ENGINEERING PHARMACEUTICAL INNOVATION

Introduction to Automation

ISPE Young Professionals
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Timothy Alosi
New England Controls

Today's Speaker

Timothy Alosi

New England Controls

Tim.Alosi@NewEnglandControls.com

- 20+ Years in Automation
- Local life sciences experience
  - Lab Integration
  - Large Scale Manufacturing
  - MES and Data Warehousing

Today's Topics

- Why Automate
- Control Concepts
- Automation System Architecture
- Process Control Application

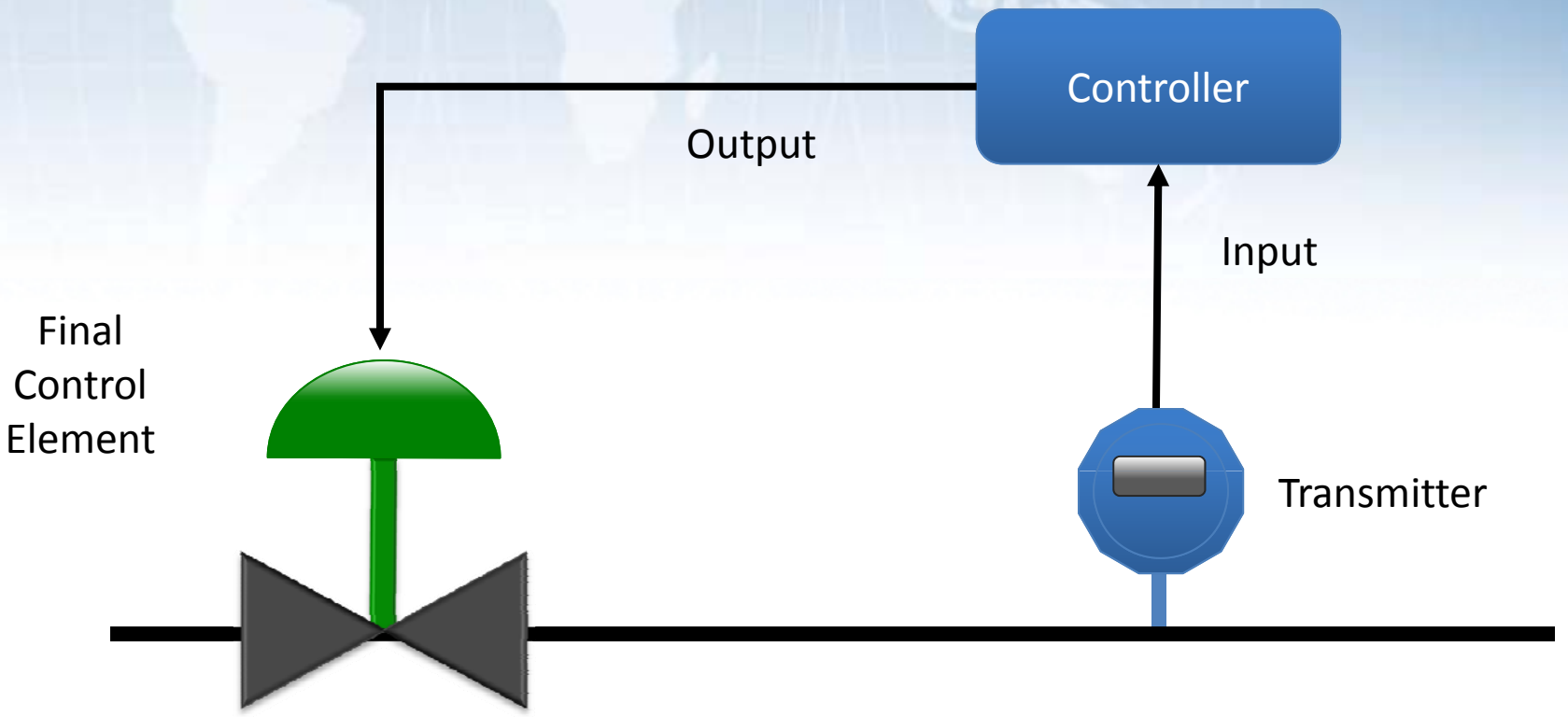
Why Automate

- Why
- Where

Control Concepts

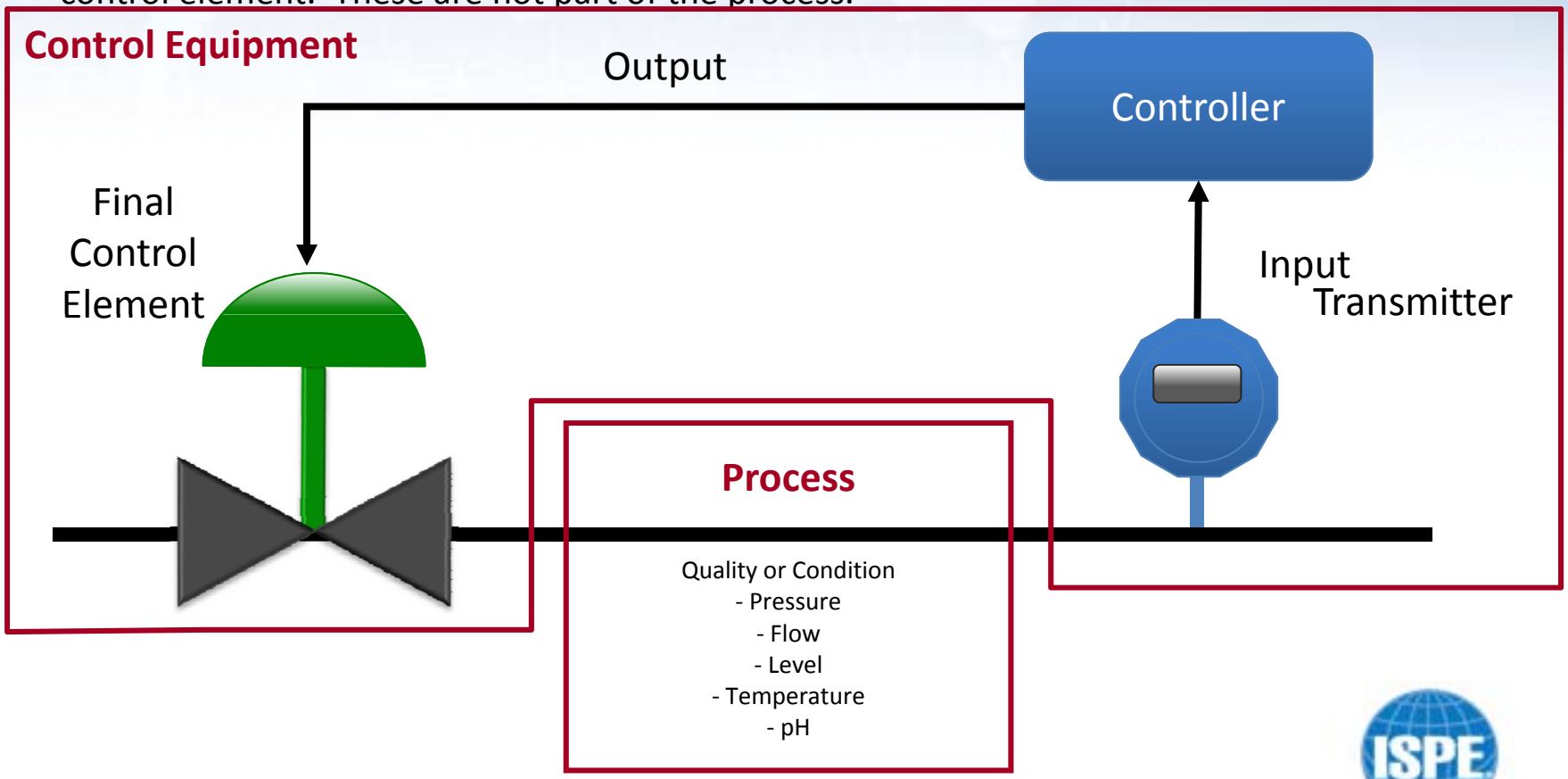
- Terminology
- Control Loop Basics

Terminology: Control Loop



Terminology: Process Defined

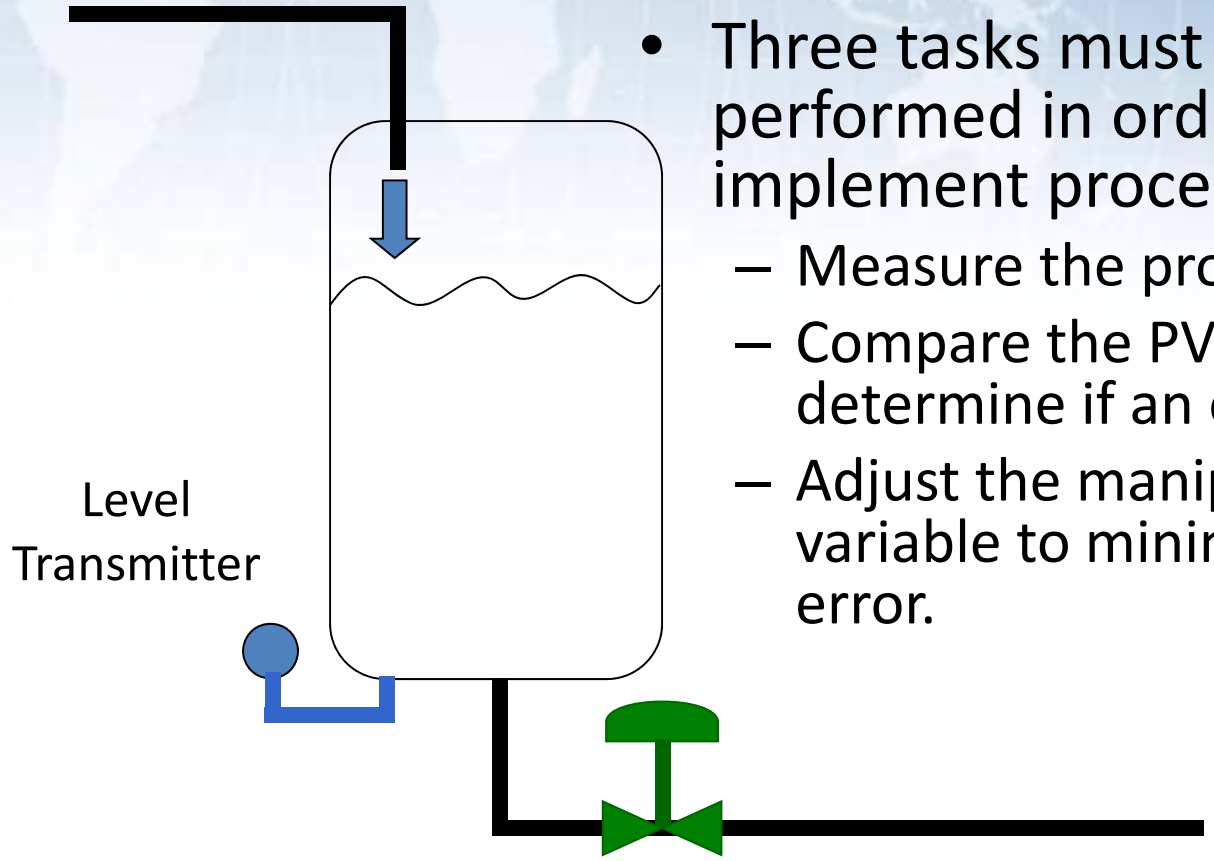
- Process – The process refers only to the quantity or condition of a fluid within a vessel or piping system.
- Control Equipment – All the other elements in the loop – the transmitter, controller, and final control element. These are not part of the process.



Terminology: Variables

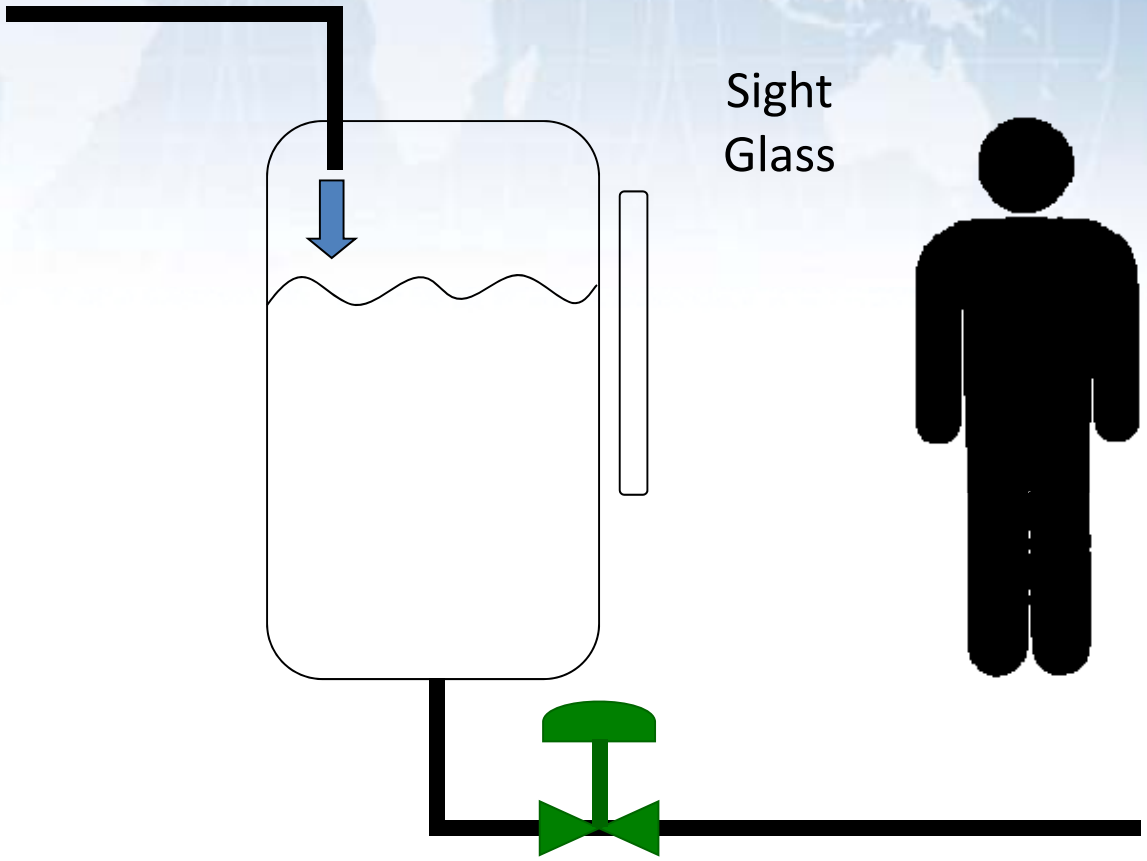
- **Controlled Variables** – These are the quantities, qualities, or conditions that are to be held at some specific value
  - Temperature
  - pH
- **Disturbances** – These are variables that can impact the quality, quantity or condition or the controlled variables.
  - WFI drop valve opening
  - Filter blockage or damage
- **Manipulated Variables** – A variable that can be manipulated to ensure that the controlled variables remain at the desired level despite disturbances to the process.
  - Control Valve position
  - Pump Speed

Process Control Example: Level Control

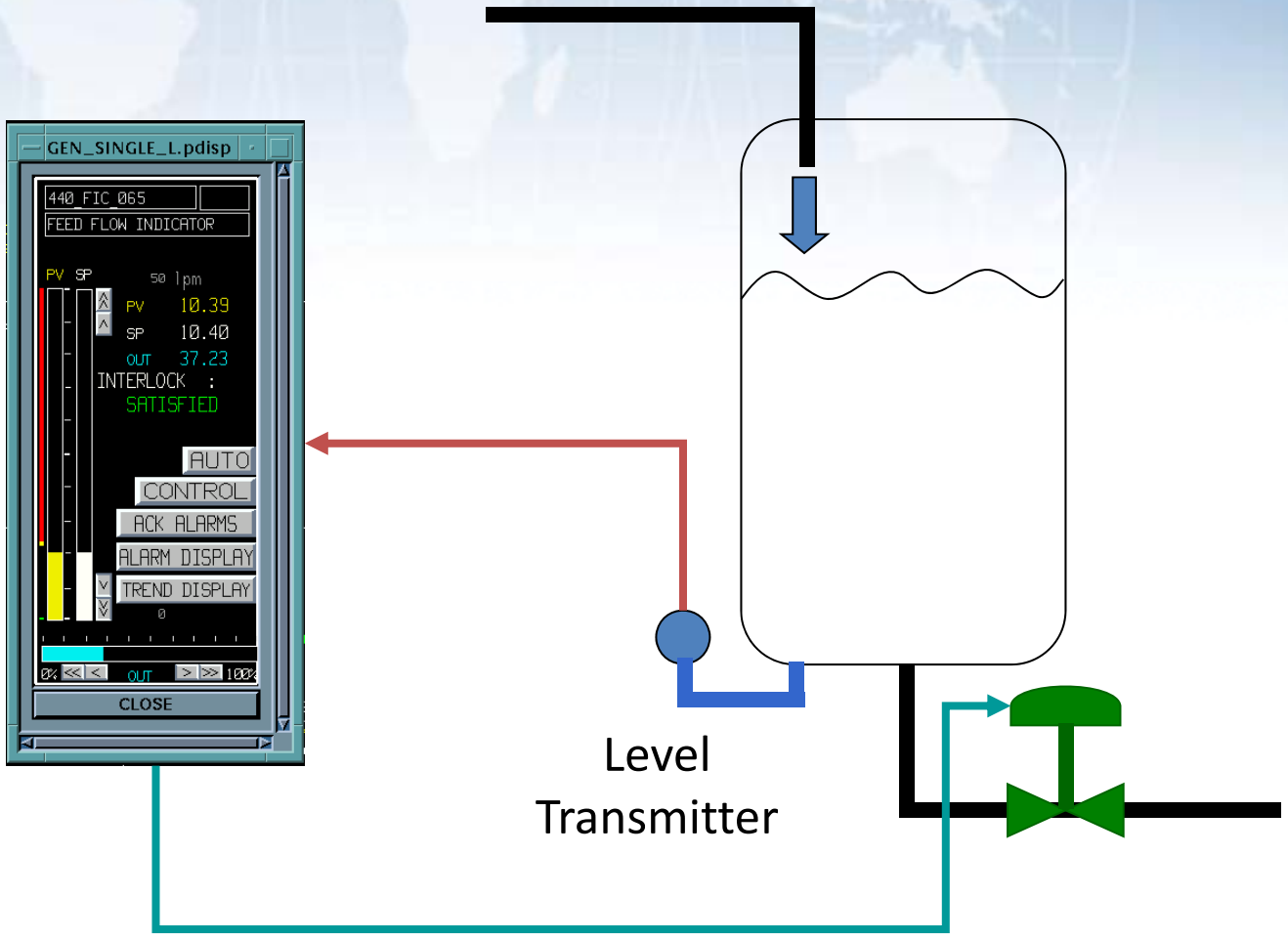


- Three tasks must be performed in order to implement process control:
  - Measure the process variable
  - Compare the PV to the SP to determine if an error exists.
  - Adjust the manipulated variable to minimize the error.

Process Control Example: Level Control



Process Control Example: Level Control



Automation Architecture

- Inputs and Outputs
- Process Controllers
- Scalability
- Communication Networks
- Application Software

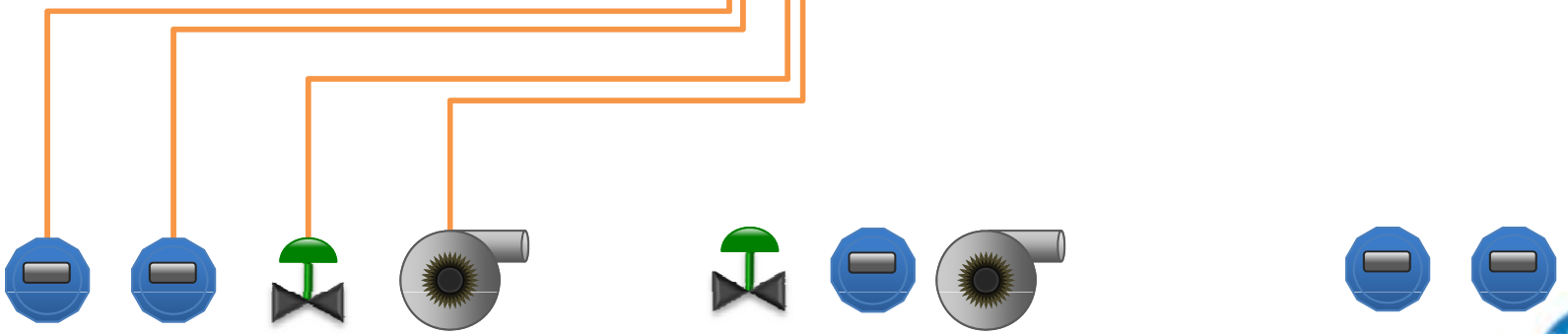
Automation System Architecture

NEED: connect to the devices that measure and manipulate the Process

Automation System Architecture

Process Controller with
Input /Output (I/O) Cards

Point-to-Point Wiring
- Analog Inputs
- Analog Outputs
- Discrete Inputs
- Discrete Outputs



NEED: connect to the devices that measure and manipulate the Process

Automation System Architecture

Process Controller with
Input /Output (I/O) Cards

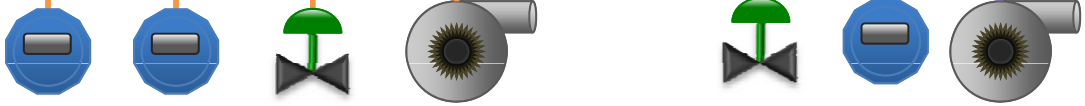
Digital Busses
- Foundation Fieldbus
- DeviceNet
- Profibus
- AS-I
- Modbus

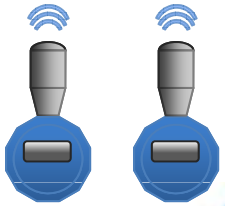
NEED: connect to the devices that measure and manipulate the Process

Automation System Architecture

Process Controller with
Input /Output (I/O) Cards

Wireless
- Industrial 802.15





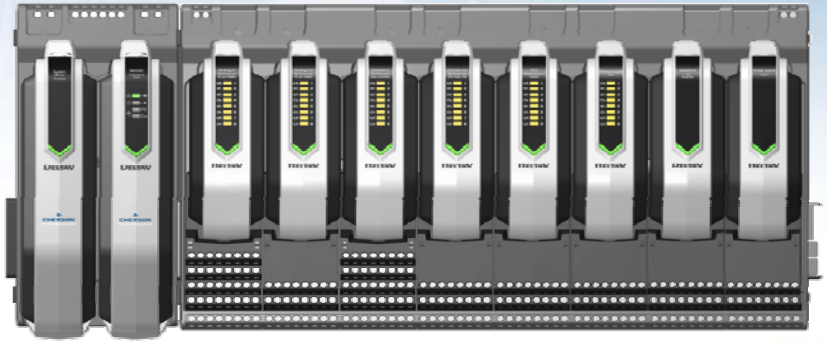
NEED: connect to the devices that measure and manipulate the Process

Types of Process Controllers

PC with Specialty IO/Software

Single Loop Controllers

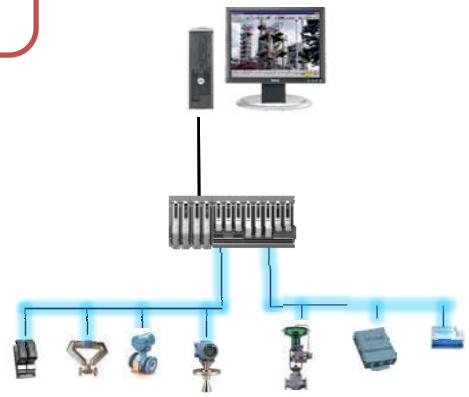
Compact "All in One"



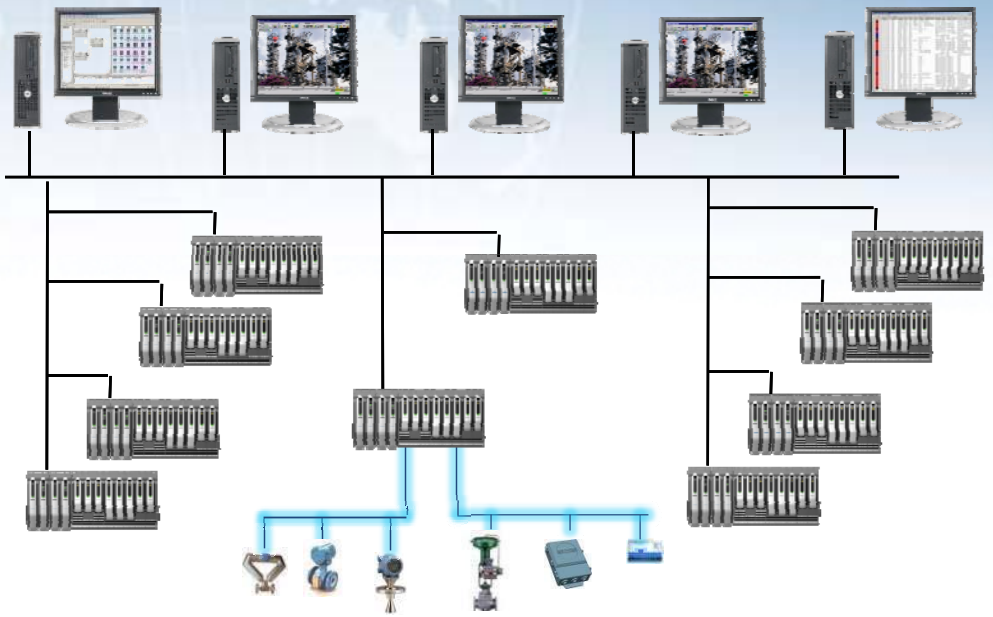
Modular "Mix and Match" Add different functionality based on needs / size

Automation in All Sizes

Single Loop Controllers
1 – 5 I/O



Small, Modular Systems
10's – 100's of I/O

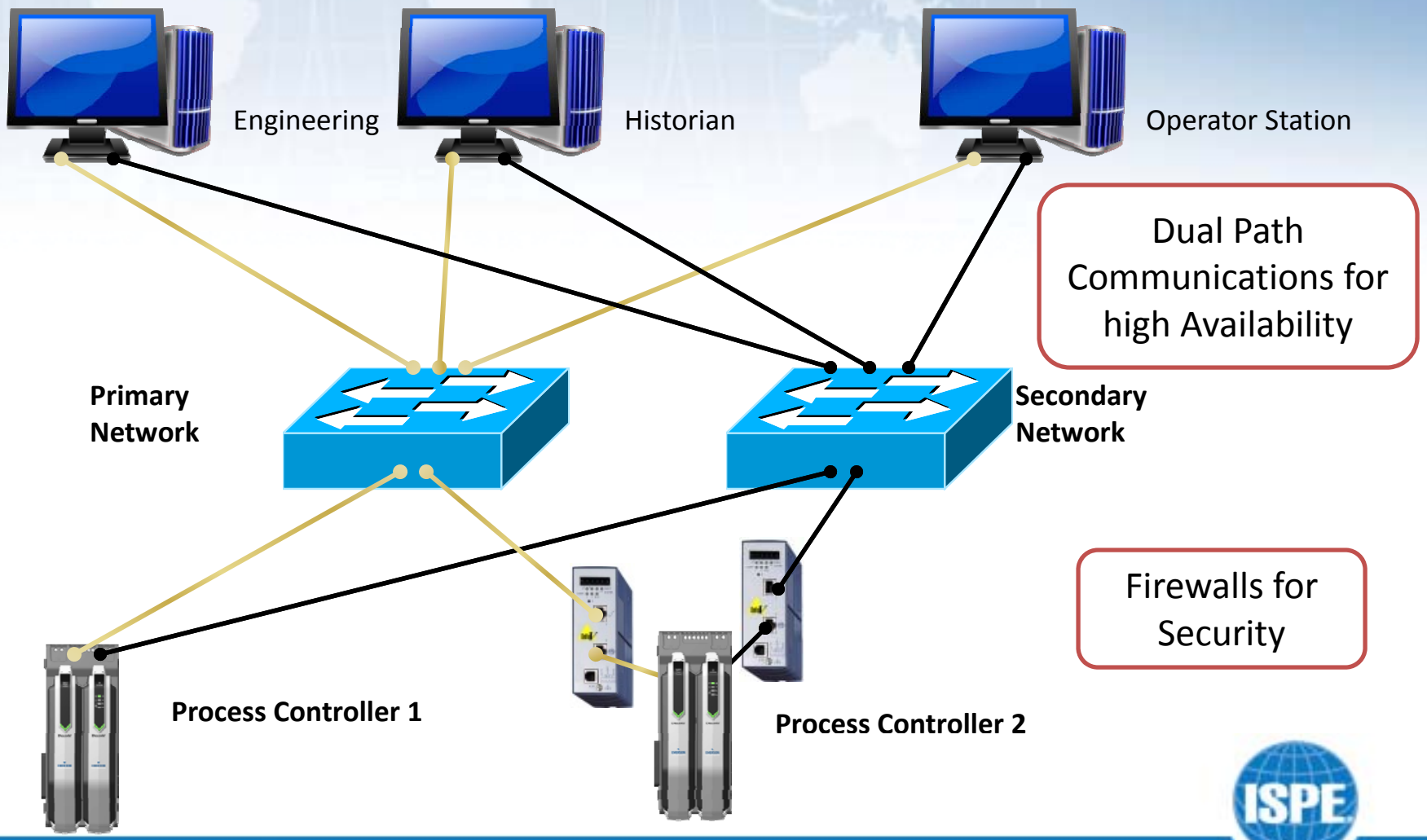


Full Size Industrial Systems
1000's – 10,000's of I/O

Redundancy


Network Connections
Digital Busses Cards
Power Supplies
Controllers
Classic I/O Cards

Automation System Networking



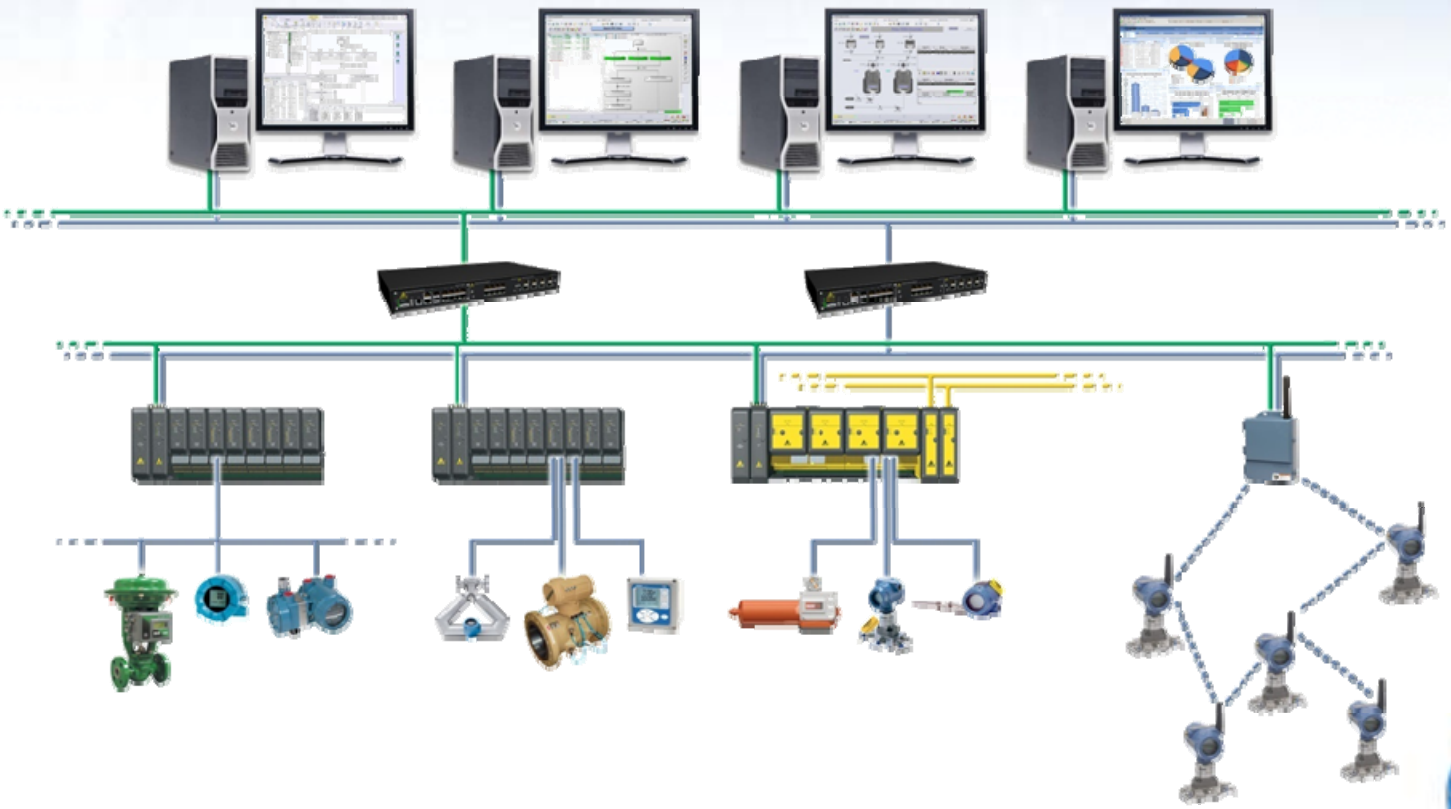
Application Software

Engineering and Diagnostics

Batch and Recipe Execution

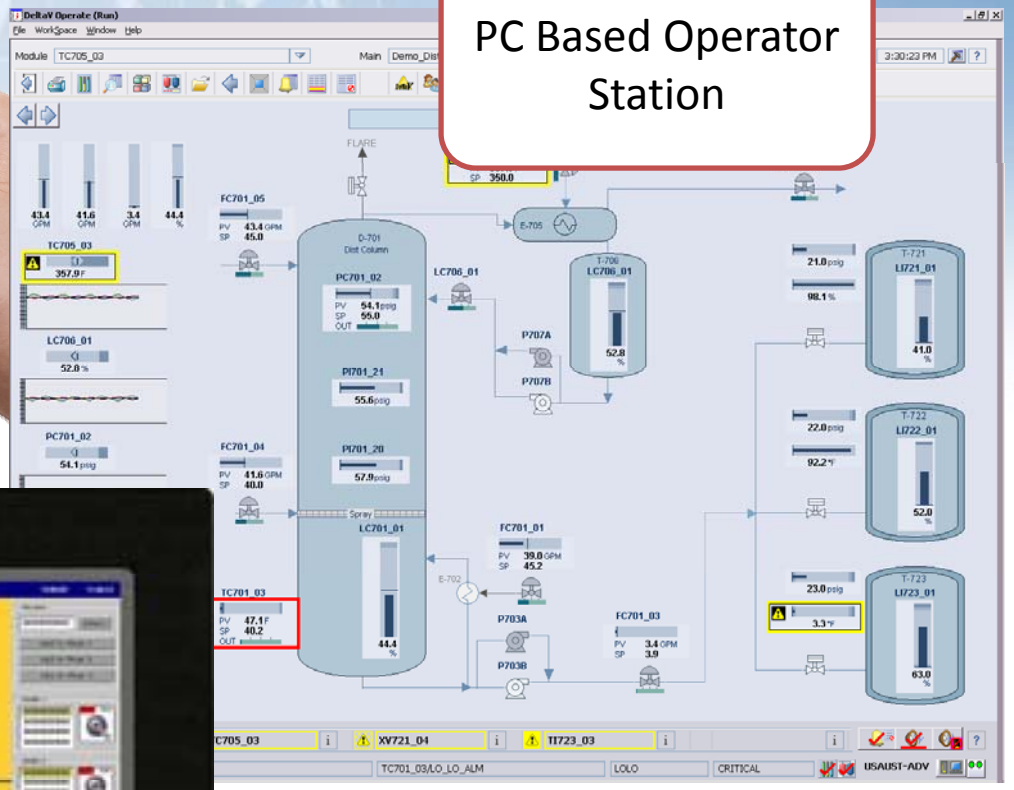
Plant Operations and Alarms

Integration, History Collection and Analysis



Operations

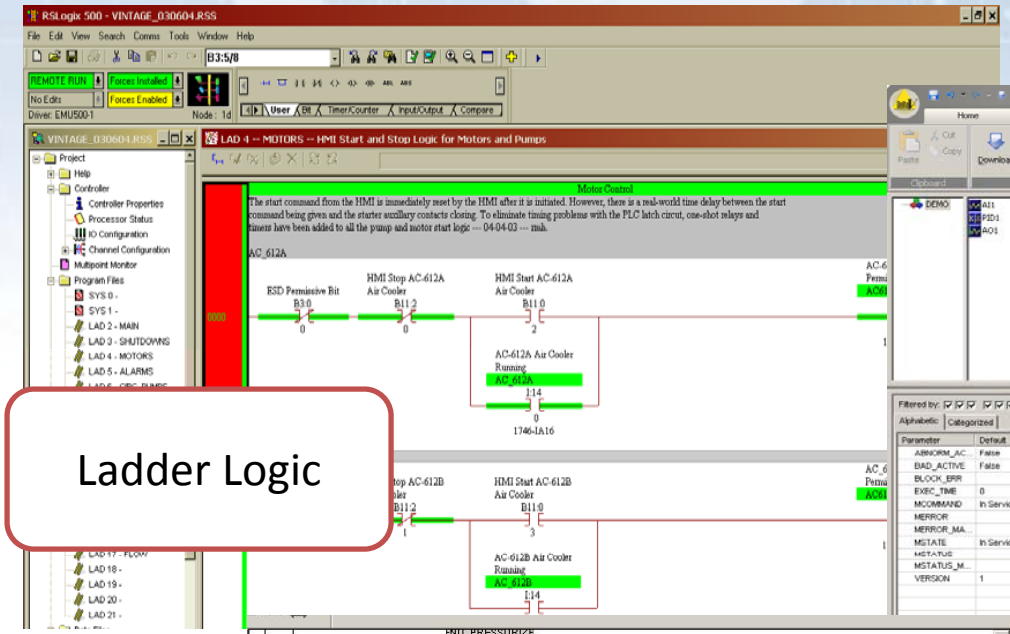
Mobile Worker HMI



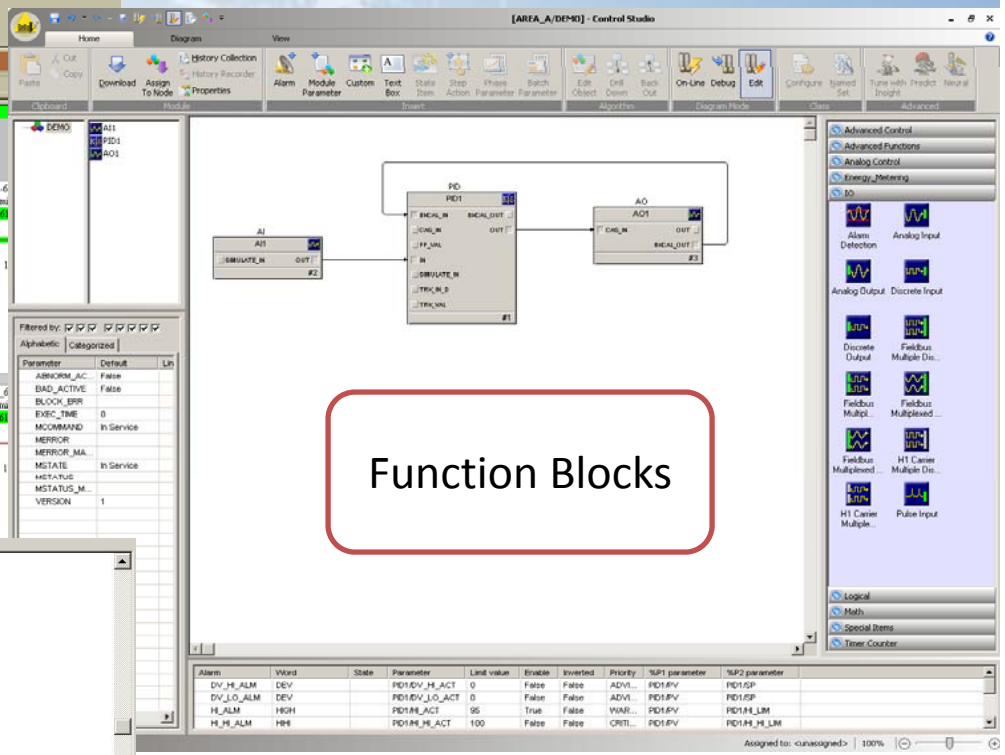
PC Based Operator Station

Panel Mounted HMI

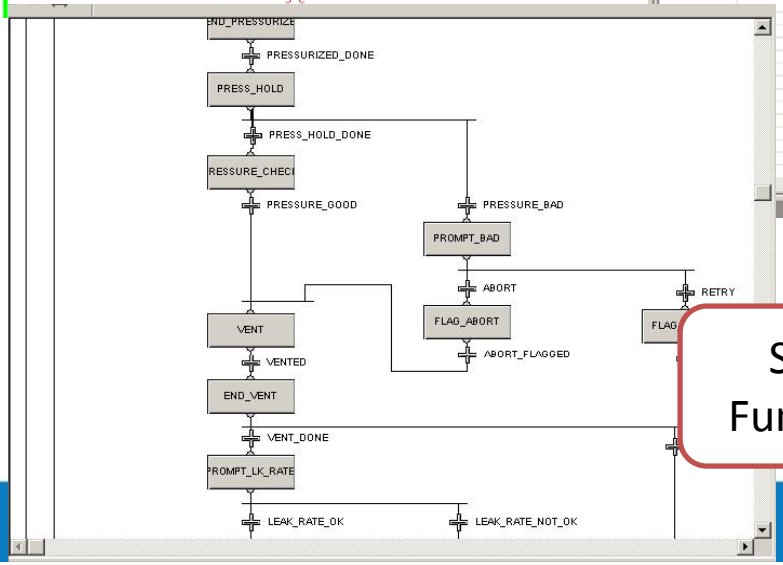
Engineering Environment



Ladder Logic

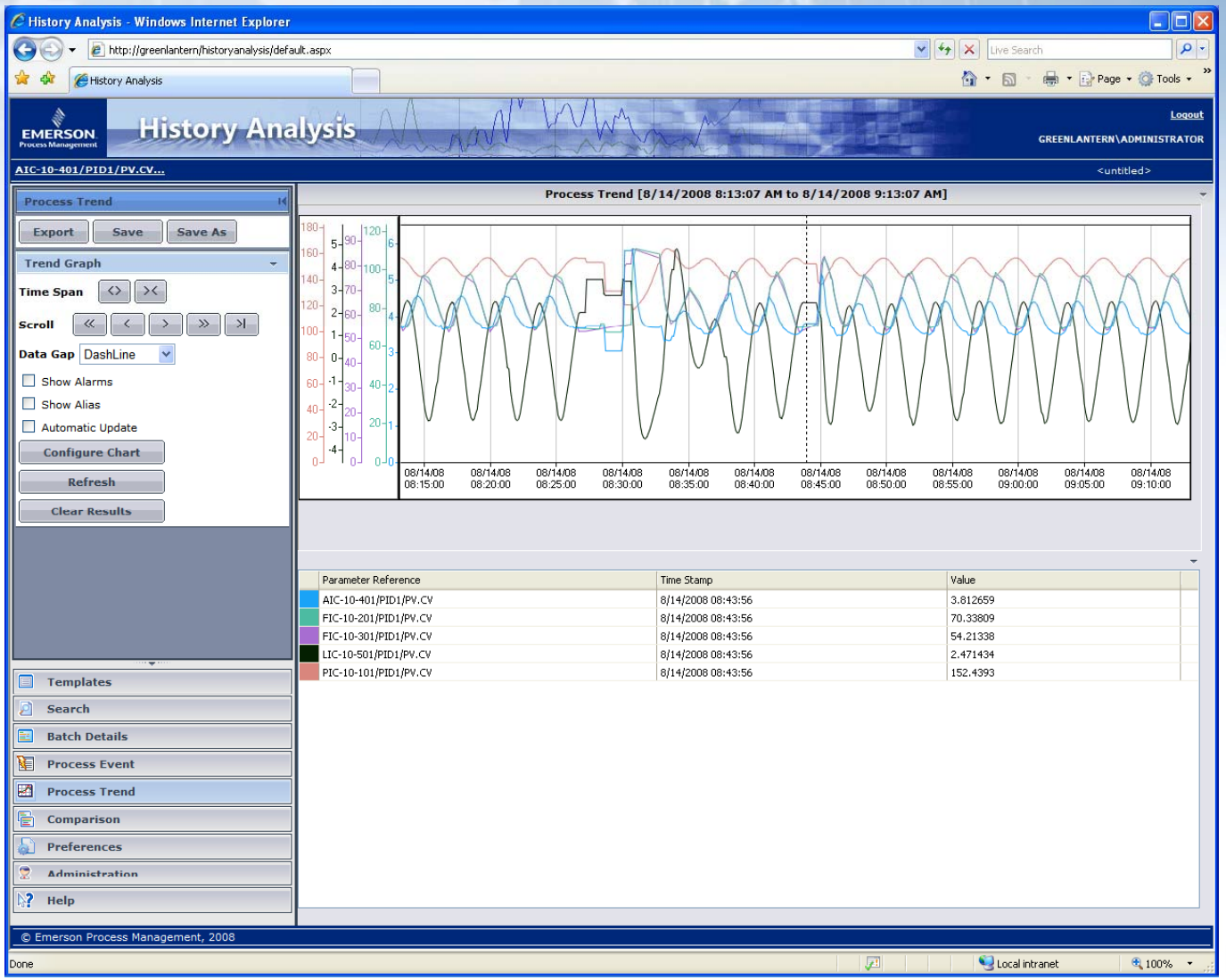


Function Blocks



Sequential Function Chart

Process Historians

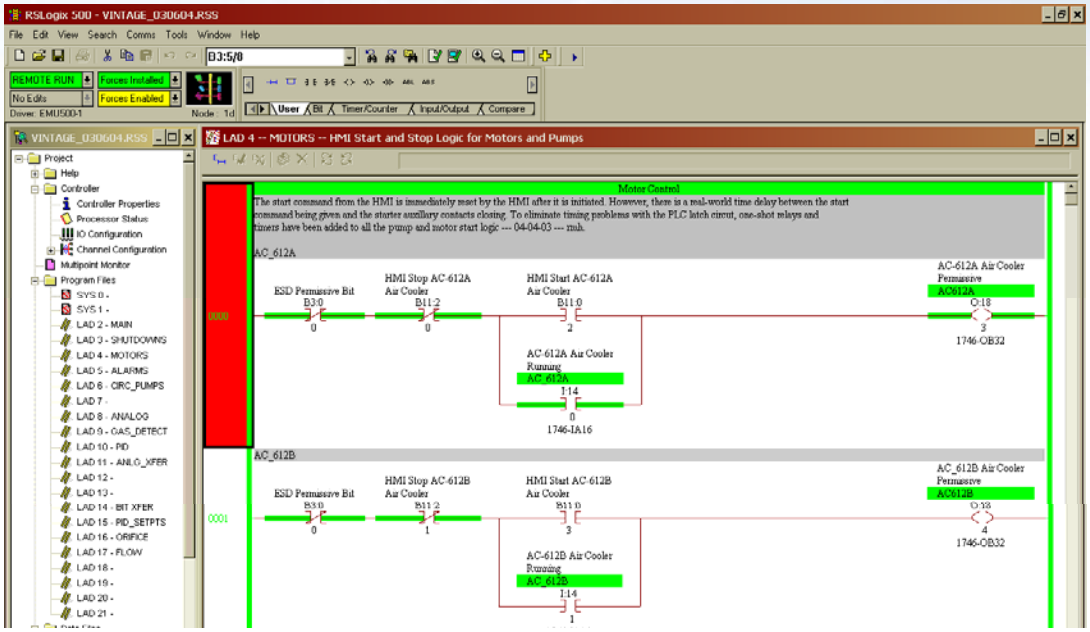


Process Control Application

- Discrete Control
- Regulatory / Continuous Control
- Process and Safety Interlocking
- Batch and Sequential Logic

Discrete Control

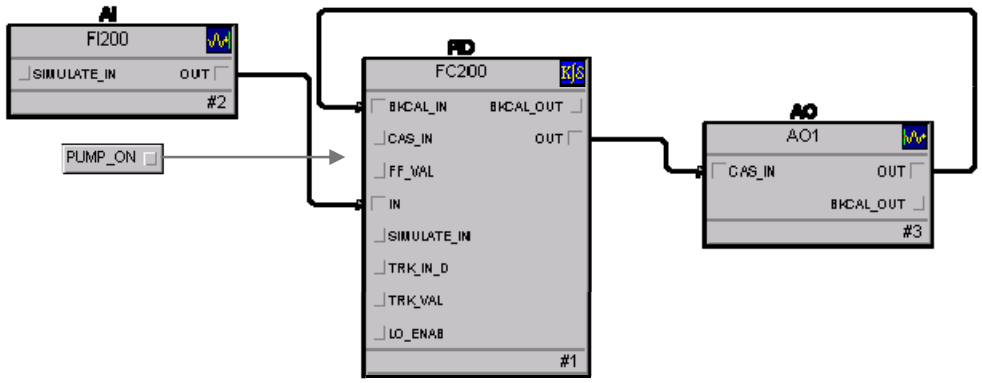
- Only two states are recognized.
- Difficult to maintain a precise set point
  - On / Off
  - Up / Down
  - Hotter / Colder
- Examples
  - Home Thermostat
  - Switches
  - Motors
  - On-Off valves



- Application Example: Machine Control (filling/capping)

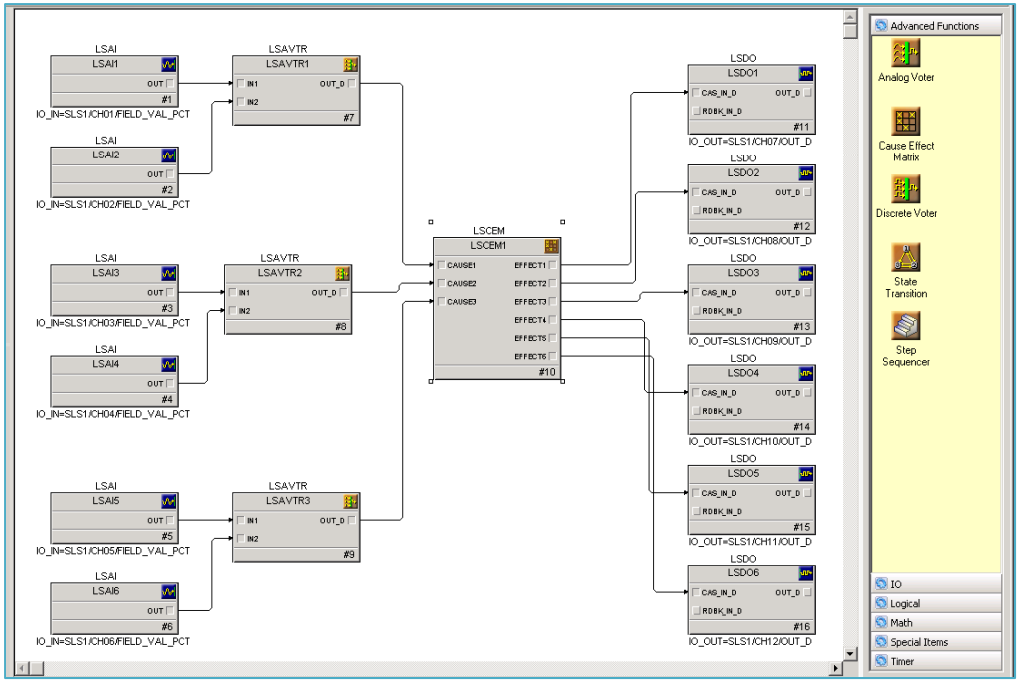
Continuous/Analog Control

- Monitoring and Controlling variable measurements and control elements (flow, pressure, temperature)
- Application Example: Bioreactor Temperature, pH and Dissolved Oxygen



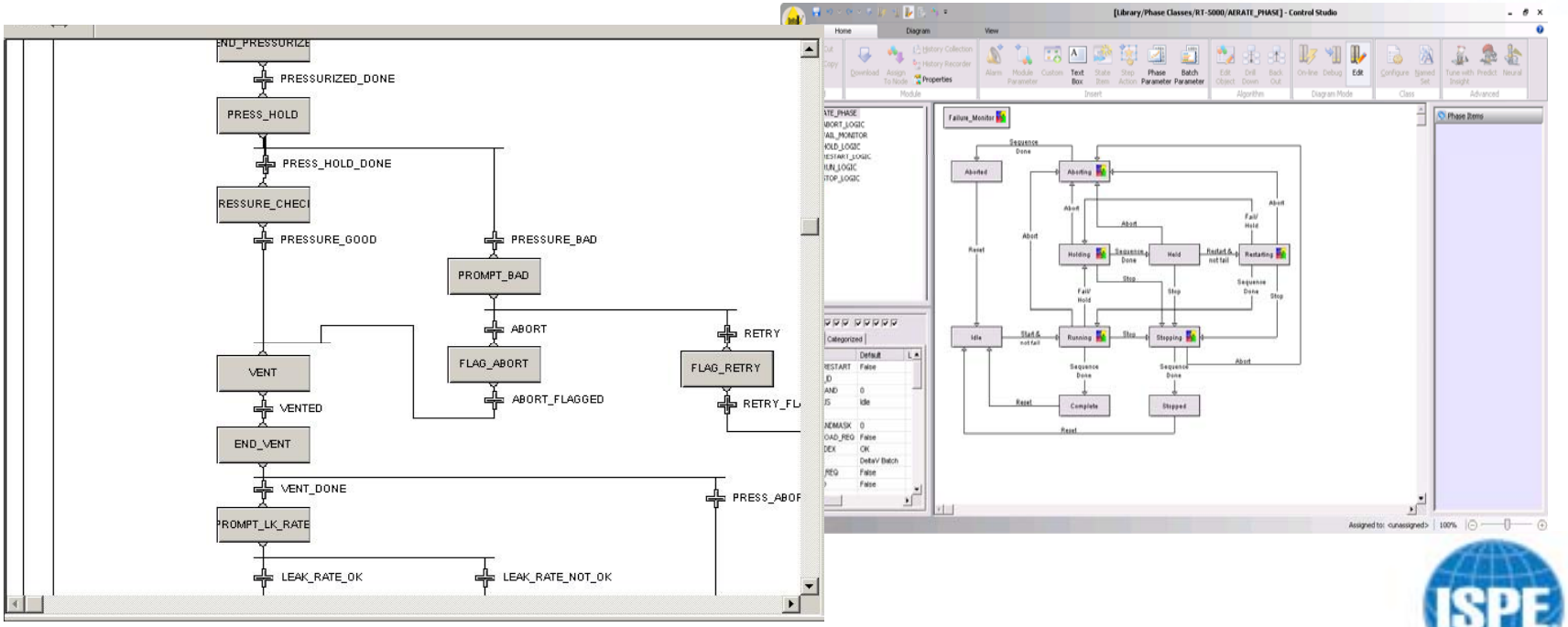
Process and Safety Interlocking

- Monitoring and reacting to conditions that could cause process excursions, equipment damage or unsafe conditions



Batch / Sequencing Control

- Coordinates both discrete and analog control to ensure that an automated sequence is completed and abnormal conditions addressed



Area

Process Cell

Unit

Equipment Module

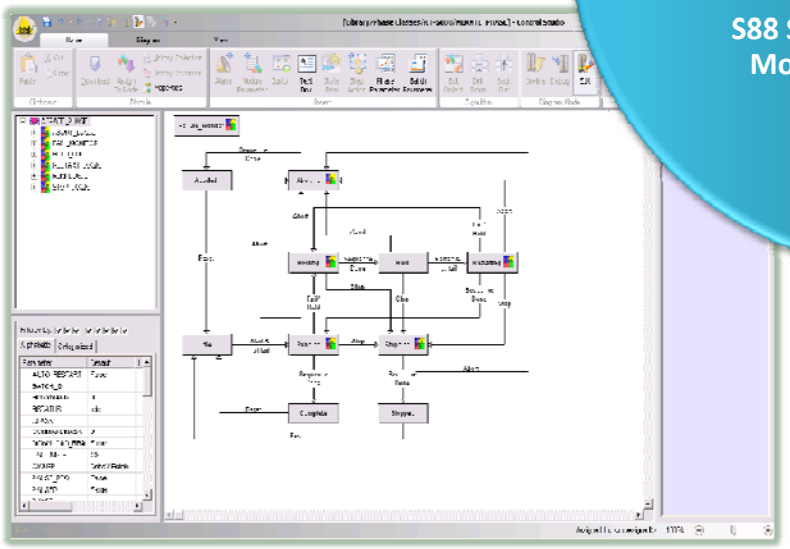
Control Module

S88 Physical Model

Class-Based Configuration

S88 State Model

S88 Procedural Model



Procedure

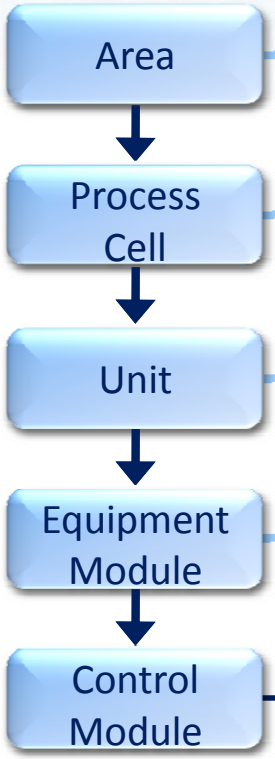
Unit Procedure

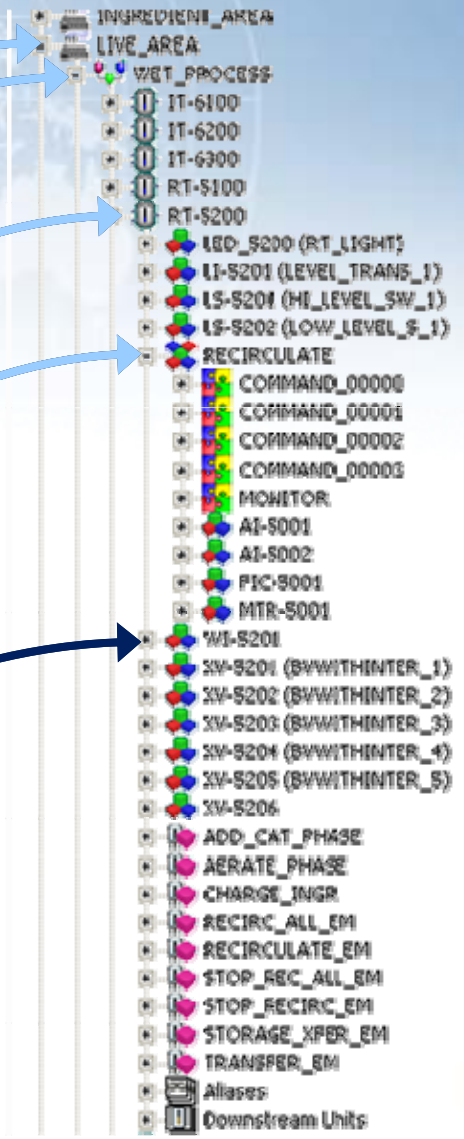
Operation

Phase

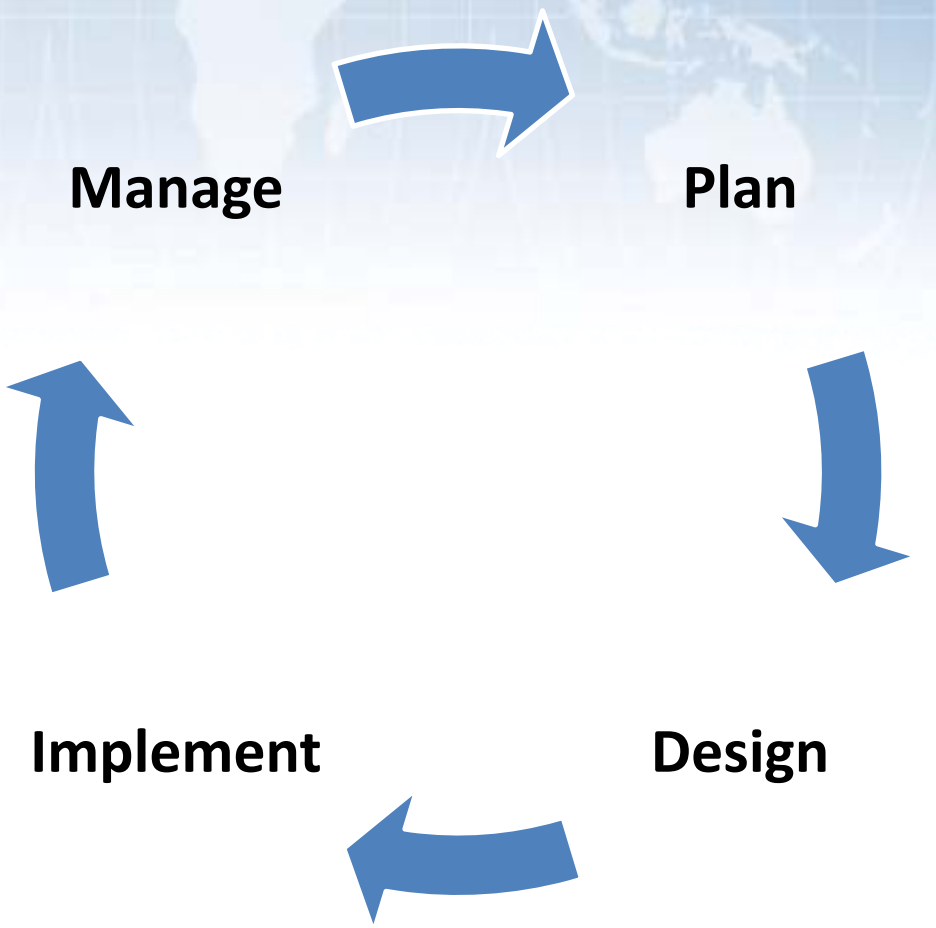
Implementation of Physical Model

S88 Physical Model

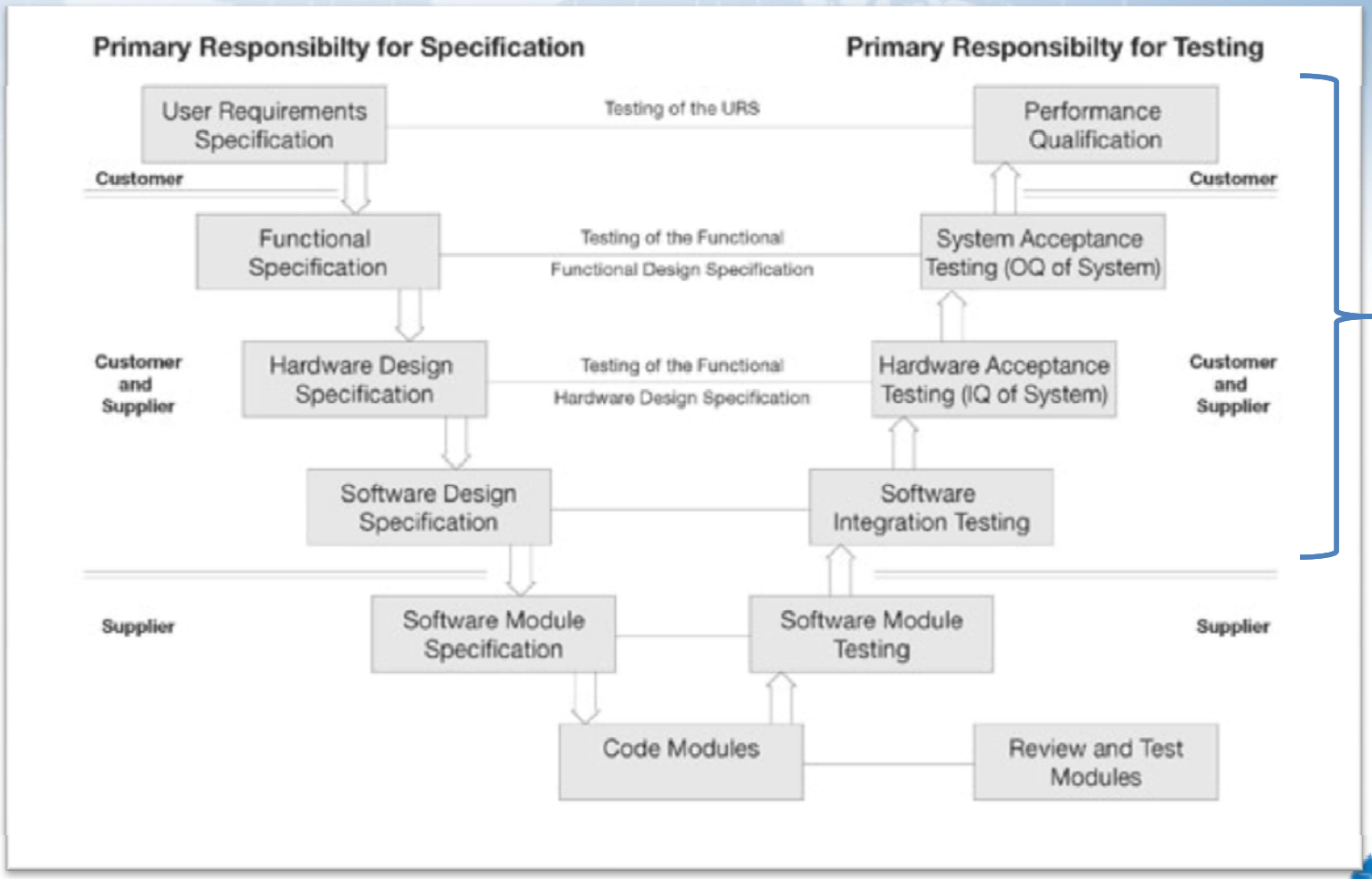




Automation Life Cycle



GAMP "V" Validation Model – Drives Project Activities



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Thank You