts will be addressed based on the commissioning policy.
3. The user comes backs after 30 minutes or so and review the results. If the commissioning policy was set for manual execution of loop tests on output devices, then the user can start doing those tests on demand.
4. User forwards information about punch list items to appropriate personnel. The punch list is classified based on the commissioning phase (sensing, binding, configuration, and testing).
5. User generates reports for all completed devices.
6. Once a punch list item is addressed, the user repeats the process and generates the appropriate reports.

The DeltaV Device Commissioner application provides a progress report (commissioning dashboard) where the number of completed devices is displayed. The dashboard provides separate metrics for DCS, SIS, and wireless devices. Filters are provided based on process area, I/O node, or controller.

Parallel Execution

In a traditional commissioning approach one commissioning team works on one device at a time, a process that could take a couple of hours per device. Commissioning a device with Smart Commissioning takes a few minutes and the benefits become even more significant when multiple devices are commissioned in parallel. In a facility with thousands of devices the savings in time and effort are significant.

Potential Savings (On-site Tasks)

With Smart Commissioning, a device can be commissioned in about 5 minutes and the benefits become even more significant when doing multiple devices in parallel. However, since the commissioning time per device depend on multiple factors, such as the number of devices commissioned in parallel, it is not possible to provide a definite time per device. However, here are some references:

1. In a test done in a lab environment, 60 devices connected to two different CIOCs (30 devices each) were commissioned in 30 minutes by a single person.
2. In a customer site, 395 devices were commissioned in 4 days by a single commissioning team. This represent about 100 devices per day, which is much faster than the typical 20 devices per day with traditional methods.

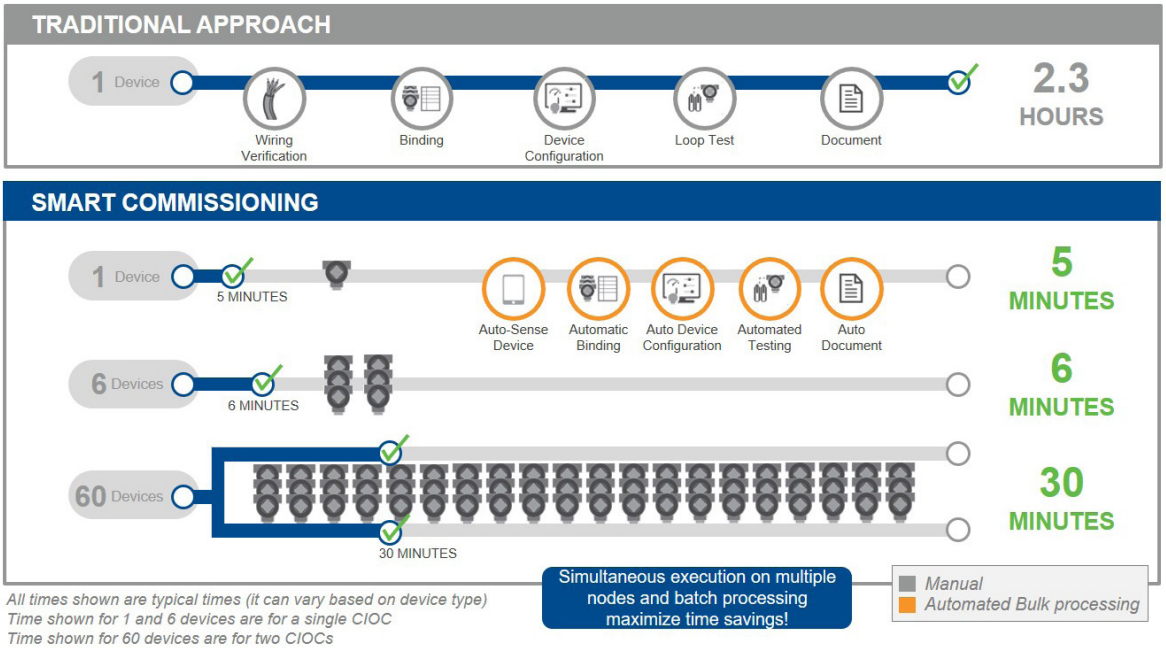

Figure 8. Smart Commissioning savings in execution phase.

Recommended Capacity Limits for Smart Commissioning

One of the main benefits delivered by Smart Commissioning is the ability to execute commissioning tasks simultaneously on multiple devices and multiple nodes, however it is recommended to be mindful about the number of concurrent sessions for the DeltaV Device Commissioner. Running too many current sessions could negatively impact the overall commissioning performance. While there is no enforced limits, it is recommended the following:

- **Maximum number of simultaneous HART devices per node** – DeltaV Device Commissioner can handle up 96 HART devices per CIOC or CSLS and up to 100 wireless HART devices per WIOC. The application throttles the process and automatically groups the devices in sets for processing. No special consideration is needed for commissioning 96 devices from one instance of DeltaV Device Commissioner.
- **Maximum number of simultaneous nodes from one instance of DeltaV Device Commissioner** – The DeltaV Device Commissioner application can process multiple nodes at the same time, however the performance could decrease if a large number of nodes are processed simultaneously, especially during the binding and configuration phases due to the database transactions and higher rate of HART communications. Executing too many nodes at the same time from a single DeltaV Device Commissioner could lead to binding errors and longer times for device configuration (i.e. AMS Device Manager's bulk transfer process). It is recommended to limit the simultaneous commissioning process to no more than 6 nodes at the same time. It is fine to have more than 6 nodes acquired at the same time but is recommended to process no more than 6 nodes at the same time.
- **Maximum number of simultaneous nodes from different instances of DeltaV Device Commissioner** – Only one DeltaV Device Commissioner session is allowed per DeltaV workstation, however multiple DeltaV Device Commissioner sessions can be run on different work stations. Each I/O node can only be processed by one DeltaV Device Commissioner application. Performance could decrease if a large number of nodes are processed simultaneously. Executing too many nodes at the same time from multiple DeltaV Device Commissioner sessions could lead to binding errors. It is recommended to limit the simultaneous commissioning process to no more than 6 concurrent sessions. Executing device configuration on multiple nodes from multiple instances can have slightly better performance than executing device configuration on multiple nodes from the same instance, however it is still recommended to limit the simultaneous execution of device commissioning to no more than 6 simultaneous sessions on different workstations.

The following table summarizes the recommended limits for Smart Commissioning:

Smart Commissioning Capacities	Fix Limit	Recommended Limit
Simultaneous HART devices per CIOC or CSLS	96	-
Simultaneous wireless HART devices per WIOC	100	-
Simultaneous nodes from either same instance or different instances of DeltaV Device Commissioner	None	6

Table 1. Recommended Capacity Limits for Smart Commissioning

Conclusions

Smart Commissioning streamlines the commissioning of field instrumentation to a DeltaV Distributed Control System (DCS) or Safety Instrumented System (SIS). It reduces effort and time for commissioning HART devices by automating most of the associated tasks involved. Expected time savings for the commissioning of HART devices are about 75%. The benefits of Smart Commissioning extend beyond the site work; it changes the way automation projects are executed.

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