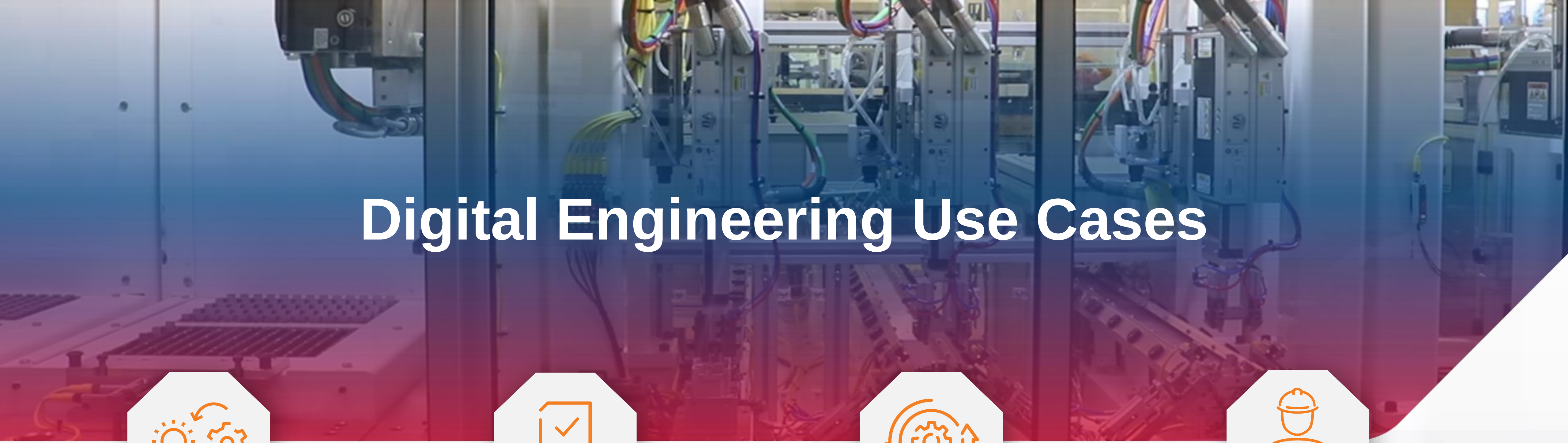
Rockwell Automation

FactoryTalk® Logix Echo

expanding **human possibility**®

PUBLIC



Digital Engineering Use Cases

Machine Prototyping

Easily design and build the next generation of machines with confidence

Virtual Commissioning

Design, test, validate, & commission machines before they go into service

Throughput Analysis

Optimize throughput with real-time 3D simulation of dynamic processes

Operator Training Simulators

Reduce risk by training your workforce in a safe, virtual environment

Digital Twin Workflow

Mitigates risks and adds flexibility in your projects

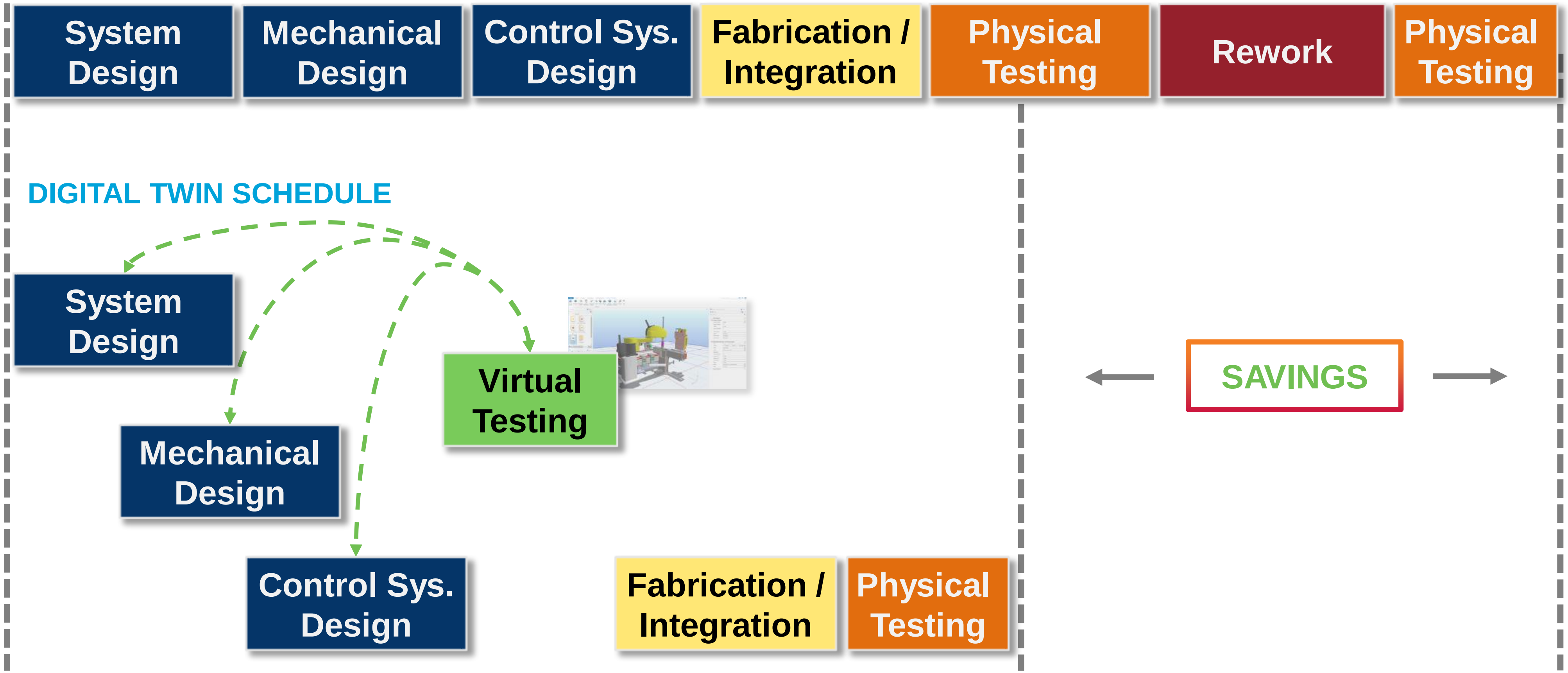
Improve project delivery timeline

Improve quality of design

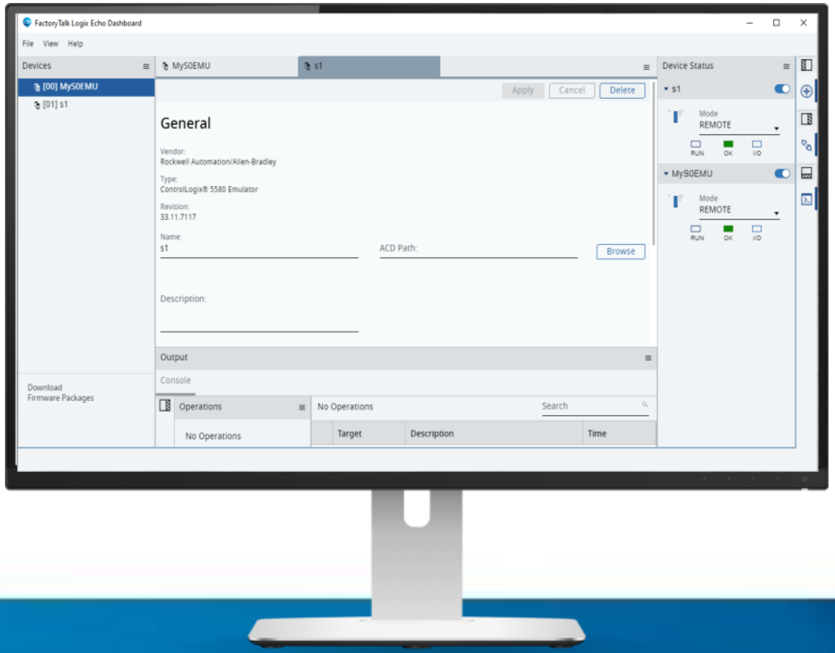
Reduce hardware dependencies

Reduce commissioning risks

TRADITIONAL SCHEDULE



FT Logix Echo



General

Vendor:
Rockwell Automation/Allen-Bradley

Type:
ControlLogix® 5580 Emulator

Revision:
33.11.7117

Name:
s1

ACD Path:

Description:

Mode: REMOTE

Mode: REMOTE

Emulate ControlLogix® 5580 Controllers

- Fully test your control code in a safe, virtual environment
- The emulated chassis supports up to 17 controllers
- Execute controller project as designed without modifications

Ethernet Connectivity

- Front port of controller emulated
- Produce/Consume and MSGs between emulated controllers
- Connect to HMI or other software with Class 3 MSGs

SDK (Public Interface)

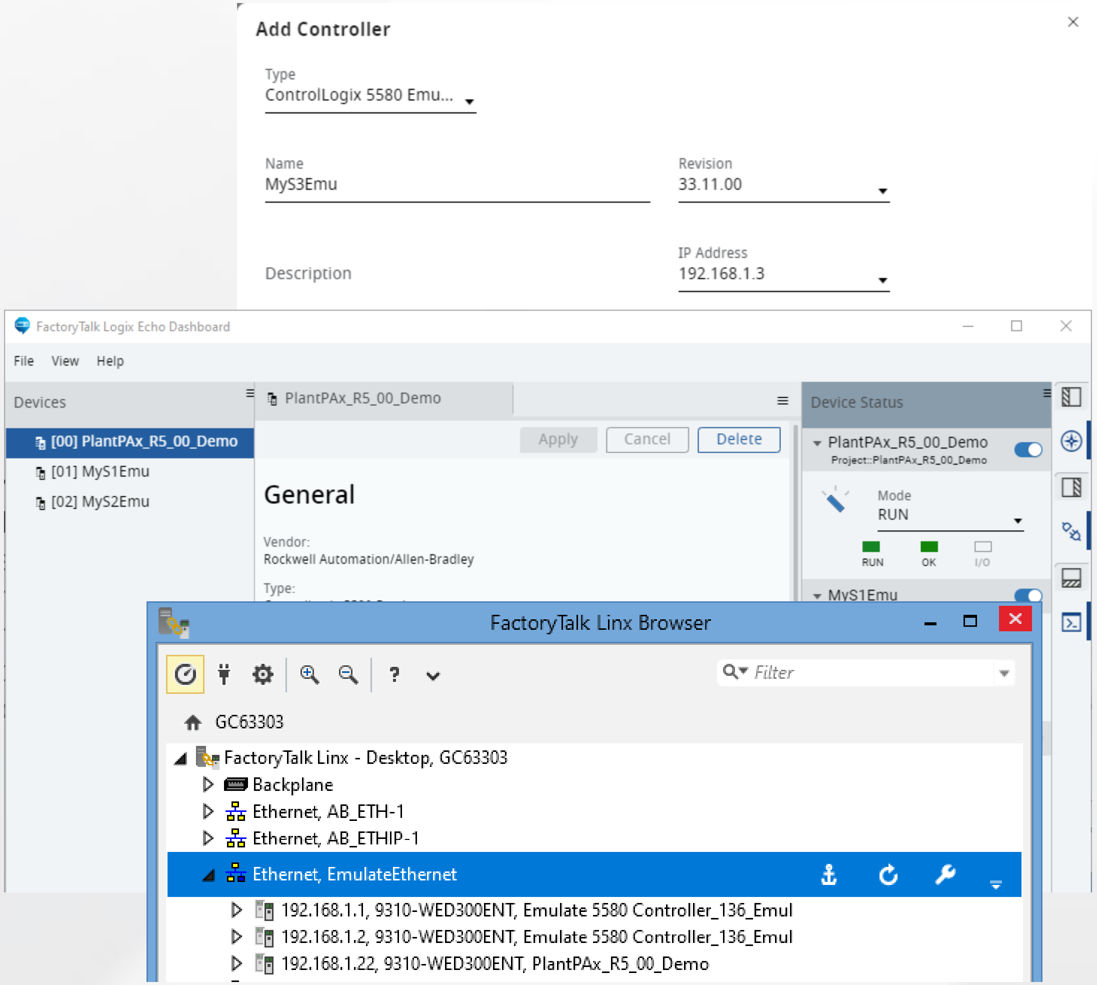
- Interface with high fidelity process simulators and Operator Training Simulators (OTS)
- High-speed data exchange
- Virtual time-scaling
- Snapshots

FT Logix Echo

Access is Similar to a Physical Controller

Setting up an emulated controller is fast

- Get the corresponding emulator firmware kit from the PCDC
- Create emulated controller instance with appropriate firmware revision and IP address
- Configured controllers appear in FactoryTalk® Linx software
- Create up 17 emulated controllers in one emulated chassis



Add Controller

Type: ControlLogix 5580 Emu...

Name: MyS3Emu

Revision: 33.11.00

Description:

IP Address: 192.168.1.3

FactoryTalk Logix Echo Dashboard

[00] PlantPAx_R5_00_Demo
[01] MyS1Emu
[02] MyS2Emu

PlantPAx_R5_00_Demo

General

Vendor: Rockwell Automation/Allen-Bradley

Type:

PlantPAx_R5_00_Demo
Project::PlantPAx_R5_00_Demo

Mode: RUN

MyS1Emu

FactoryTalk Linx Browser

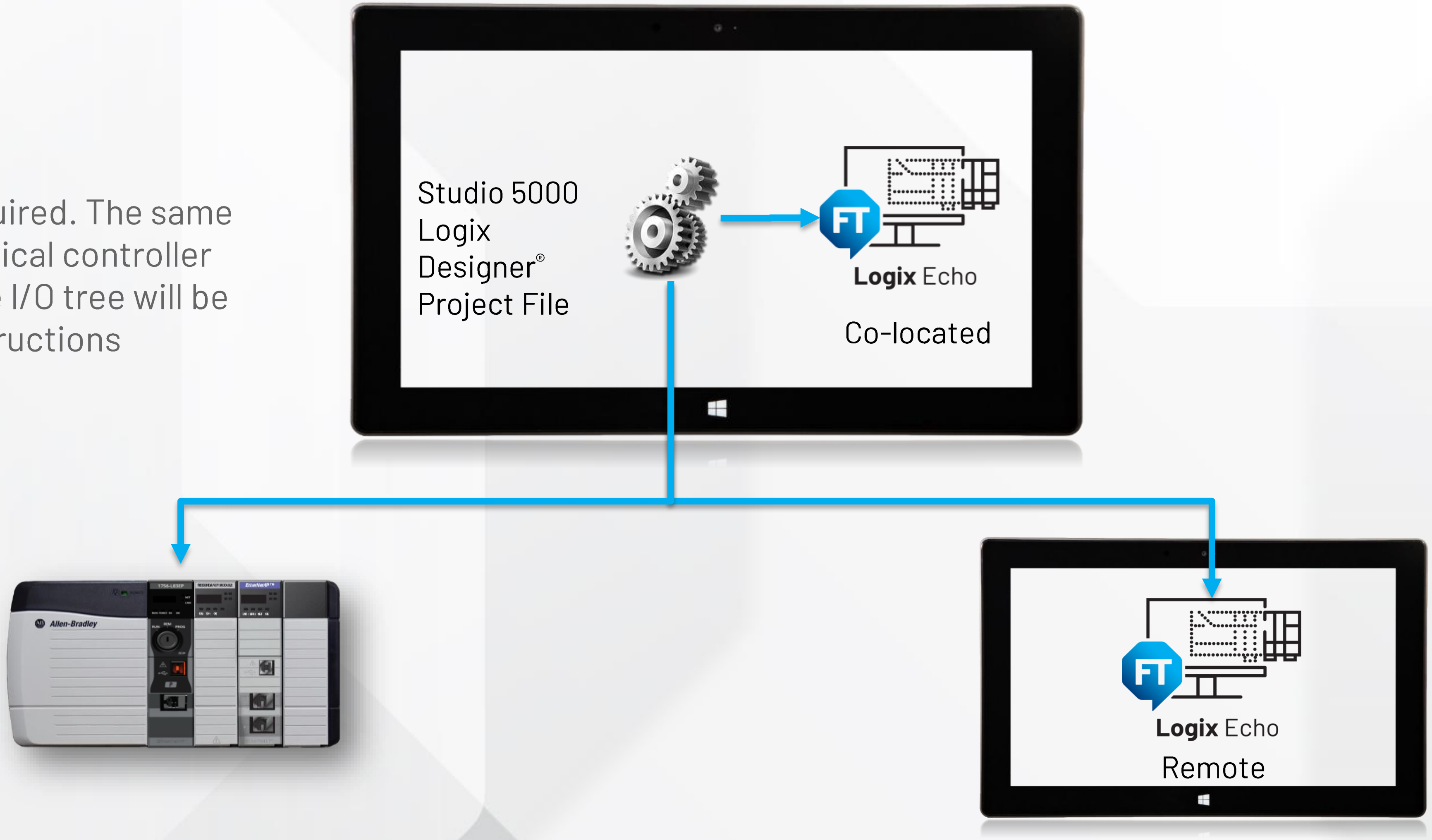
GC63303
FactoryTalk Linx - Desktop, GC63303
Backplane
Ethernet, AB_ETH-1
Ethernet, AB_ETHIP-1
Ethernet, EmulateEthernet
192.168.1.1, 9310-WED300ENT, Emulate 5580 Controller_136_Emul
192.168.1.2, 9310-WED300ENT, Emulate 5580 Controller_136_Emul
192.168.1.22, 9310-WED300ENT, PlantPAx_R5_00_Demo

FT Logix Echo

Apply Same Project to Physical or Emulated Controller

Same Project File

No changes to the project file required. The same project file developed for the physical controller will download to the emulator. The I/O tree will be maintained, all languages and instructions supported.



Logix Echo

Supported Controllers

ControlLogix® 5580 Controllers

All -E, -XT, -NSE and –P controllers

Logix Echo

Firmware version 33 or later

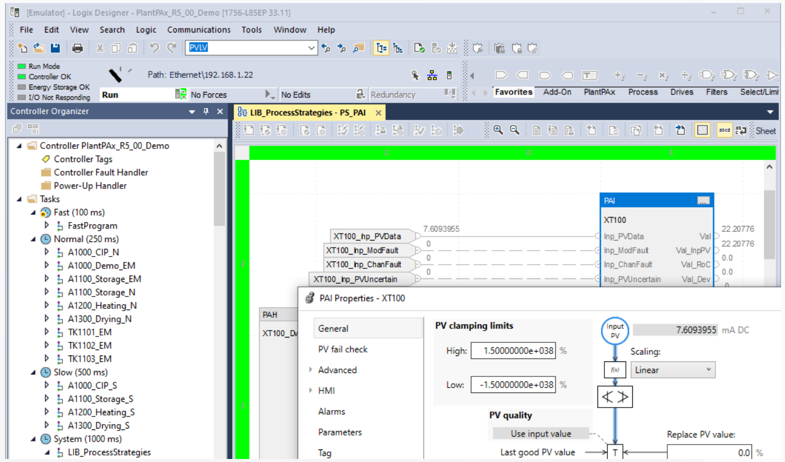
Catalogs

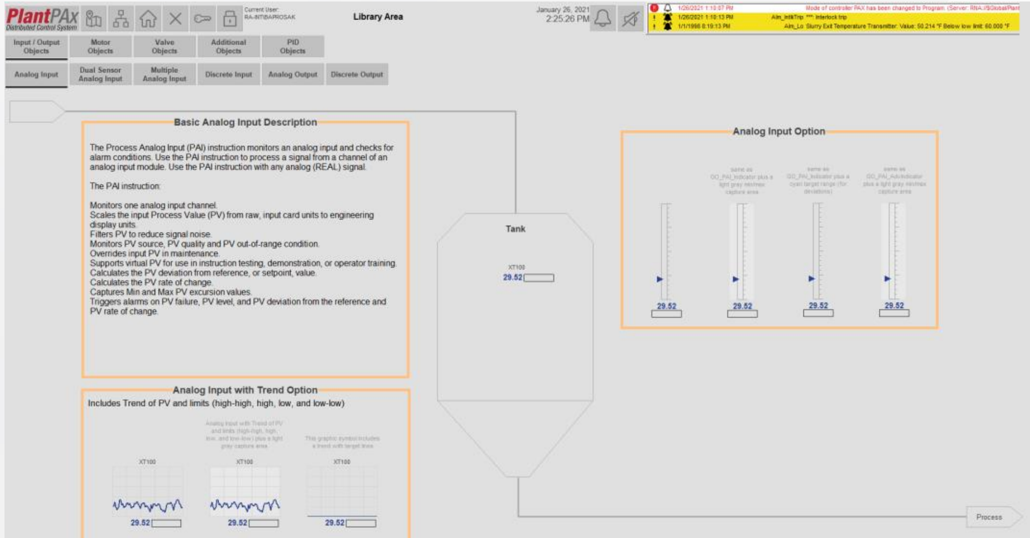
1756-L81E	1756-L82E	1756-L83E	1756-L84E	1756-L85E
1756-L81EK	1756-L82EK	1756-L83EK	1756-L84EK	1756-L85EK
1756-L81E-NSE	1756-L82E-NSE	1756-L83E-NSE	1756-L84E-NSE	1756-L85E-NSE
1756-L81EXT	1756-L82EXT	1756-L83EXT	1756-L84EXT	1756-L85EXT
1756-L81EP		1756-L83EP		1756-L85EP

Future Releases: GuardLogix® 5580, CompactLogix™ 5380 and Compact GuardLogix® 5380 Controllers

FT Logix Echo

Simulate Control Code and HMI Interaction All from a Single Workstation or Distributed





Basic Analog Input Description

The Process Analog Input (PAI) instruction monitors an analog input and checks for alarm conditions. Use the PAI instruction to process a signal from a channel of an analog input module. Use the PAI instruction with any analog (REAL) signal.

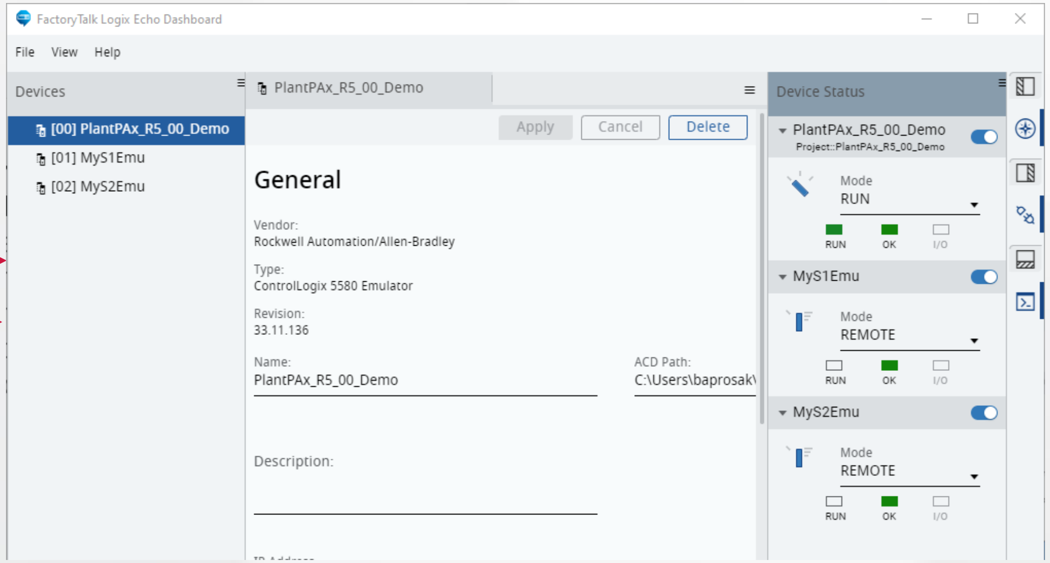
The PAI instruction:

Monitors one analog input channel.
Scales the input Process Value (PV) from raw, input card units to engineering display units.
Filters PV to reduce signal noise.
Monitors PV source, PV quality and PV out-of-range condition.
Overrides input PV in maintenance.
Supports virtual PV for use in instruction testing, demonstration, or operator training.
Calculates the PV deviation from reference, or setpoint, value.
Calculates the PV rate of change.
Captures Min and Max PV excursion values.
Triggers alarms on PV failure, PV level, and PV deviation from the reference and PV rate of change.

Analog Input with Trend Option

Includes Trend of PV and limits (high-high, high, low, and low-low)

Step 1: create Logix application and run in Studio 5000® Logix Emulate™



General

Vendor:
Rockwell Automation/Allen-Bradley

Type:
ControlLogix 5580 Emulator

Revision:
33.11.136

Name:
PlantPAx_R5_00_Demo

ACD Path:
C:\Users\baprosak\

Description:

PlantPAx_R5_00_Demo
Project::PlantPAx_R5_00_Demo
Mode
RUN

MyS1Emu
Mode
REMOTE

MyS2Emu
Mode
REMOTE

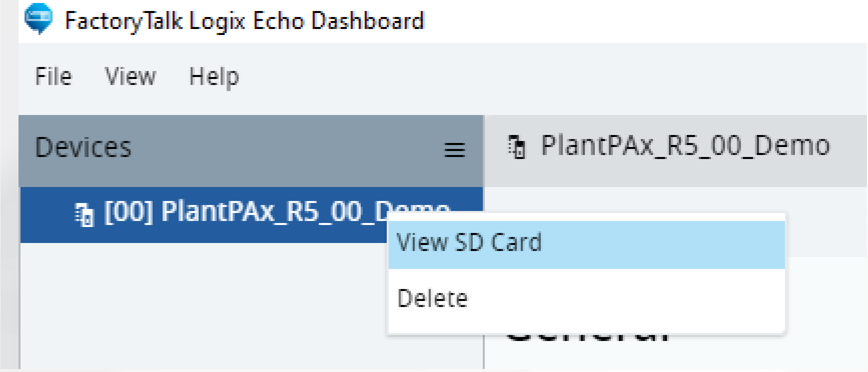
Step 2: Existing HMI shortcut(s) will work provided the emulated controller is at same IP as physical controller

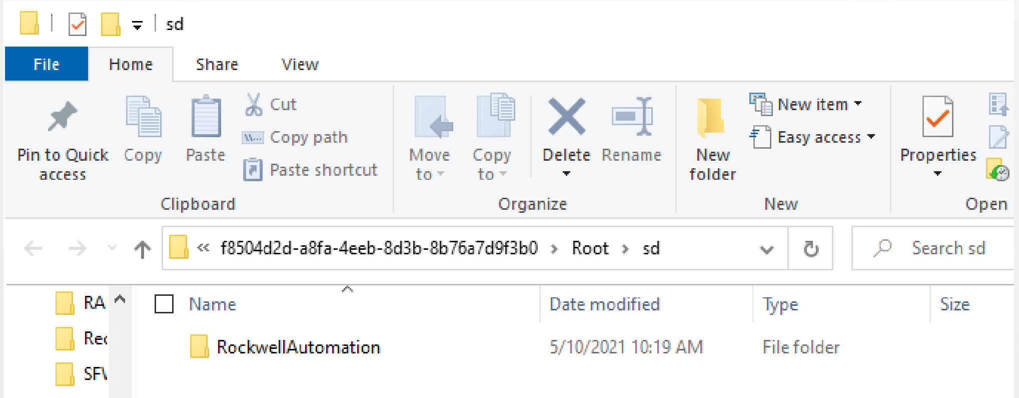
FT Logix Echo

Virtual SD Card Support

Support for SD Cards

- By default, a virtual SD card is attached to a controller (as a folder on your Windows directory)
- You can backup/restore projects, read/write data from the controller applications, log, just as you would with a physical SD card in the controller.
- Unlike the physical controller:
  - Firmware is not stored to the virtual SD
  - The content is stored unencrypted





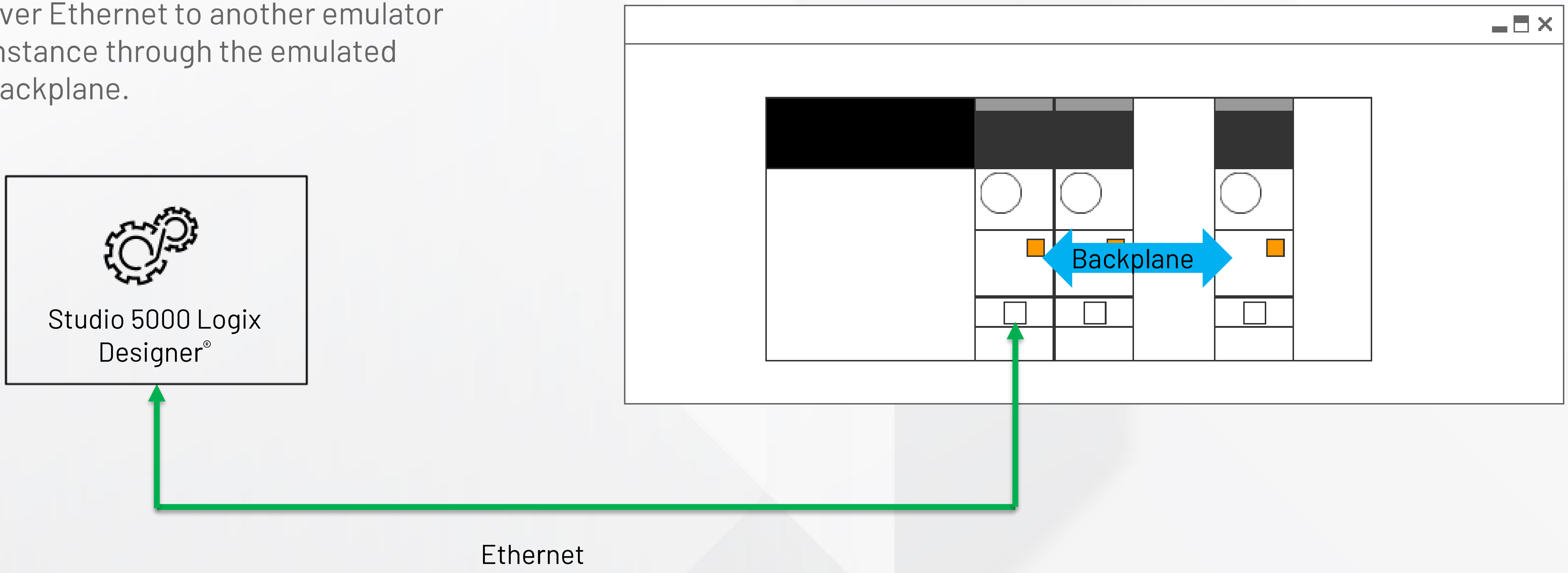
f8504d2d-a8fa-4eeb-8d3b-8b76a7d9f3b0 › Root › sd

Name	Date modified	Type	Size
RockwellAutomation	5/10/2021 10:19 AM	File folder	

FT Logix Echo

Studio 5000 Logix Designer® to Emulator Instance

Studio 5000 Logix Designer® can download over Ethernet. It can also bridge through one emulator instance connected over Ethernet to another emulator instance through the emulated backplane.

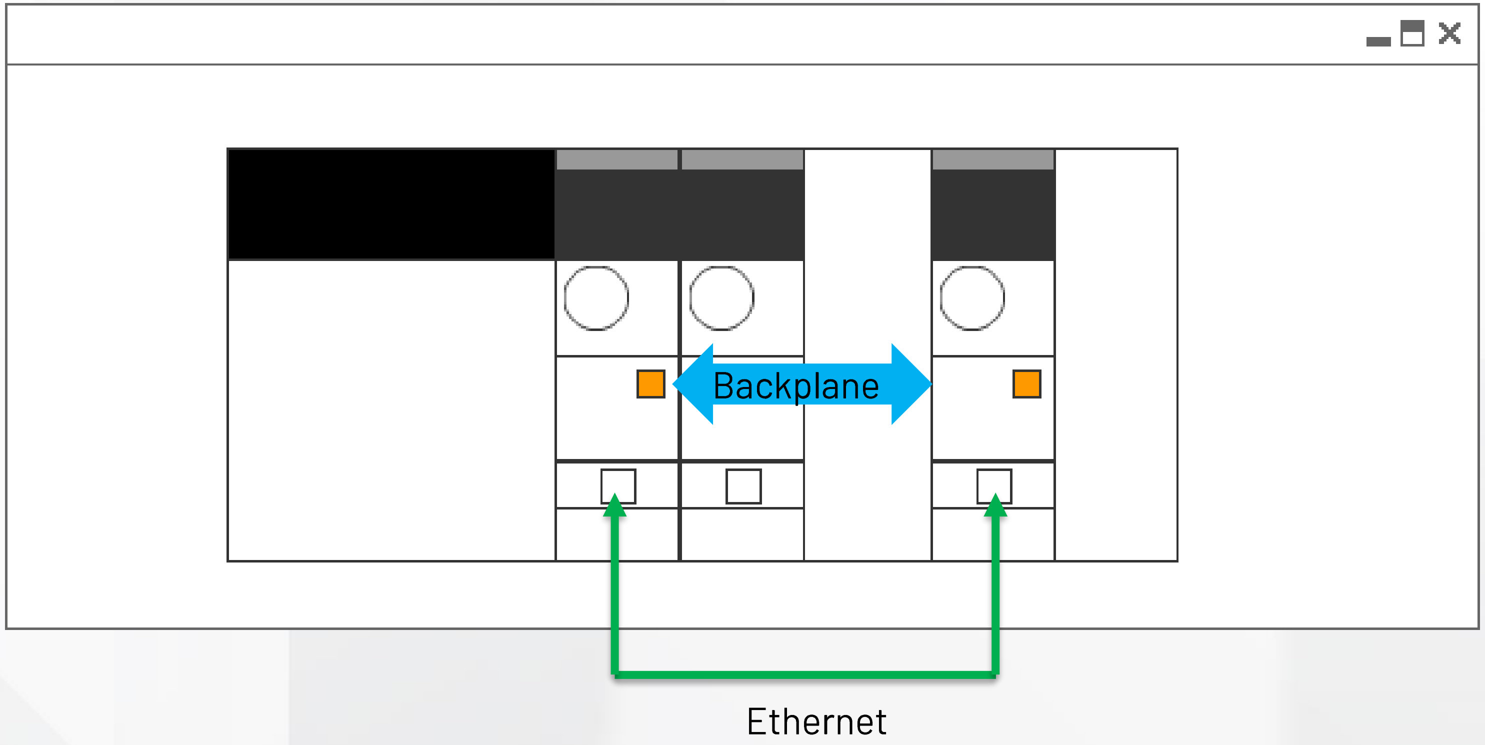


FT Logix Echo

Emulator-2-Emulator Communications

Class 1 (Produce/Consume) or Class 3 (Messages) communication between emulator instances can be established across:

- the emulated back plane
- Ethernet using the EtherNet/IP protocol.

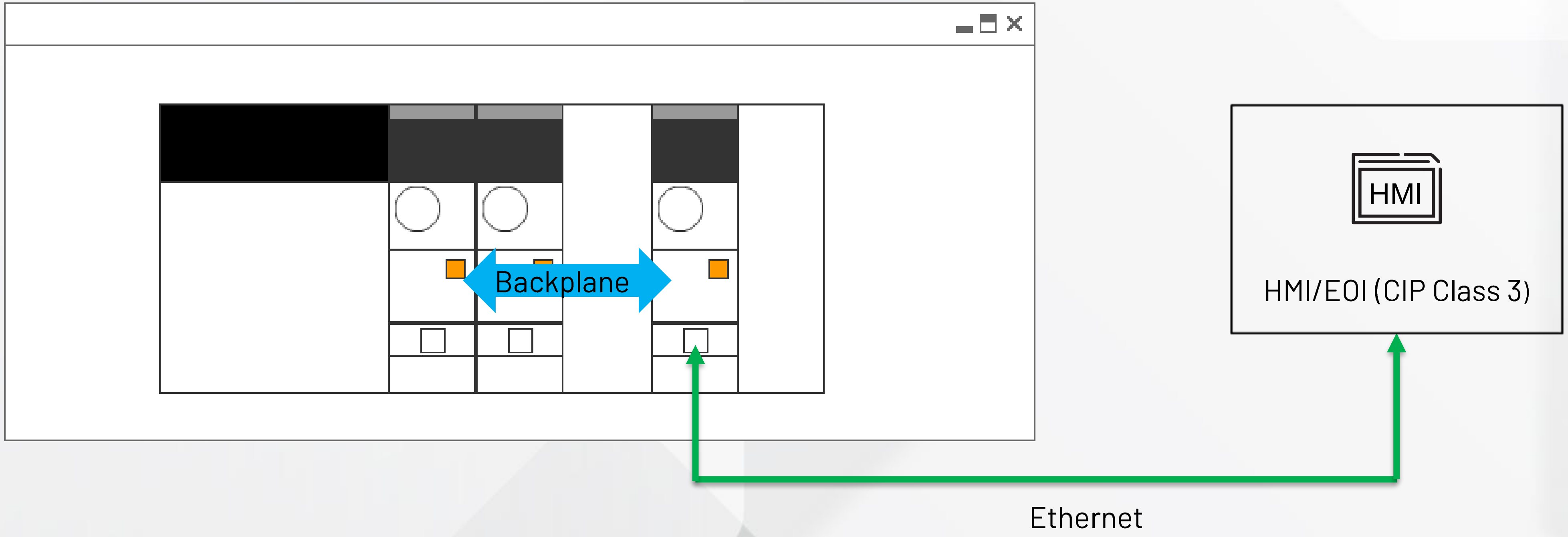


FT Logix Echo

Emulator-2-HMI/Other CIP-based software

Class 3 (Messages) communication between emulator instance and HMI/other CIP-based software:

- Over EtherNet/IP
- Bridged over backplane to EtherNet/IP

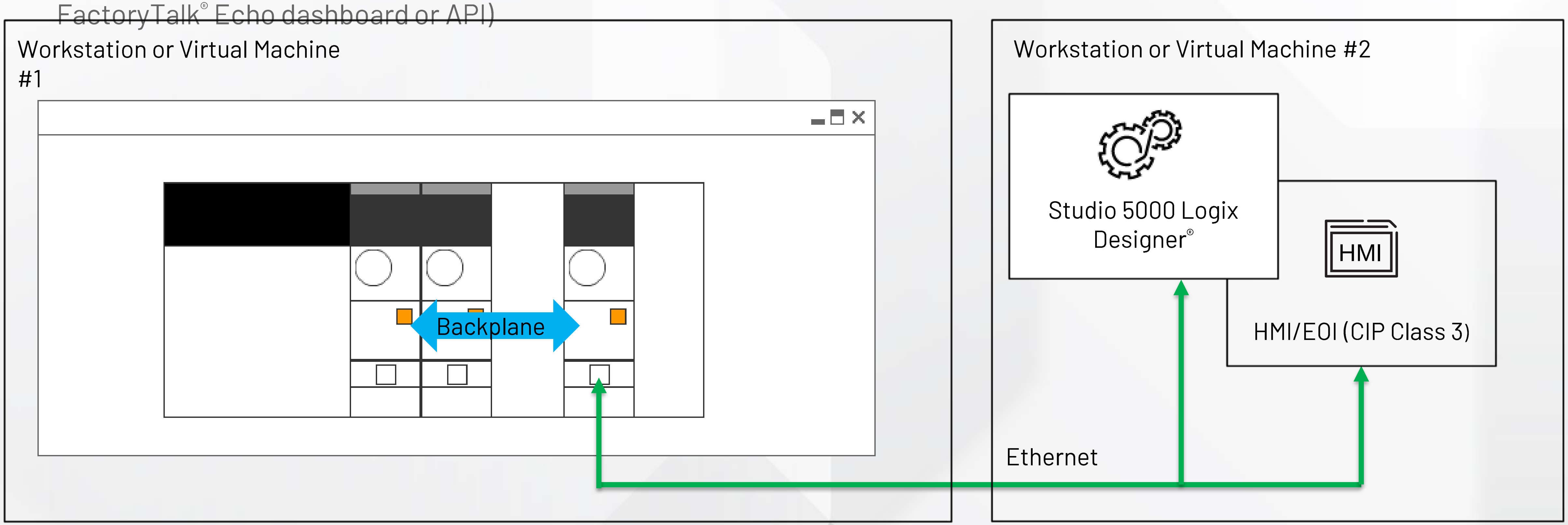


FT Logix Echo

Remote connections to Emulators

Remote instances of Studio 5000® Logix Emulate™ and HMI software can communicate with the emulator instances over Ethernet.

- When Studio 5000 Logix Designer® is not installed on the same OS as FactoryTalk® Logix Echo certain workflows are disabled that depend on Logix Designer application services (ie Creating an emulator from ACD, program Download through FactoryTalk® Echo dashboard or API)



Workstation or Virtual Machine #1
Backplane
Workstation or Virtual Machine #2
Studio 5000 Logix Designer®
HMI
HMI/EOI (CIP Class 3)
Ethernet

PUBLIC

IP Address Considerations

- Only one controller needs an IP address assigned (the rest of the controllers can be bridged to through the Ethernet connected controller, over the backplane
- The dashboard will only present IP addresses that are configured on the workstation including the loopback address, reserved in Windows for testing, 127.0.0.1.
- After assigning 127.0.0.1 to an emulator, you can reassign the IP address to any loopback address (127.x.x.x) on the general properties pane of the controller.
- Alternatively, if you have administrative privileges, additional IP addresses can be assigned to your network adapters to support additional controllers on Ethernet.

Important

- Studio 5000 Logix Designer® will not allow you to use loopback addresses for the controller in the I/O tree, preventing you from using loopback addresses for Produce/Consume messages between emulators over Ethernet.

Performance - Communications

Maximum Achievable Specifications

- Class 1 Produced/Consumed messages between emulators: 20,000 pps
- Class 1 chassis total: 160,000 pps
- Class 3: 700 messages/second
- Class 3 chassis total: 3,700 messages/second
- Minimum RPI: 10ms

Important

- As the software runs as a normal user program, it can and will be interrupted by other Windows services and processes adversely impacting performance
- Despite 99.9% of messages getting successfully transmitted/received, CIP connections will occasionally timeout due to interrupts from other Windows services

Performance – Installation Hardware Requirements

CPU – 2.2 GHz Intel Core i3 or faster processor:

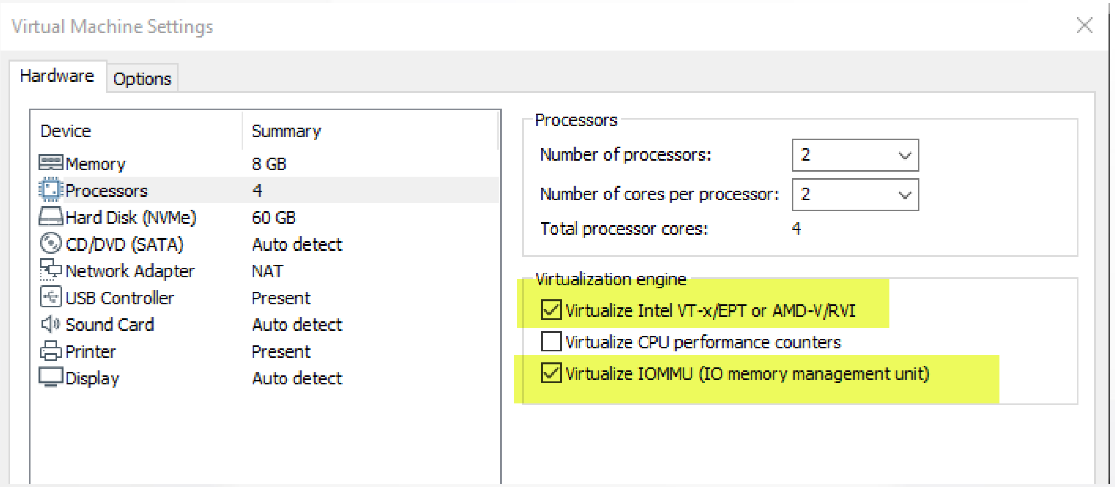
- At least one logical core for the OS
- At least two logical cores for the core FactoryTalk® Logix Echo application
- At least one logical core per emulated controller instance
- Additional logical cores dependent on additional software installed on workstation

Memory – at least 8GB:

- 2GB for the base FactoryTalk® Logix Echo application
- 256MB per emulated controller instance (4.52GB for full 17 controller emulated chassis
- Additional memory for OS and other software applications

Virtual Machine Consideration

- Use Intel Virtualization Technology



Virtual Machine Settings

Hardware | Options

Device	Summary
Memory	8 GB
Processors	4
Hard Disk (NVMe)	60 GB
CD/DVD (SATA)	Auto detect
Network Adapter	NAT
USB Controller	Present
Sound Card	Auto detect
Printer	Present
Display	Auto detect

Processors

Number of processors: 2

Number of cores per processor: 2

Total processor cores: 4

Virtualization engine

☑ Virtualize Intel VT-x/EPT or AMD-V/RVI

□ Virtualize CPU performance counters

☑ Virtualize IOMMU (IO memory management unit)

Performance - Download

Note on Building the Project

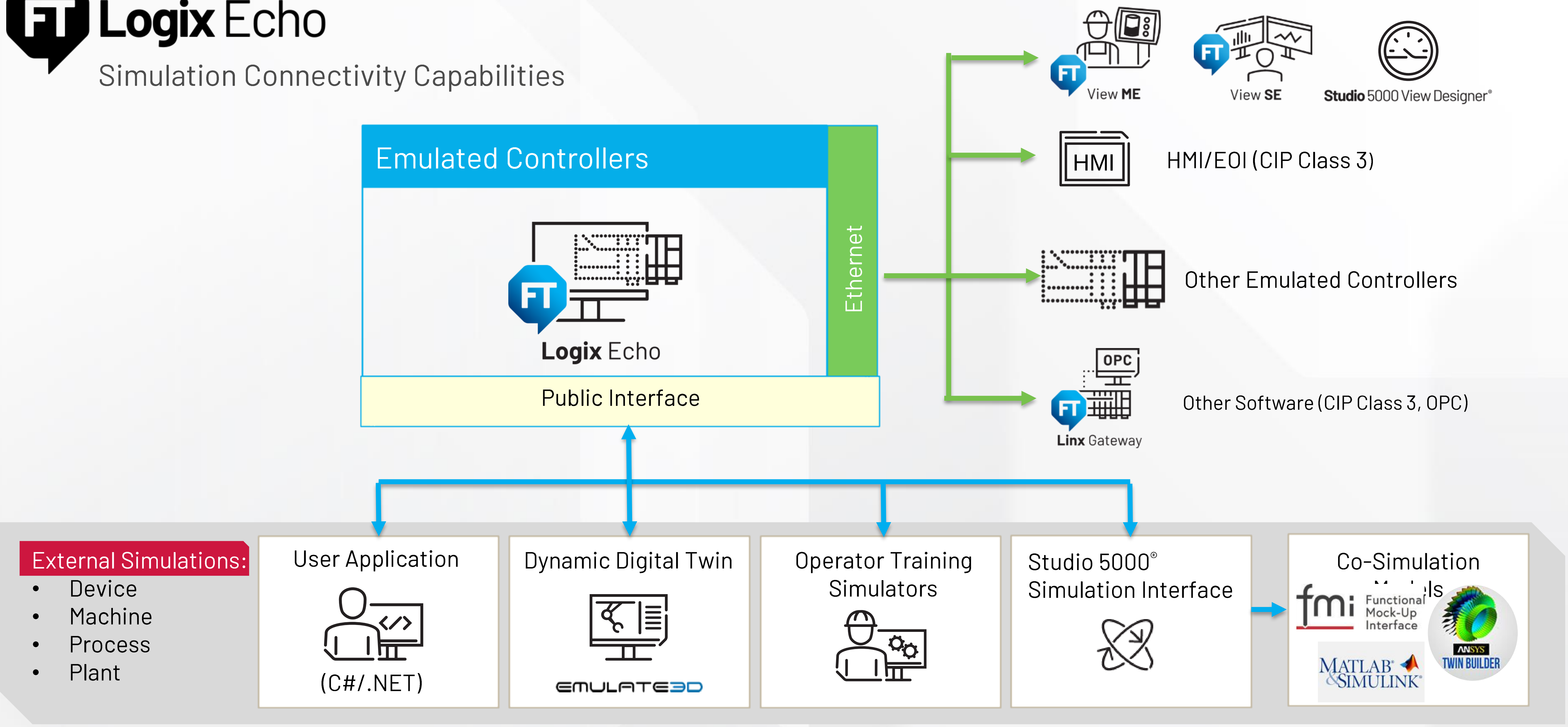
- Studio 5000 Logix Designer® will build for the physical controller by default

First Download

- If you build before connecting to the emulator, the build process will be repeated when connecting to the emulated controller for the first time
- Subsequent downloads are typically 2x faster than on physical controllers

Logix Echo

Simulation Connectivity Capabilities



Emulated Controllers

Ethernet

Logix Echo

Public Interface

View ME

View SE

Studio 5000 View Designer®

HMI/EOI (CIP Class 3)

Other Emulated Controllers

Other Software (CIP Class 3, OPC)

Linx Gateway

External Simulations:

- Device
- Machine
- Process
- Plant

User Application

(C#/.NET)

Dynamic Digital Twin

Operator Training Simulators

Studio 5000® Simulation Interface

Co-Simulation Models

FactoryTalk® Logix Echo SDK

Integrate FactoryTalk® Logix Echo into your own Software Applications

User Application

(C#/.NET)

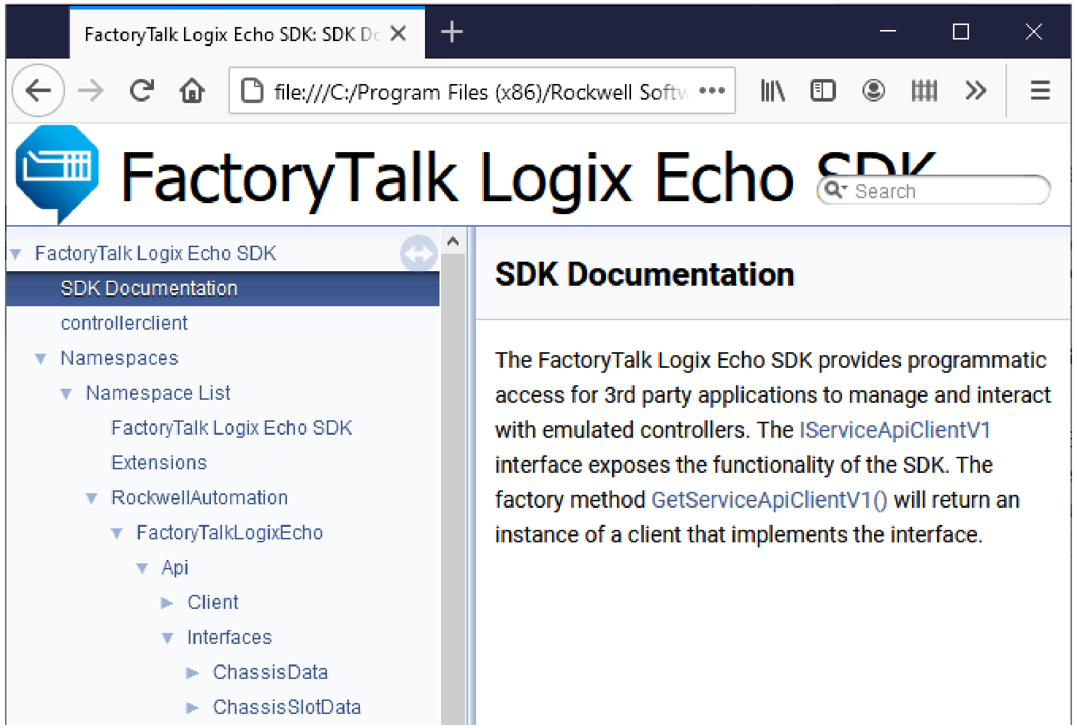
Integrate all FactoryTalk® Logix Echo functionality into your own software application. Use the SDK and API to build applications to connect directly to controllers for simulation and data analysis

The SDK documentation kit contains:

- Detailed explanations of all the API functions and their uses with sample code
- NuGet package, which includes .NET Standard 2.0 assemblies which allow access to API. (Installable in any .NET application that supports .NET Standard 2.0)

Two Sets of APIs:

- Service API: Use to manage the system and to perform all the functions that can be done from the dashboard
- Controller API: Use to control the execution, scale time, and access tags in an emulated controller


FactoryTalk Logix Echo SDK: SDK Do
file:///C:/Program Files (x86)/Rockwell Softw
FactoryTalk Logix Echo SDK
Search
FactoryTalk Logix Echo SDK
SDK Documentation
controllerclient
Namespaces
Namespace List
FactoryTalk Logix Echo SDK
Extensions
RockwellAutomation
FactoryTalkLogixEcho
Api
Client
Interfaces
ChassisData
ChassisSlotData

SDK Documentation

The FactoryTalk Logix Echo SDK provides programmatic access for 3rd party applications to manage and interact with emulated controllers. The IServiceApiClientV1 interface exposes the functionality of the SDK. The factory method GetServiceApiClientV1() will return an instance of a client that implements the interface.

Emulate3D™ Integration

Introduction: A note about Free-Running vs. Co-Simulation Modes

Dynamic Digital Twin

EMULATE3D

Free-Running mode:

- By default the virtual timing model of the emulated controller tracks real-time (windows system time) as closely as possible (to within a few milliseconds), we refer to this as 'Free-Running mode'.
- In the event there are not enough computing resources to track the system time, the model will begin skipping Continuous Task scans (and will set a fault once too many scan skips are necessary to keep up)

FMI for Co-Simulation

- Through the API the emulator can be switched into Co-Simulation mode using the FMI for Co-Simulation Interface. This is an open standard interface for coupling simulation models in a co-simulation environment. The data exchange between models (for example the controller model and the plant/machine model in Emulate3D™) is restricted to discrete communication points. In the time between, the models are solved independently from each other. A time master application (in our case Emulate3D™) controls the data exchange between the models and the time synchronization.

Functional Mockup Interface for Co-Simulation

Dynamic Digital Twin

Available in Emulate3D™ 2020 minor release at launch of FactoryTalk® Logix Echo

Integration using Co-Simulation and Data Exchange API

- Enables E3D model and controller model to be synchronized
- Supports time-scaling (Change between Free-running mode and Co-Simulation mode)
- Modifying Continuous Task Fidelity (skip task scans)

Integration over Class 1 or Class 3

- E3D can communicate over EtherNet/IP just like physical controllers

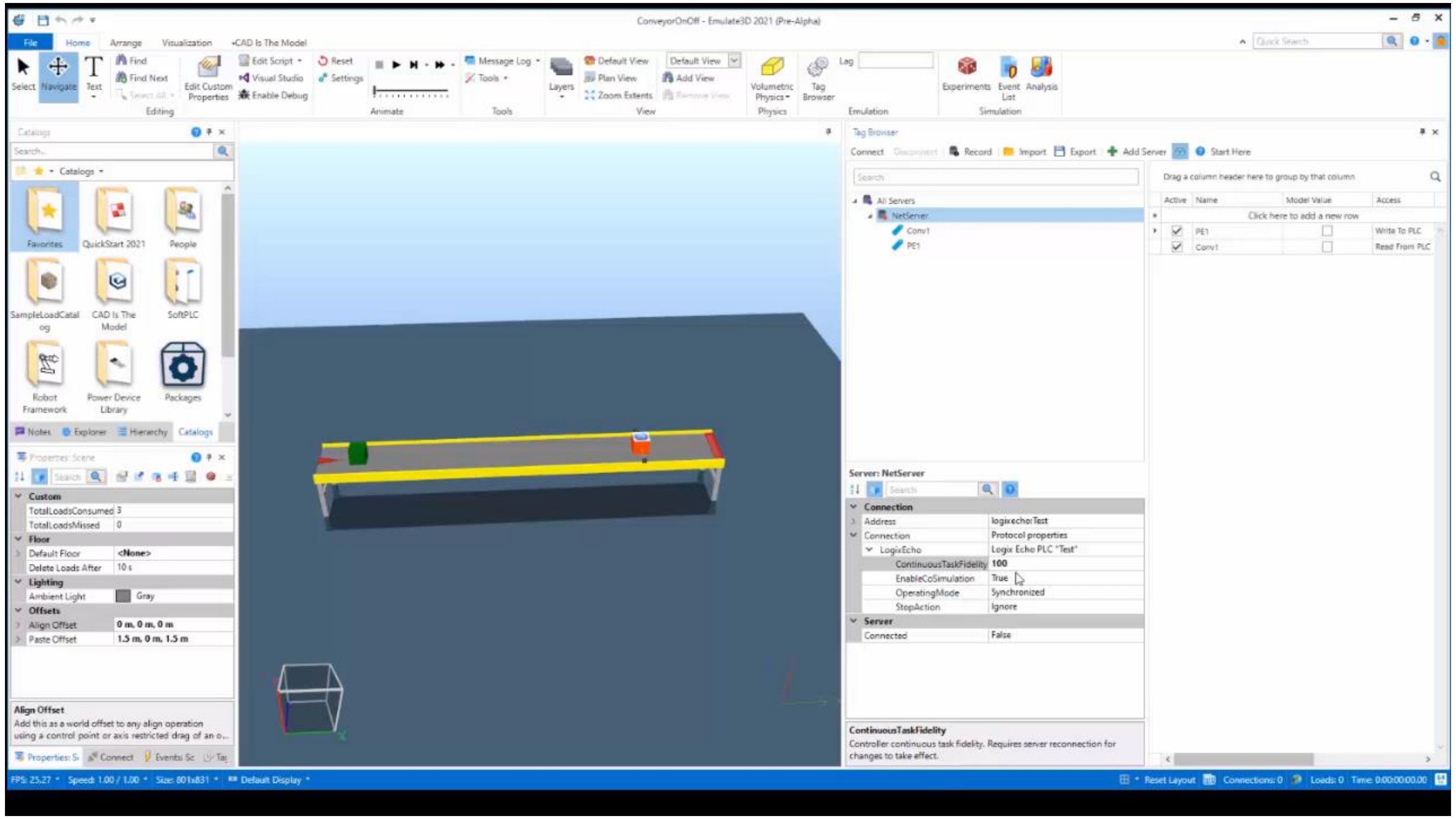
Emulate3D™ Integration

Dynamic Digital Twin

Available in Emulate3D™ 2020 minor release at launch of FactoryTalk® Logix Echo

Example 1:

- E3D runs as fast as possible with Controller in **Co-Simulation** mode
- Emulate3D™ reports the controller can be scaled to ~3x



Active	Name	Model Value	Access
☑	PE1	□	Write To PLC
☑	Conv1	□	Read From PLC

Custom	
TotalLoadsConsumed	3
TotalLoadsMissed	0
Floor	
Default Floor	<None>
Delete Loads After	10 s
Lighting	
Ambient Light	Gray
Offsets	
Align Offset	0 m, 0 m, 0 m
Paste Offset	1.5 m, 0 m, 1.5 m

Align Offset
Add this as a world offset to any align operation using a control point or axis restricted drag of an o...

Connection	
Address	logixecho:Test
Connection	Protocol properties
LogixEcho	Logix Echo PLC "Test"
ContinuousTaskFidelity	100
EnableCoSimulation	True
OperatingMode	Synchronized
StopAction	Ignore
Server	
Connected	False

ContinuousTaskFidelity
Controller continuous task fidelity. Requires server reconnection for changes to take effect.

FPS: 25.27 · Speed: 1.00 / 1.00 · Size: 801x831 · Default Display

Reset Layout · Connections: 0 · Loads: 0 · Time: 0:00:00:00.00

Emulate3D™ Integration

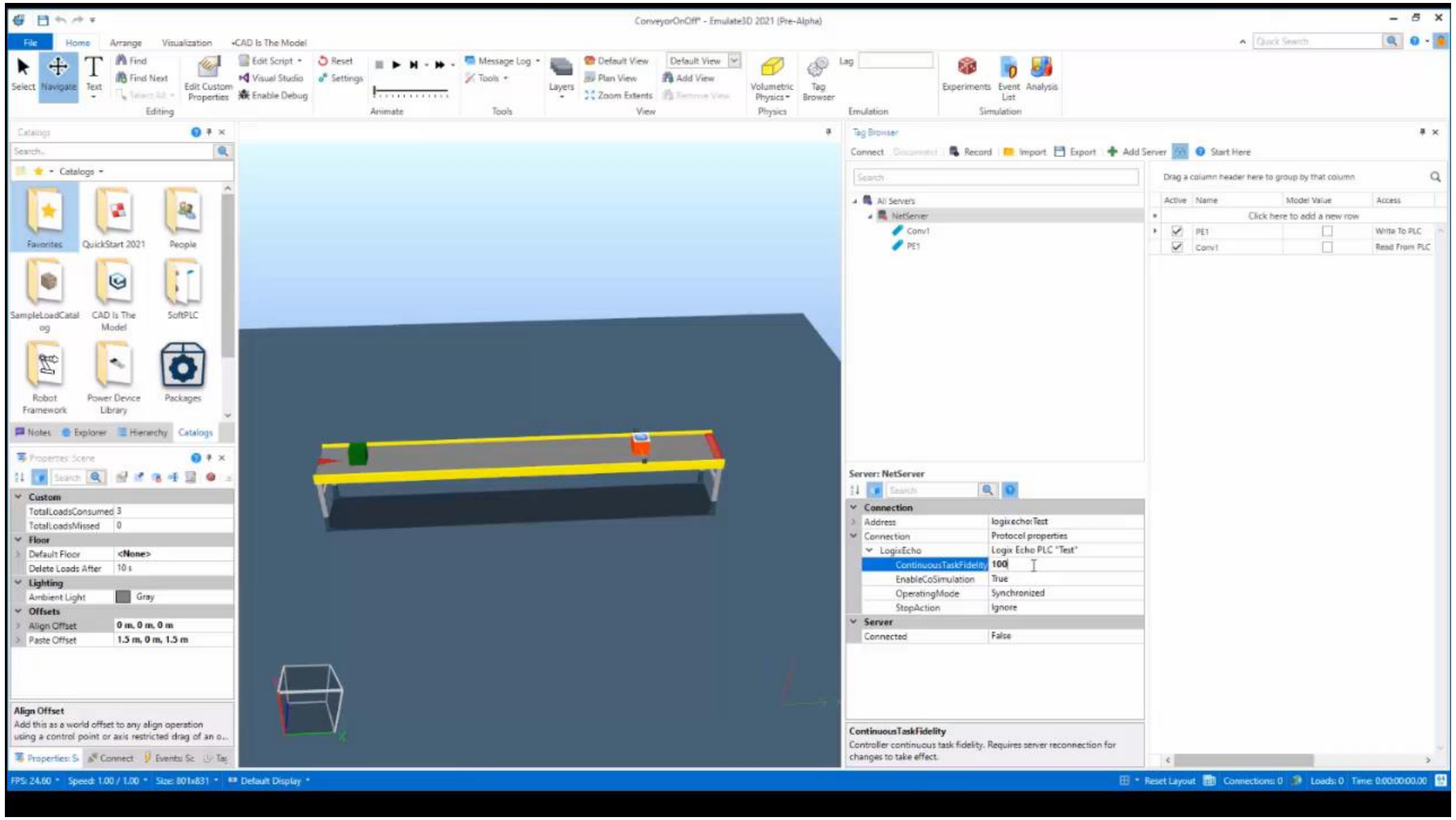
Available in Emulate3D™ 2020 minor release at launch of FactoryTalk® Logix Echo

Dynamic Digital Twin

EMULATE3D

Example 2:

- Emulate3D™ runs as fast as possible with Controller in **Co-Simulation** mode
- User reduces the **Continuous Task Fidelity to 10%**
- Emulate3D™ reports the controller can be scaled to ~11x-12x



Active	Name	Model Value	Access
☑	PE1	□	Write To PLC
☑	Conv1	□	Read From PLC

Properties: Scene

Custom	
TotalLoadsConsumed	3
TotalLoadsMissed	0
Floor	
Default Floor	<None>
Delete Loads After	10 s
Lighting	
Ambient Light	Gray
Offsets	
Align Offset	0 m, 0 m, 0 m
Paste Offset	1.5 m, 0 m, 1.5 m

Align Offset
Add this as a world offset to any align operation using a control point or axis restricted drag of an o...

Server: NetServer

Connection	
Address	logixecho:Test
Connection	Protocol properties
LogixEcho	Logix Echo PLC "Test"
ContinuousTaskFidelity	100
EnableCoSimulation	True
OperatingMode	Synchronized
StopAction	Ignore
Server	
Connected	False

ContinuousTaskFidelity
Controller continuous task fidelity. Requires server reconnection for changes to take effect.

Operator Training Simulators

High-Speed Data Exchange and Co-Simulation Interface for Integration with OTS

Operator Training Simulators

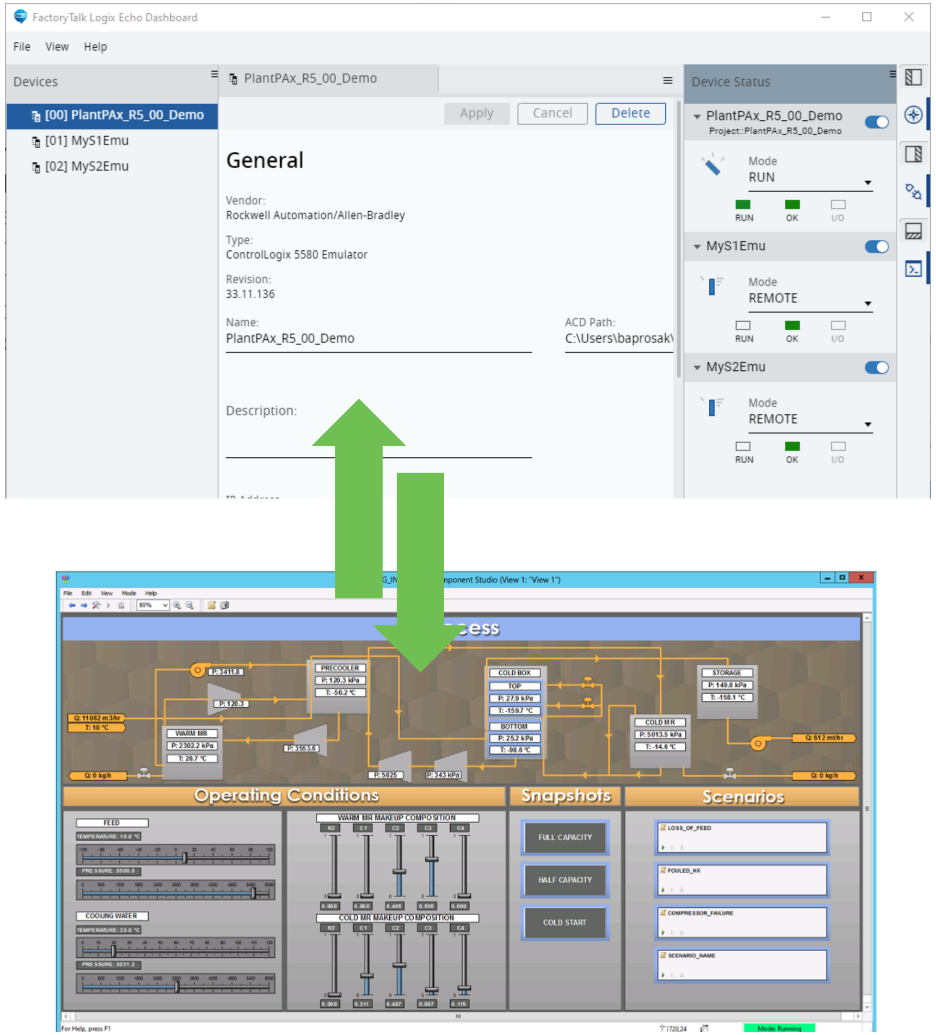
Overview

- Use your own or 3rd-party party simulation tools to interact with emulated controllers to create and simulate the plant responses

Benefits

- Provides dynamic, real-time responses like the actual plant
- Train operators in specific scenarios in a safe, fully functioning virtual system using the actual displays from operations
- Develop and test new control strategies or plant optimizations in a lab environment

Emulated controllers



FactoryTalk Logix Echo Dashboard

File View Help

Devices

[00] PlantPAx_R5_00_Demo
[01] MyS1Emu
[02] MyS2Emu

PlantPAx_R5_00_Demo

Apply Cancel Delete

General

Vendor: Rockwell Automation/Allen-Bradley

Type: ControlLogix 5580 Emulator

Revision: 33.11.136

Name: PlantPAx_R5_00_Demo

ACD Path: C:\Users\baprosak\

Description:

Device Status

PlantPAx_R5_00_Demo
Project::PlantPAx_R5_00_Demo
Mode: RUN
RUN OK I/O

MyS1Emu
Mode: REMOTE
RUN OK I/O

MyS2Emu
Mode: REMOTE
RUN OK I/O

Operator Training Simulator

FT Logix Echo

Snapshot Capabilities

Operator Training Simulators

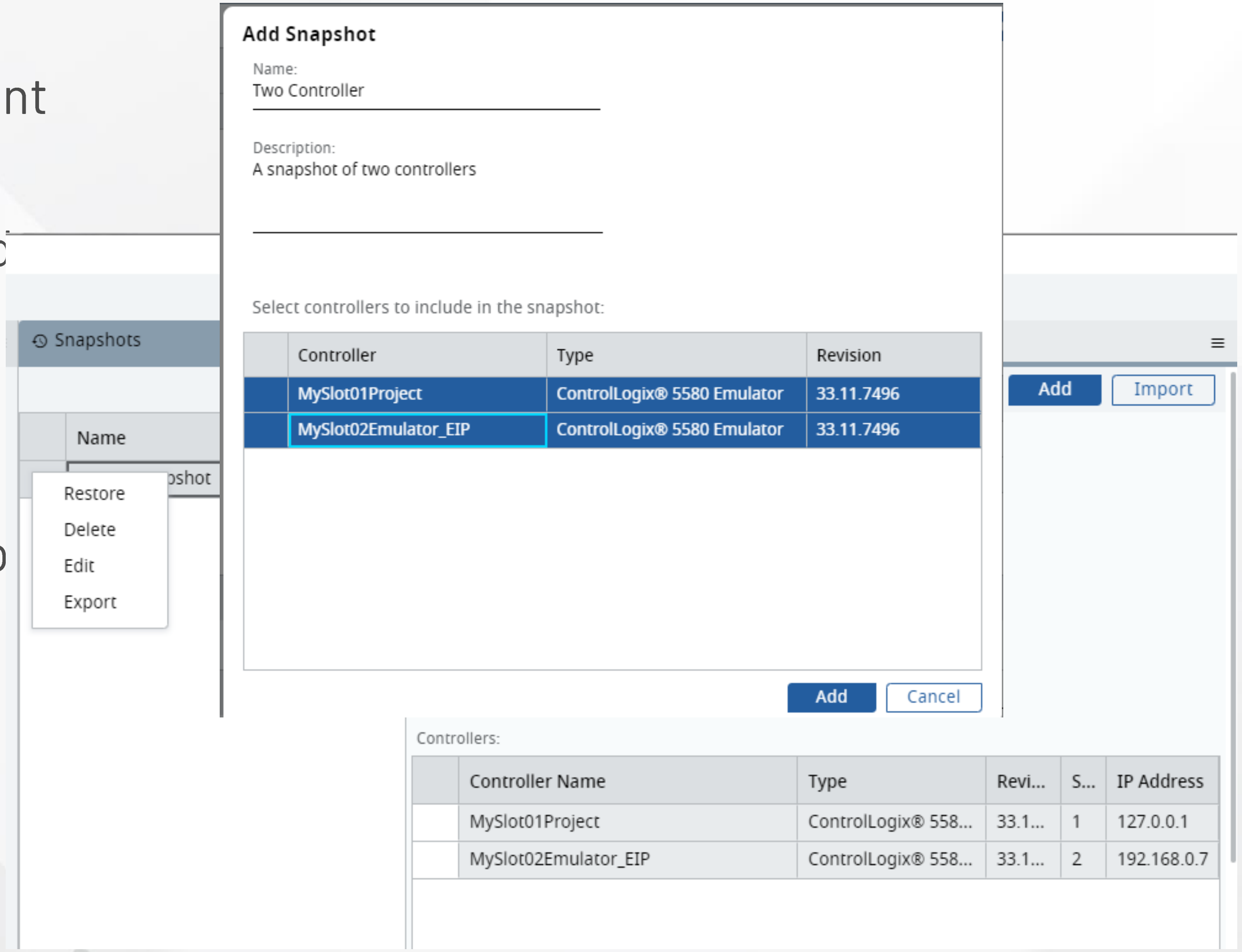
Snapshot Concept

Save one or more controller's state at a specific point in time which can latter be restored

- Includes controller time, application tag data anc execution context

Use Cases

- Operator Training Simulators: Restore training scenarios that are difficult or time-consuming to recreate
- Automated Testing: Continuously recall a known scenario for testing



Add Snapshot

Name: Two Controller

Description: A snapshot of two controllers

Select controllers to include in the snapshot:

	Controller	Type	Revision
	MySlot01Project	ControlLogix® 5580 Emulator	33.11.7496
	MySlot02Emulator_EIP	ControlLogix® 5580 Emulator	33.11.7496

Controllers:

	Controller Name	Type	Revi...	S...	IP Address
	MySlot01Project	ControlLogix® 558...	33.1...	1	127.0.0.1
	MySlot02Emulator_EIP	ControlLogix® 558...	33.1...	2	192.168.0.7

FT Logix Echo

Snapshot – What happens

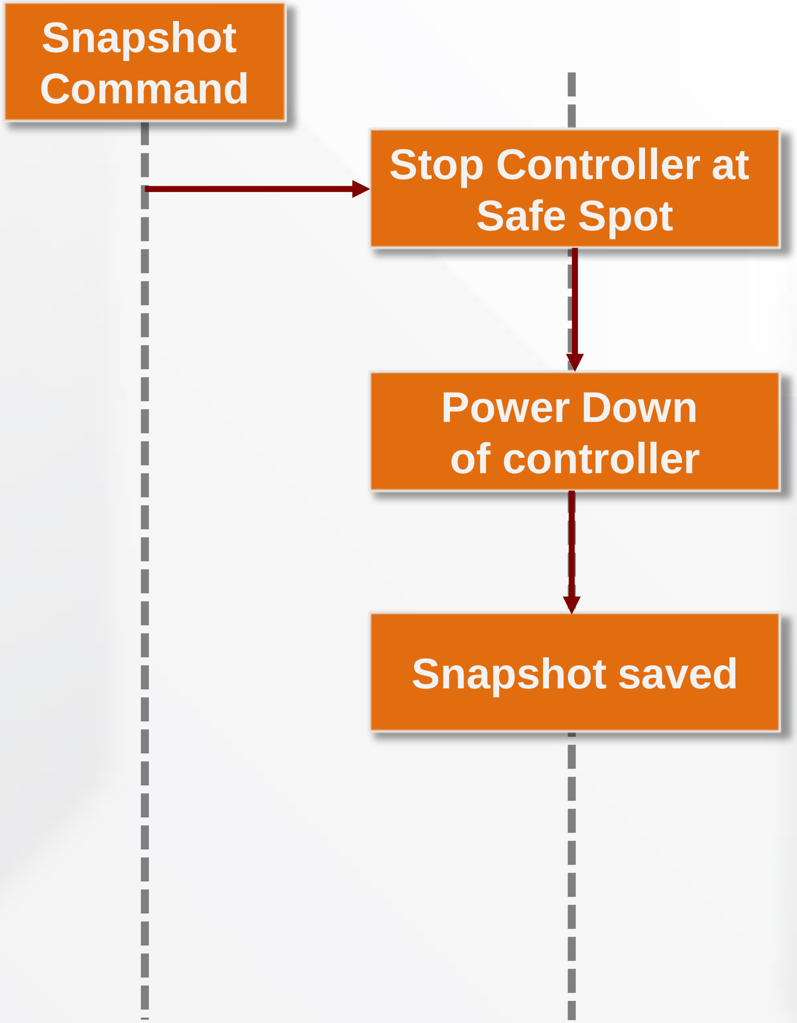
Operator Training Simulators

Saving a Snapshot

A “Power Cycle Persistence Snapshot”: We take an entire capture of the controller (static and dynamic data, like what happens during a power down of a physical controller)

Sequence of Events

- Snapshot Command: To prevent data integrity issues the controller is paused at the end of task scanning (beginning or end of continuous task (or idle if no continuous task)
- The controller powers down to save dynamic and static data
- Power up of the controller (first scan and pre-scan skipped)
- The full state is captured as a snapshot



FT Logix Echo

Snapshot – What happens

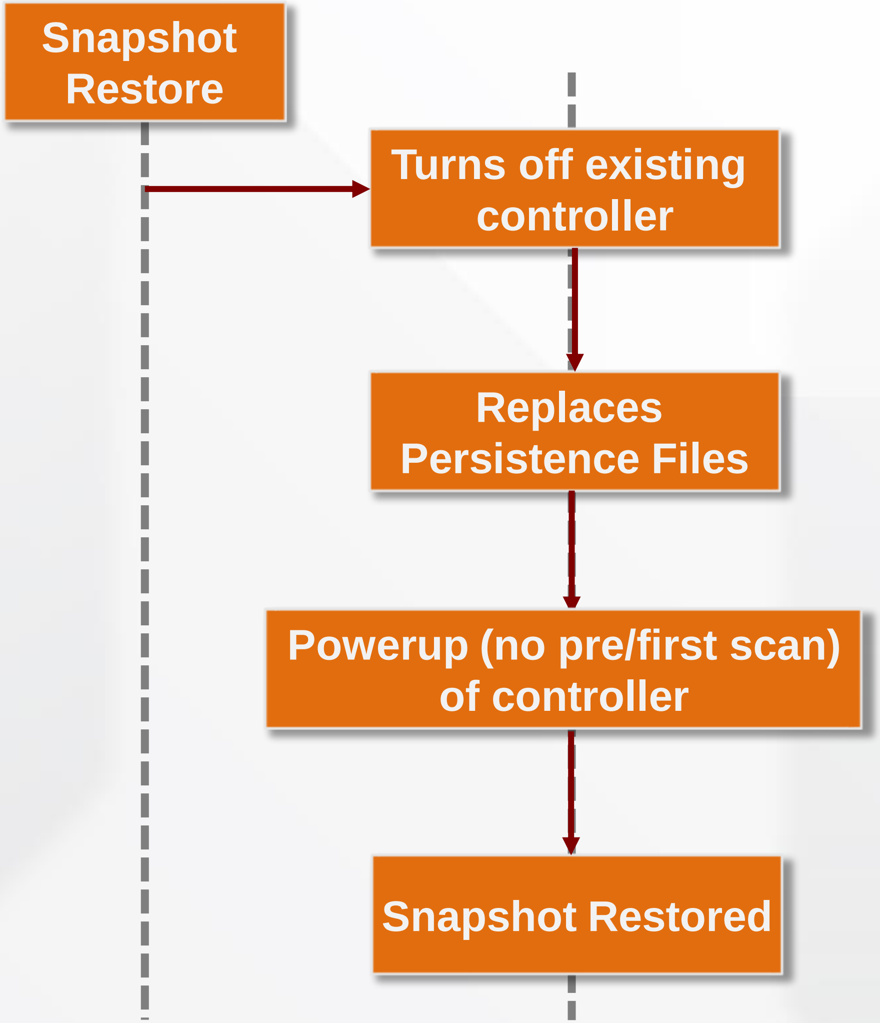
Operator Training Simulators

Restoring a Snapshot

Replaces over existing controllers

Sequence of Events

- Snapshot Restore: Turns off existing controllers. Controllers must be present in target slots of the snapshot restore. Inconsistencies presented to the user.
- The persistence files are replaced with the files from the snapshot
- On powerup the controller restores and resumes user execution, skipping first scan or pre-scan operations
- While the IP address from the snapshot will be applied to the controller, it will not bind to the IP address unless that IP is present on the workstation


Snapshot Restore
Turns off existing controller
Replaces Persistence Files
Powerup (no pre/first scan) of controller
Snapshot Restored

FT Logix Echo

Integration with Studio 5000® Simulation Interface

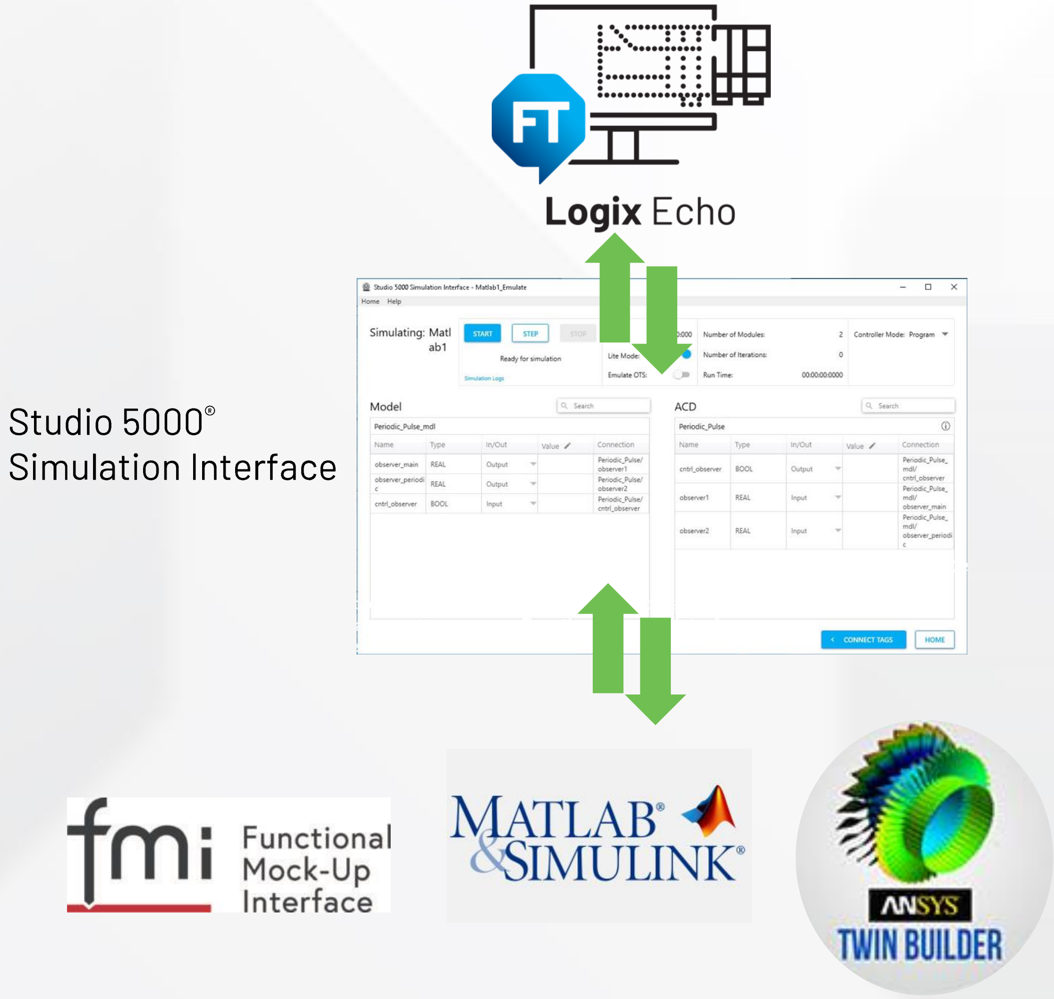
Studio 5000®
Simulation Interface

Connect

Leverage Studio 5000® Simulation Interface to map tags in your emulated controller to variables in your mathematical model for precise simulation scenarios

Supported Interfaces

- Functional Mockup Interface: Open standard for model data exchange. Import FMI 2.0 co-simulation compliant models in Studio 5000® Simulation Interface
- MATLAB with Simulink. Exchange data with Simulink models.
- New: Import and reduced order model digital twins



Studio 5000®
Simulation Interface

Studio 5000 Simulation Interface - Matlab1_Emulate

Simulating: Matlab1

Ready for simulation

Lite Mode:

Emulate OTS:

Number of Modules: 2

Number of Iterations: 0

Run Time: 00:00:00:0000

Controller Mode: Program

Model

Periodic_Pulse_mdl

Name	Type	In/Out	Value	Connection
observer_main	REAL	Output		Periodic_Pulse/observer1
observer_periodic	REAL	Output		Periodic_Pulse/observer2
cntrl_observer	BOOL	Input		Periodic_Pulse/cntrl_observer

ACD

Periodic_Pulse

Name	Type	In/Out	Value	Connection
cntrl_observer	BOOL	Output		Periodic_Pulse_mdl/cntrl_observer
observer1	REAL	Input		Periodic_Pulse_mdl/observer_main
observer2	REAL	Input		Periodic_Pulse_mdl/observer_periodic

The emulator is designed to be a virtual controller, used in the development, testing and simulation environments

With an emulator, **you can**:

- Download and run logic written in any Logix language
- Be online with Logix Designer application, and all that entails
- Connect from an HMI [except for HMI Button Control (HMIBC)]
- Produce/Consume tags with other emulators
- Use MESSAGE instructions
- Use virtual axes for motion applications. [Future feature call Axis Test Mode will enable simulation of "real" axes"]
- Download a project configured for redundancy, although it will always behave as a "Primary with no Partner" (simplex mode)

With an emulator, **you cannot**:

- Connect to physical I/O devices
- Connect motion axes to real drives
- Produce/consume tags with other physical controllers
- Use licensed-based source protection (precompile & encrypt)
- Emulate a true redundancy primary/secondary pair (duplex mode)

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Differences between emulated controllers and physical controllers

Functionality	Emulated Controller Behavior
Communication to physical devices	The emulated controller is restricted from establishing connections to physical devices. However, the API can be used to simulate input and output values
License-based source protection	Not supported, must be removed before downloading the project
SD card encryption	Content on virtual SD card is not encrypted or digitally signed
Automatic Diagnostics	Only controller instance diagnostics are collected. No I/O device diagnostics supported.
Email	Email functionality is not supported
USB port	Not supported
Serial Number matching	Ignores serial number matching

Differences between emulated controllers and physical controllers – Con’t.

Functionality	Emulated Controller Behavior
Module discovery	Not supported.
Motion support	Motion support is limited to virtual axes and consumed axes only. (Physical axes must be unscheduled). Produce-consume virtual axes supported.
Connections between controllers	Produce/Consume messages work between emulated controllers. Other I/O modules in the I/O Tree will show as faulted.
Time-scaling	Supported through the API.
SNMP	Not supported
Redundancy	Operates only as a primary controller. High availability reports success, but the sync. with a second controller/support of sync modules is not available. Scan time does not reflect redundancy impacts.
Controller webpages	Not supported

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Differences between emulated controllers and physical controllers – Con't.

Functionality	Emulated Controller Behavior
Fault dumps	Fault dumps are always stored in the virtual SD card directory, even if detached in emulated controller properties. Important: contents are not encrypted
HMIBC instructions	HMI Button Control (HMIBC) instructions do not function (no Class 1 connection to HMI)
GSV and SSV instructions	Supports Get System Value (GSV) and Set System Value (SSV) instructions for emulated controller instances only. When GSV and SSV instructions target external objects, the instructions return the result for an unconnected device.

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