



ACCELERATING
INNOVATION

3-1347 - Building a Simulation System for a hybrid, multivendor DeltaV based automation system

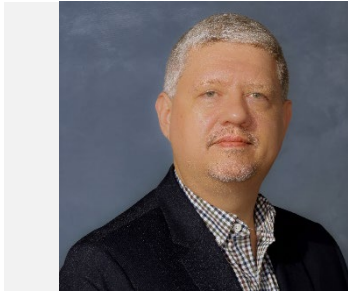
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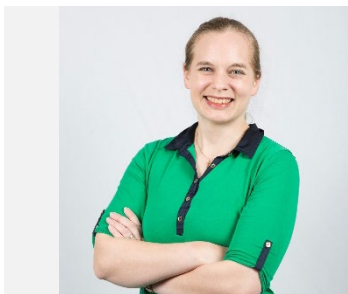
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Agenda

Paul Cianchetti

Joey Hess

Alyssa Thomas

All

Project Overview

Solution Description

Execution, Outcomes, & Learnings

Questions?

Project Overview

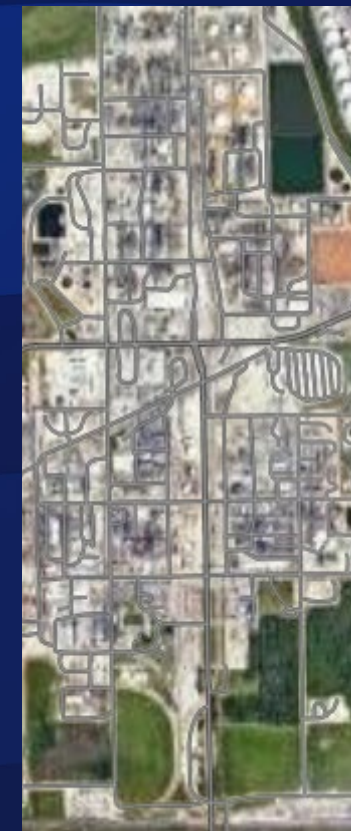


Dow

Deer Park Operations, Deer Park, TX

Dow (NYSE: DOW) is one of the world's leading materials science companies, serving customers in high-growth markets such as packaging, infrastructure, mobility and consumer applications. Our global breadth, asset integration and scale, focused innovation, leading business positions and commitment to sustainability enable us to achieve profitable growth and help deliver a sustainable future. We operate manufacturing sites in 30 countries and employ approximately 36,000 people. Dow delivered sales of approximately \$43 billion in 2024. References to Dow or the Company mean Dow Inc. and its subsidiaries. Learn more about us and our ambition to be the most innovative, customer-centric, inclusive and sustainable materials science company in the world by visiting www.dow.com.

In August 1946, Rohm and Haas purchased a 534-acre tract in Deer Park, Texas, 15 miles southeast of Houston. This was an ideal site. Three different pipeline companies served the area with natural gas, and several nearby petrochemical plants could supply other starting materials. In April of 2009, Rohm and Haas was acquired by The Dow Chemical Company.



Deer Park, MMA Project Overview

MMA Unit Overview:

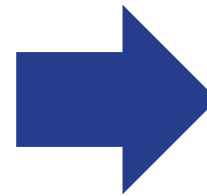
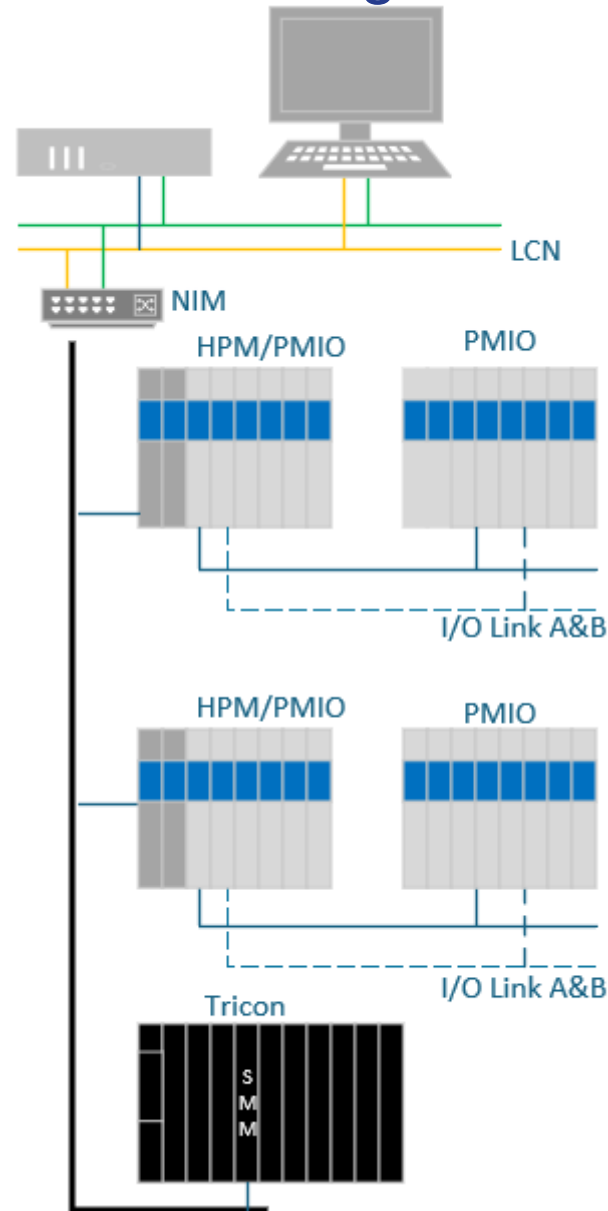
- Produces acrylic monomers
- Located in Dow Chemical Deer Park, Texas.
- Deer Park Operations is one of the world's largest single manufacturing sites for acrylic monomers

Automation Scope:

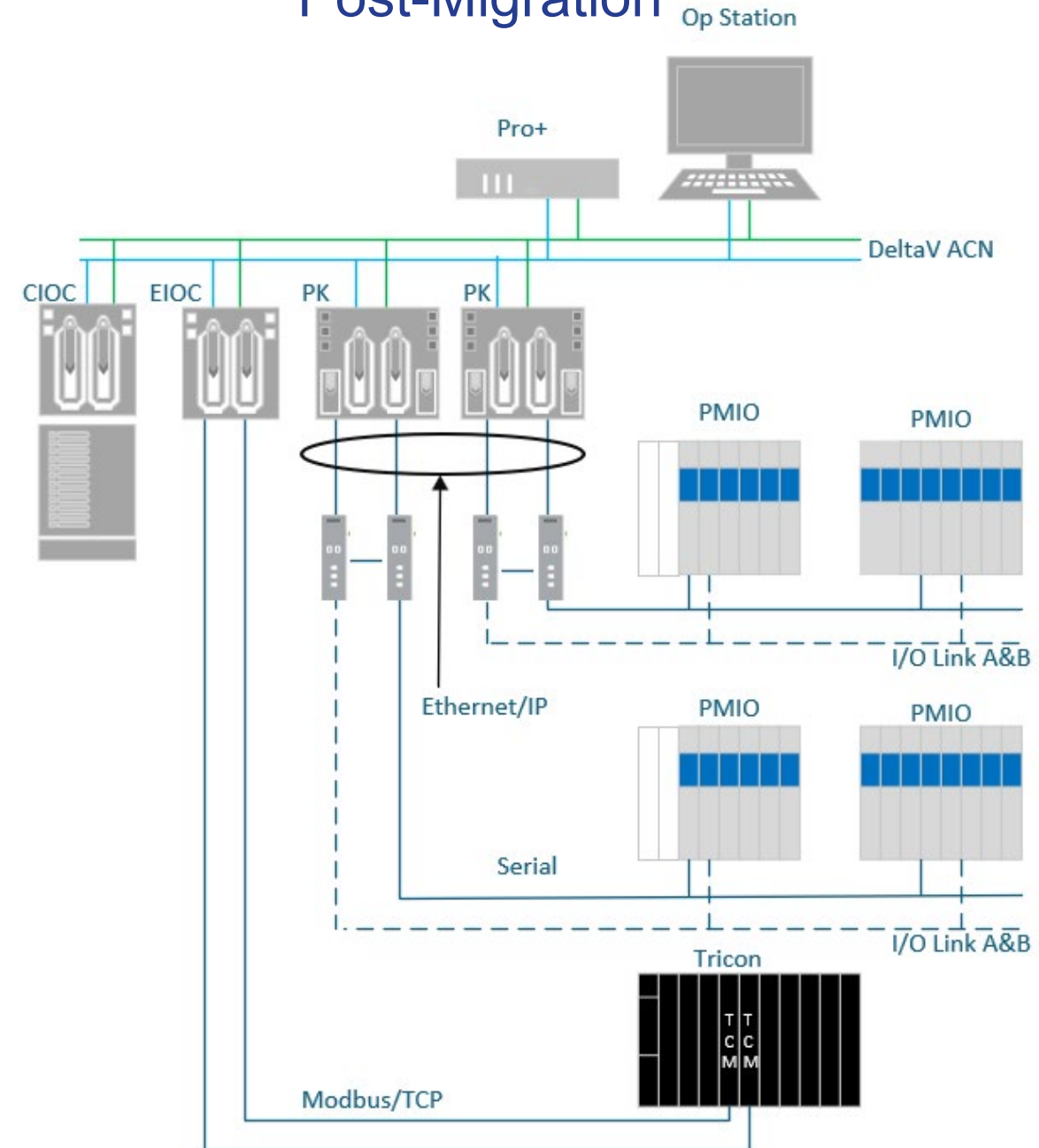
- ~1300 I/O
- Replace TDC 3000 HPMs, servers, and operator stations with DeltaV components
- Utilize TDC 3000 PMIO via DeltaV IO Connect for Honeywell to minimize need for new instruments and re-wiring
- Implement State Based Control where it brings value to operations
- Integrate existing Triconex Safety System with new DeltaV
- 7 • Development of new medium fidelity simulation for code testing and operator training

Automation System Architecture Migration

Pre-Migration



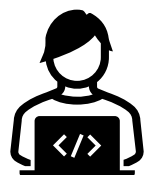
Post-Migration



Dow's Simulation Philosophy

Every code change should be developed and tested in an offline system against a process model and only moved to a production system after this is complete. The associated process model should, at a minimum, include instrument/device tiebacks and be directionally correct from a mass and energy balance perspective.

Project Importance



Code Development & Testing

- Complete code re-write from TDC 3000
- Implementing state-based control
- Fixing/Improving interlocks and control schemes
- Implementing IO Connect
- Significant Triconex Integration



Operator Training

- HMI changed significantly
- Operating philosophy change → loop based to State Based Control
- Operator system interactions changed significantly
- Operators needed the confidence to run the plant from Day 1



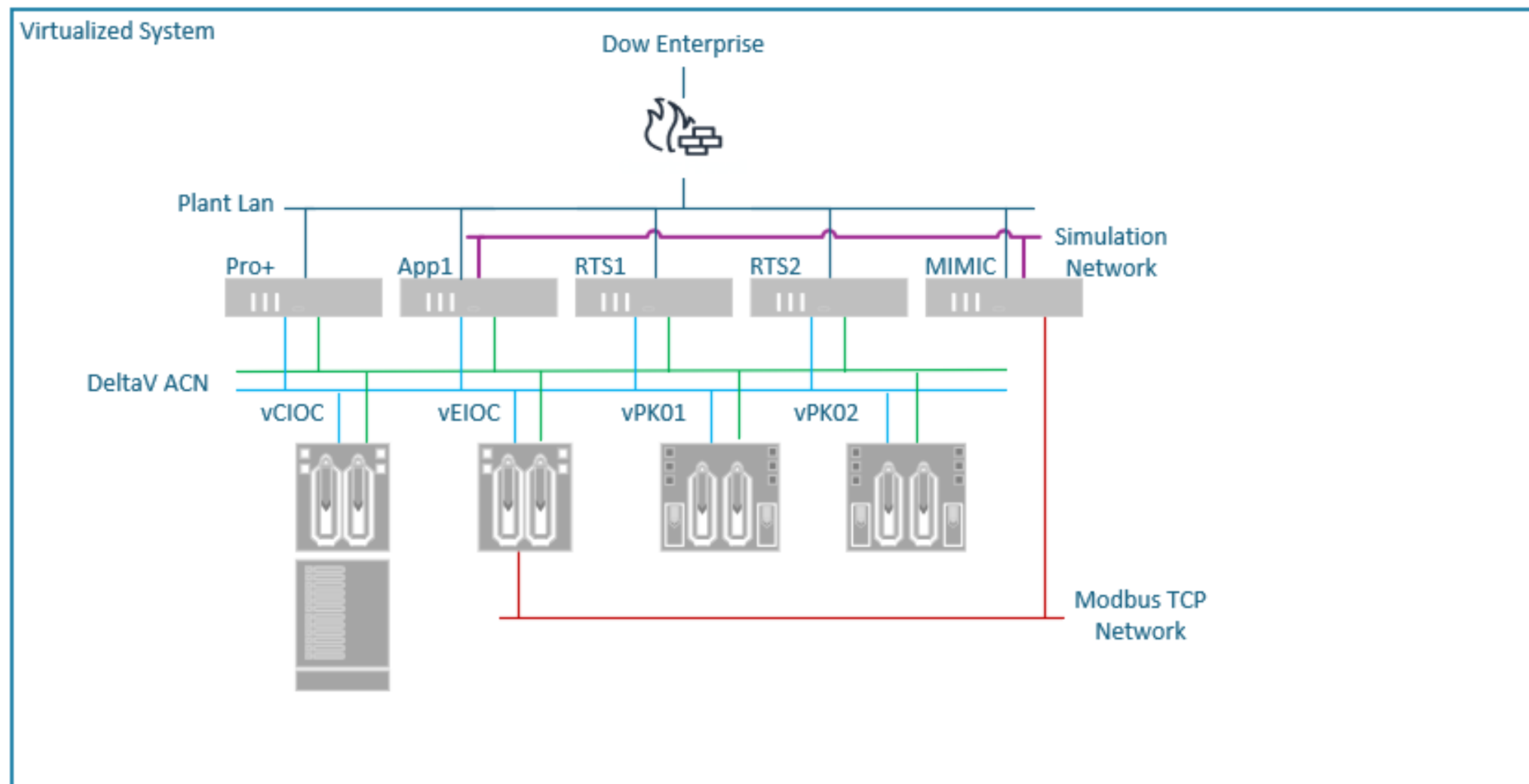
Simulation Fidelity & Integration

- SIS and BPCS code needed to proven to work together
- Individual Unit code needed to be tested separately, but also together
- All I/O addressing needed to be proven prior to startup
- Many units needed medium fidelity process model to be believable for operator training AND code dev and testing

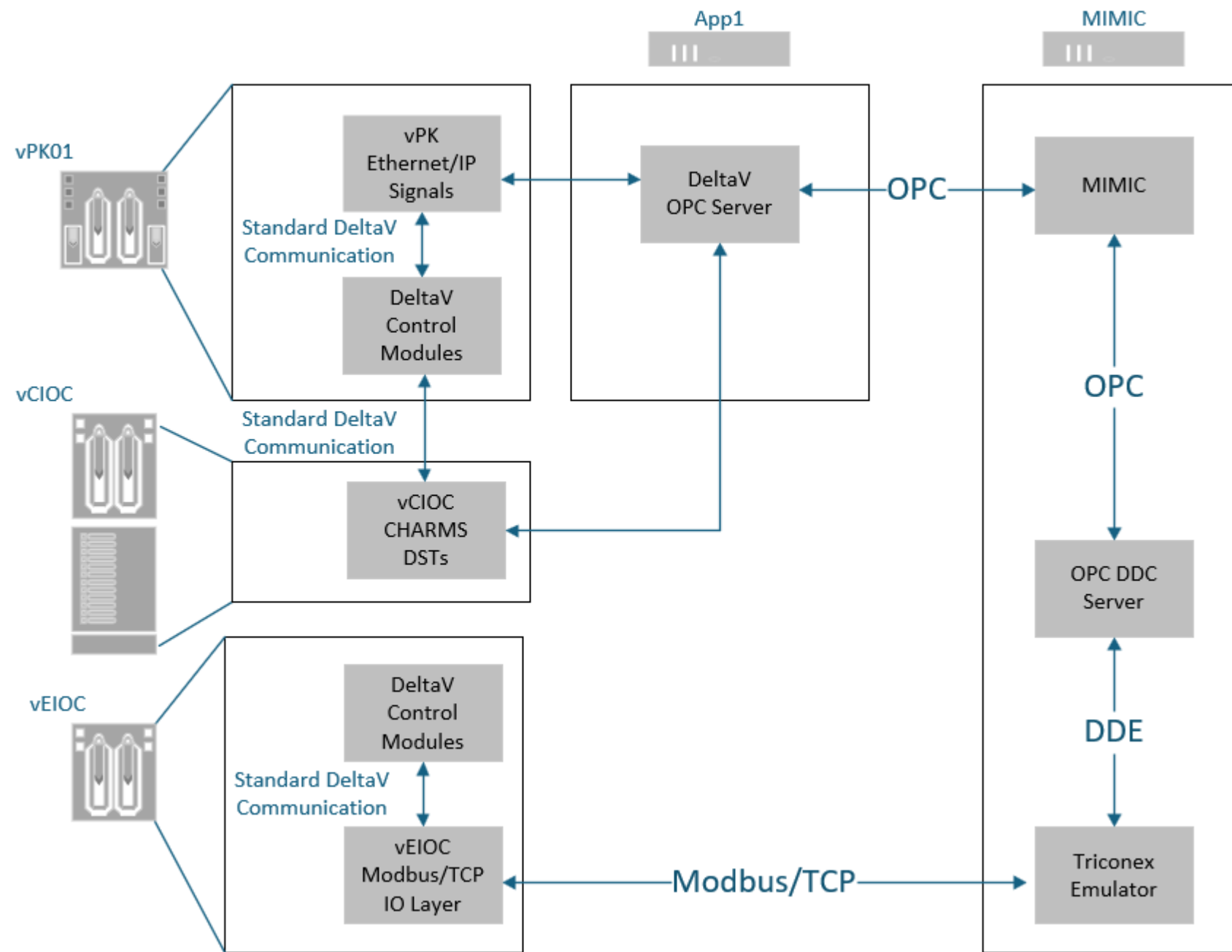
Solution Description

Simulation Solution: "Hardware"

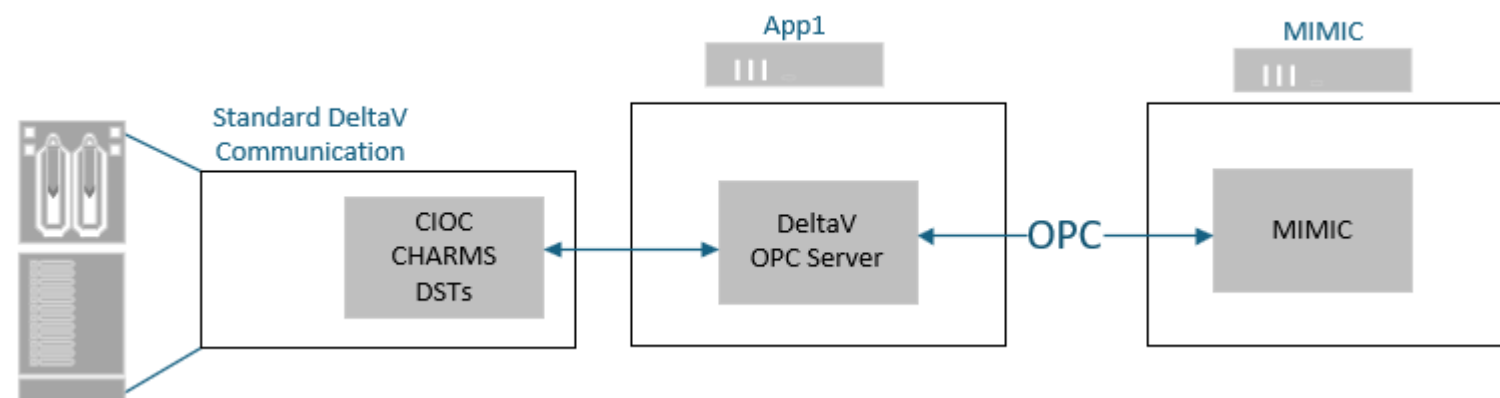
- Created a virtualized system with MIMIC, virtual DeltaV hardware, and necessary virtual networks



Simulation Solution: Software/Communication



Simulation Solution: vCIOC CHARMS DSTs



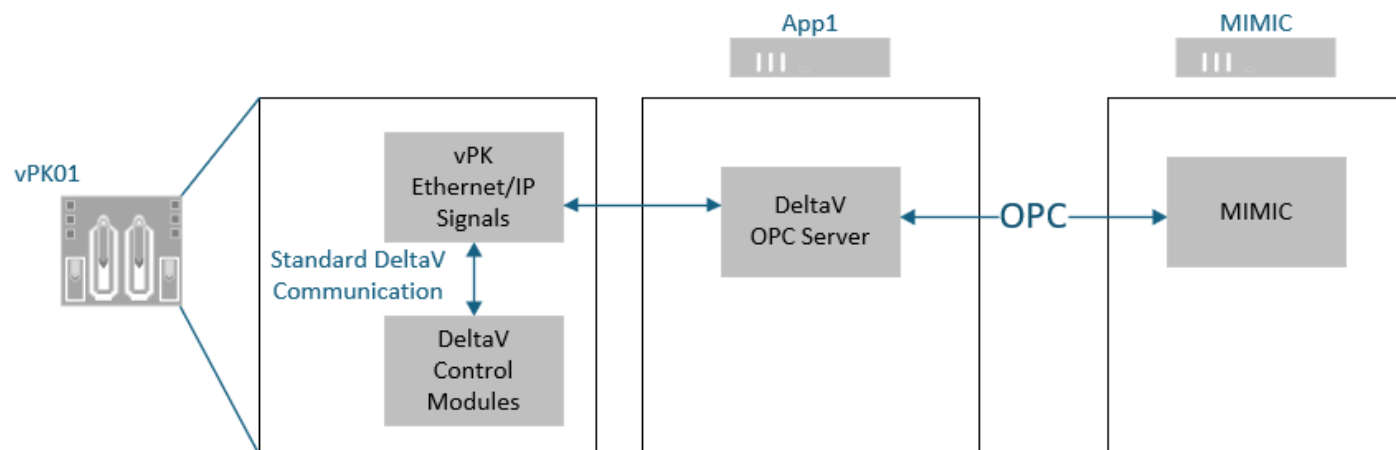
DeltaV CHARM IO Def
OPC SERVER: OPC.DeltaV.1
MACHINE: APP1

SIOTag count: 11

| SIO_TAG | ... | BASEPLATE | CHANNEL | CHARM_VALUE | POSITION | DEVICE_SI... | ATTRIBUTE | DIRECTION | SIOTAG_SUBVALUE |
|--------------|-----|-----------|---------|-------------|----------|--------------|---------------|-----------|-----------------|
| PT-33201-... | | n/a | n/a | n/a | n/a | *PT-33201... | FIELD_VAL_PCT | WRITE | Percent |
| RCV-3326... | | n/a | n/a | n/a | n/a | *RV-33260... | OUT_D | READ | Discrete |
| RCV-3327... | | n/a | n/a | n/a | n/a | *RV-33271... | OUT_D | READ | Discrete |
| RCV-3338... | ... | n/a | n/a | n/a | n/a | *RV-33380... | OUT_D | READ | Discrete |
| RV-33150-... | | n/a | n/a | n/a | n/a | *RV-33150... | OUT_D | READ | Discrete |
| RV-33201-... | | n/a | n/a | n/a | n/a | *RV-33201... | OUT_D | READ | Discrete |
| RV-33201-... | | n/a | n/a | n/a | n/a | *RV-33201... | OUT_D | READ | Discrete |
| RV-33201-... | | n/a | n/a | n/a | n/a | *RV-33201... | OUT_D | READ | Discrete |
| RV-33380-... | | n/a | n/a | n/a | n/a | *RV-33380... | OUT_D | READ | Discrete |
| XY201021 | ... | n/a | n/a | n/a | n/a | *XY201021 | OUT_D | READ | Discrete |
| XY201022 | ... | n/a | n/a | n/a | n/a | *XY201022 | OUT_D | READ | Discrete |

- Nothing fancy here... Utilized standard MIMIC DeltaV CHARM IO Def to communicate to CHARMS DSTs

Simulation Solution: vPK Ethernet/IP Signals



Analog Example

DeltaV Virtual Controller IO Def
 OPC SERVER: OPC.DeltaV.1
 MACHINE: APP1
 SIOTag count:278

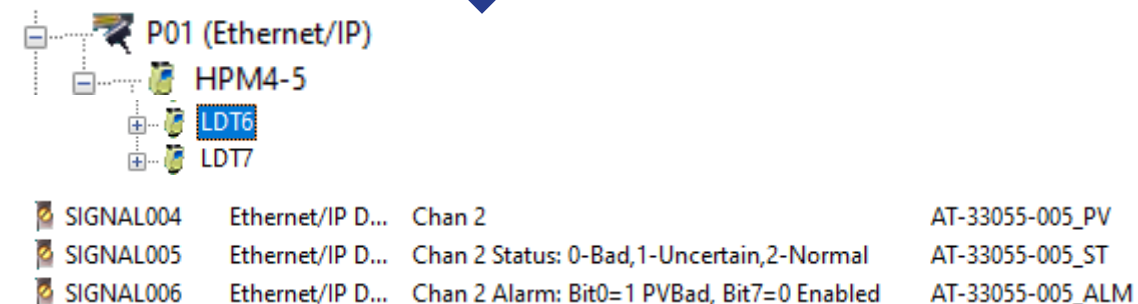
| SIO_TAG | DIRECTION | ITEM_PATH | SIOTAG_SUBVALUE |
|-----------------|-----------|----------------------------|-----------------|
| * | | | |
| AT-33055-005_PV | WRITE | *AT-33055-005_PV/FIELD_VAL | XD |
| AT-33055-011_PV | WRITE | *AT-33055-011_PV/FIELD_VAL | XD |

- DeltaV Honeywell IO Connect presented some challenges ...

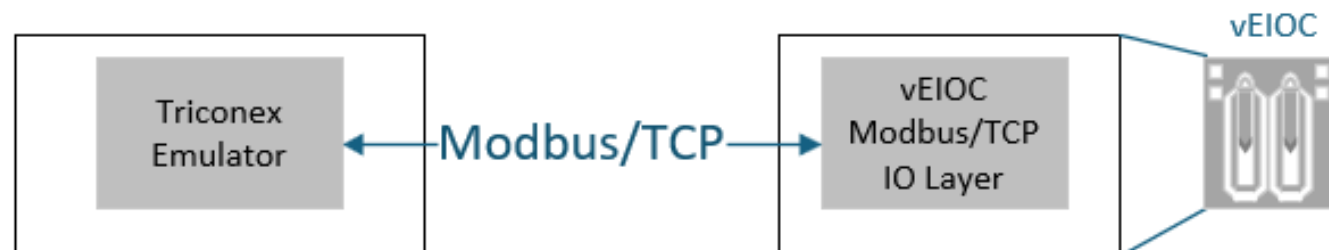
- Utilizes Ethernet/IP Signal, To communicate to the E/IP Signals, we utilized the MIMIC Virtual Controller IO Def
- Each Physical Analog Device(Transmitter/Control Valve) requires multiple different individual signals..1 for process value, 1 for status, 1 for an alarm bit, 1 for read back value(AO Only).
- Digitals are more complicated...IO Connect utilizes multiple, multi-bit variables that must be packed and/or unpacked before use in control modules(e.g. 8 DI field values packed into a single 8bit integer). MIMIC has to replicate this behavior so that the DeltaV configuration is correct.
- This allowed us to configure the control modules with the correct signal tags and confirm all of the IO mapping in a virtualized environment

OPC Server: OPC.DeltaV.1
 MACHINE: APP1
 Total Items: 2726

| INITIALIZATION_ITEM | INITIALIZATION_VALUE |
|-----------------------------|----------------------|
| * | |
| *AT-33055-005_ALM/FIELD_VAL | 0 |
| *AT-33055-005_ST/FIELD_VAL | 2 |



Simulation Solution: vEIOC Modbus/TCP IO



- vEIOC and Triconex Emulator both support Modbus/TCP in a virtualized environment.
- The Triconex Emulator is a built-in component of the TriStation Triconex configuration software
- Surprisingly...we didn't have to do anything special...just configure the vEIOC Modbus LDTs with the proper Triconex Modbus addresses and configure the proper IP addresses in the vEIOC and the Triconex Emulator
- Configuration of our DeltaV Control Modules was also straight forward as standard I/O FBs(AI, AO, EDC, etc.) could reference the vEIOC Modbus Signals directly

Triconex Emulator/ Triconex Configuration

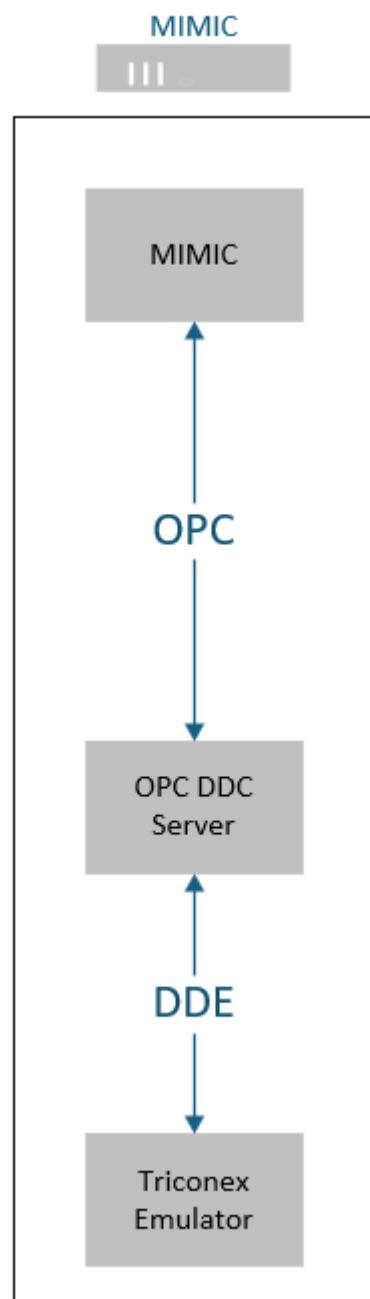
| Tagname | Point Type | Alias Type | Data Type | Point Address | Alias # |
|---------------|------------|------------|-----------|---------------|---------|
| MB183001_FLAG | Memory | Read Only | BOOL | n/a | 12016 |
| MB201067_FLAG | Memory | Read Only | BOOL | n/a | 12017 |

DeltaV

| Signal Name | Signal Description | Modbus Address | Direction | Data Type |
|-------------|----------------------|----------------|-----------|-----------|
| R12016 | Modbus Device Signal | MBI-33183-001T | Input | Boolean |
| R12017 | Modbus Device Signal | MBI-33201-067T | Input | Boolean |



Simulation Solution: Triconex ↔ MIMIC



- Triconex Emulator can use numerous protocols...but only 1 can read and write to the actual I/O tags → Dynamic Data Exchange(DDE)
- However, MIMIC primarily communicates via OPC.
- The solution was to find an OPC DDE Server. The OPC side can communicate to MIMIC while the DDE side communicates to the Triconex Emulator
- MIMIC then reads and writes via the OPC DDE Server directly to the I/O tags configured in the Triconex Emulator
- OPC DDE Server runs in the same session as the Emulator as a background task

Open OPC IO Def
OPC SERVER: SWToolbox.TOPServer.V6
MACHINE: localhost

SIOTag count:317

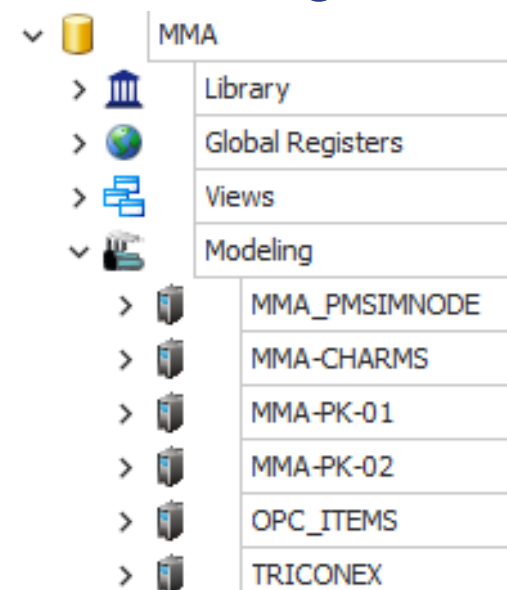
| SIO_TAG | DESCRIPTION | DIRECTION | ITEM_PATH |
|----------------|-------------|-----------|---------------------------------------|
| * | | | |
| ▶ AT240015_RAW | | WRITE | TriconEmulator.TRINODE01.AT240015_RAW |

| Project | Tag Name | Address | Data Type |
|---|--------------|-------------------------|-----------|
| <ul style="list-style-type: none"> Connectivity Channel1 Data Type Examples Simulation Examples TriconEmulator <ul style="list-style-type: none"> TRINODE01 Aliases | AT240015_RAW | TRINODE01 Command!30079 | Short |

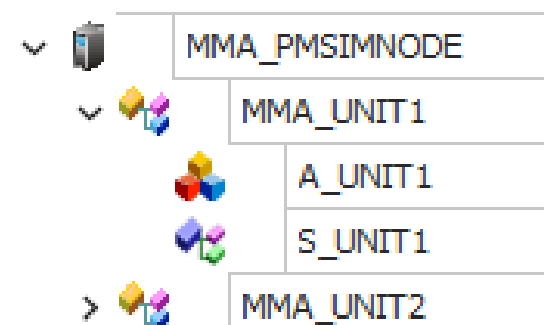
Simulation Solution: MIMIC Design

- General Design
 - Three Node Types(Hardware, IO Connect Initialization, and actual Process Model)
 - Each Node organized into Areas according to layout of the plant and unit
 - Hardware Nodes focused on I/O tiebacks and communications with models for each device
 - Process Model focused on process dynamics utilizing models built with standard MIMIC FBs and advanced modules from MIMIC's Process Core

Overall Organization

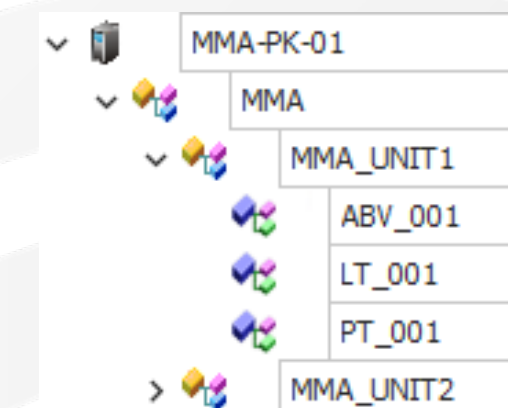


Process Model Node Example



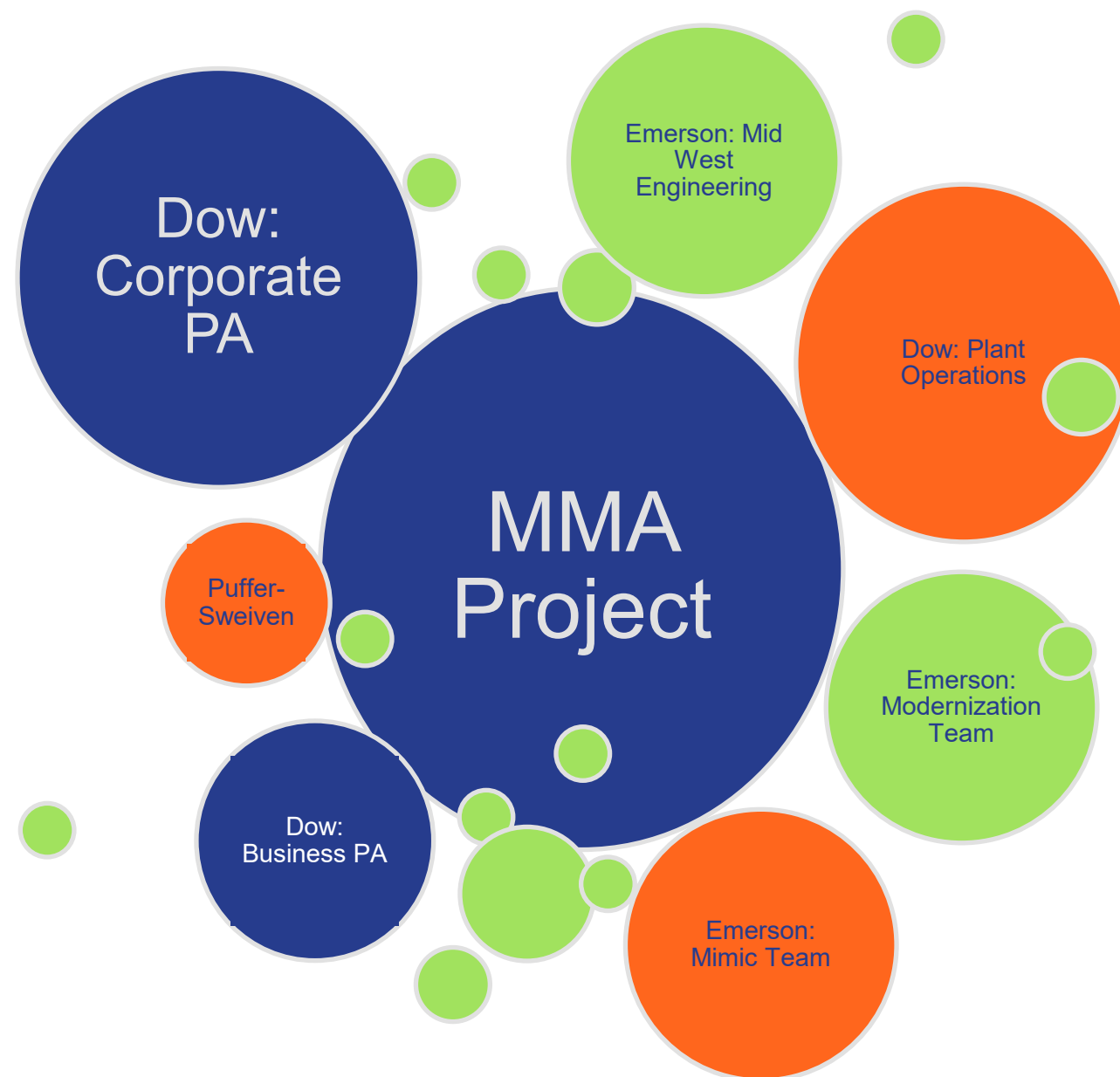
Data

Hardware Node Example



Execution, Outcome & Learnings

Project Team Makeup: Dow & Emerson



- Multiple teams both within Dow and Emerson made up the overall project team
- Overall Coordination by Dow Corporate PA: PA Lead(Alyssa Thomas)
- Dow Corporate PA: Platform and application implementation design, Code Development, Overall Project Management, Code Checkout, Startup Support, Simulation System Design
- Dow Plant Operations: Automation Requirements, Procedure updates, Startup Support
- Dow Business PA: Automation & Technology Requirements, Simulation Requirements, Operator Training, Startup Support
- Emerson Mid-West Eng: Emerson Project Management, Code Development, Code Checkout, Startup Support
- Emerson Modernization: IO Connect Development and Support
- Emerson MIMIC: Process Model Design, Development, Support
- Puffer-Sweiven: Production Hardware & System Installation at plant, Operator Training System set-up

Simulation and Process Model Development

- Overall Team effort to build and develop the simulation
 - Dow Corporate PA built/designed the control system
 - Dow Business PA and Plant Operations provided the requirements
 - Emerson MIMIC team developed the Process Model and organization within MIMIC
 - Dow Business PA, Plant Operations, and Emerson team validated model making corrections/improvements as needed



Code Checkout

- Three phases
 - Individual Developer(Dow and Emerson) testing of their own code on individual units
 - Integrated testing—interaction with other units
 - Dow Business PA and Plant Operations Useability testing...edge case testing, new control scheme validation
 - Yes...this is the “Let’s see if we can break it” testing.
- MIMIC designed with testing above in mind
 - Units can be tested individually or integrated together to see interactions. MIMIC has natural break points built in for this
 - Graphics were built to hide complexity of the underlying simulation and allow for a more natural user interface for common activities such as filling/draining tanks to specific points or heating/cooling to specific temperatures
 - Advanced MIMIC modules in Process Core utilized to make process dynamics more realistic where needed.
 - This allowed for the new control scheme testing and more realistic operator training

Operator Training

- The Operating philosophy change meant training had to prepare operators and day staff to run the new control system.
- Operators were also new to DeltaV and had to become familiar with the DeltaV control system interface.
- Two operators were trained at a time in two rounds, with each round repeated until all operators received training
 - Early(June 2024) training was one week to introduce operators to the DeltaV and the new control design
 - Final(late Summer/early fall) training was two weeks. It reviewed earlier learnings and went through updated procedures to startup and shutdown the plant. Scenarios of process upsets were also covered
- Both sets of training were conducted by Dow Business PA with technical support from Dow Corporate PA.
- Dow used our own method of testing Operator knowledge at the end(did not use Mimic Training Scenarios).



Overall Timeline

- Simulation system designed and built in the spring/early summer of 2024
- Testing and code checkout commenced as soon as system was available
- Operator training occurred in the late summer/Fall of 2024
- Plant startup occurred in late November/early December of 2024

Learnings

Positives

- System actually worked despite the variety of vendor software and communication protocols involved
- Triconex integration and testing was the easiest part—this was not expected
- Process model was realistic enough to meet plant and project needs
- Knowledge of Emerson MIMIC Team and interaction with them

Negatives

- Took time for Dow/Emerson to align on what data/inputs were needed for the process model
- Triconex Emulator must run in Session 0 of VM
- Simulation at DST layer in virtual controller doesn't allow for the use of DeltaV snapshots
- Model/Organization complexity
 - A_MODELS vs S_MODELS
- Not able to upgrade virtual controller hardware with latest firmware or fixes
- Level of skill needed to fix/improve MIMIC model
- Windows 11 could not RDP to Windows 10 in simulation—Fixed now, Thanks Microsoft...

True Challenges

- Random crashes of MIMIC VM
- Virtual Controller DST bug
 - MIMIC would write to the correct DST...but data would end up in the wrong place
- Overall system performance
 - there were so many people and so much work being done simultaneously that we had to re-architect several times.
 - DeltaV Live/ Delta Database very sluggish – uses more CPU than Operate
- EIOC/DeltaV Live bug caused modules not to be available from DeltaV Live



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Thank You