Beyond Boundaries

Transforming Interoperability for the Next Generation of Factories

Zach Etier – NGC Enterprise Architect

Presenters Bio – Zach Etier

Current Role:

- Enterprise Architect
  - Focused on Digital Transformation of the Manufacturing Floor

Background:

- Oklahoma State University
  - Aerospace Engineering
  - Mechanical Engineering
  - Computer Science
- 6 Years at Northrop Grumman

Accomplishments:

- Lead Architect at NGC for IT/OT
- Supported Numerous IIoT Deployments at NGC

Agenda

1. Definition of Interoperability
2. Why the focus on interoperability today?
    1. Industry 4.0
    2. Vertical vs Horizontal Design Patterns
3. The Datahub
    1. Intelligence Hub
4. NGC Case Study:
    1. Background
    2. Challenges
    3. Architecture
5. Interoperability Themes applied to Supply Chain
6. Conclusion
7. Q/A

Interoperability Definition

*"The ability for **diverse** devices, applications, data, and processes to seamlessly connect, communicate, and coordinate, ensuring efficient exchange and use of information"*

- GPT 4.0

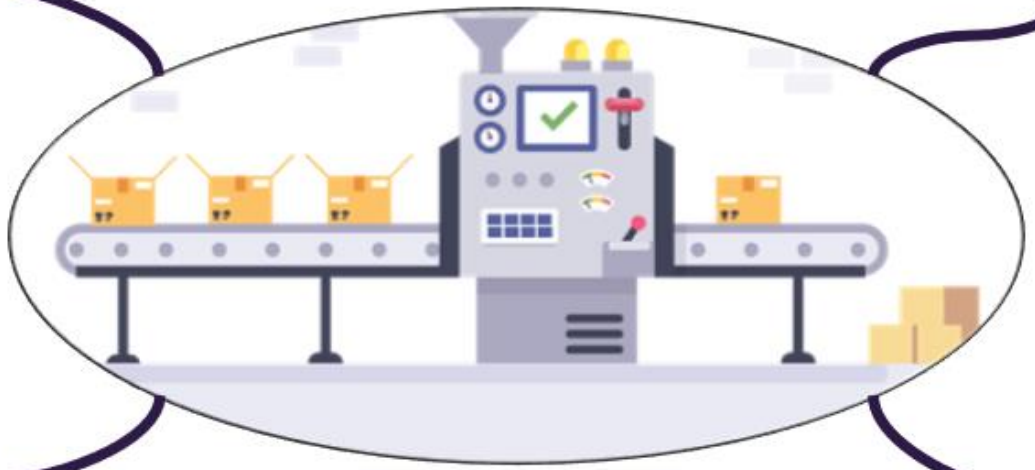
What is interoperability in the context of Manufacturing?

Interoperability: Devices

"The ability for diverse devices, applications, data, and processes to seamlessly connect, communicate, and coordinate, ensuring efficient exchange and use of information"

Device Type
- CNC
- 3D Printer
- Etc.

Connectivity
- None
- Serial (Legacy)
- Ethernet (Modern)



Machine Data
- Job/Profile
- Formatted Report
- Telemetry
- Etc.

Data Format
- JSON
- XML
- Object
- .docx/pdf
- Etc.

Interoperability: Applications

"The ability for diverse devices, applications, data, and processes to seamlessly connect, communicate, and coordinate, ensuring efficient exchange and use of information"

MES
- SAP PEO
- Deltek
- Solumina
- OpsCenter
- Etc.

ERP
- SAP
- Costpoint
- Etc.

SCADA
- Ignition
- FactoryTalk
- Etc.

Historian
- Canary
- OSI Pi
- InfluxDB
- Etc.

IIoT Platform
- Thingworx
- Ignition
- AWS/Azure
- Etc.

PLM
- Teamcenter
- Windchill
- Etc.

IoT Gateway
- KepServerEx
- Etc

Interoperability: Data

"The ability for diverse devices, applications, data, and processes to seamlessly connect, communicate, and coordinate, ensuring efficient exchange and use of information"

Data Type
- Structured vs Unstructured
- Relational, Streamed, TimeSeries, etc.

Data Velocity
- Real Time
- Scheduled/Batch
- Etc.

Data Volume
- Big Data
- Etc.

Data Format
- JSON
- XML
- Object
- Etc.

Data Governance
- Non-Invasive
- Etc.

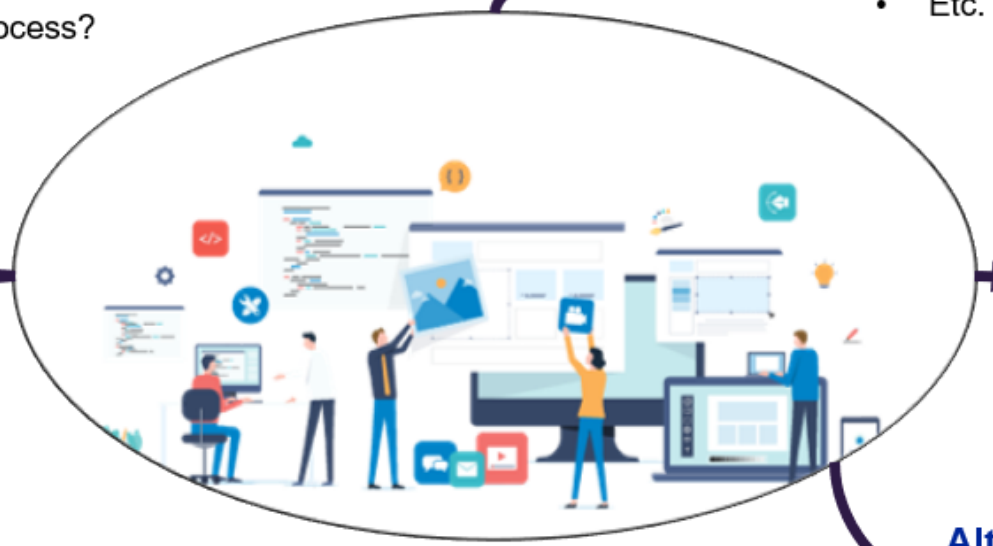
Interoperability: Processes

"The ability for diverse devices, applications, data, and processes to seamlessly connect, communicate, and coordinate, ensuring efficient exchange and use of information"

Actors
- Mfg. Operator
- Mfg. Area Owner
- QA
- Etc.

Devices
- What devices support the process?

Applications
- What apps support the process?



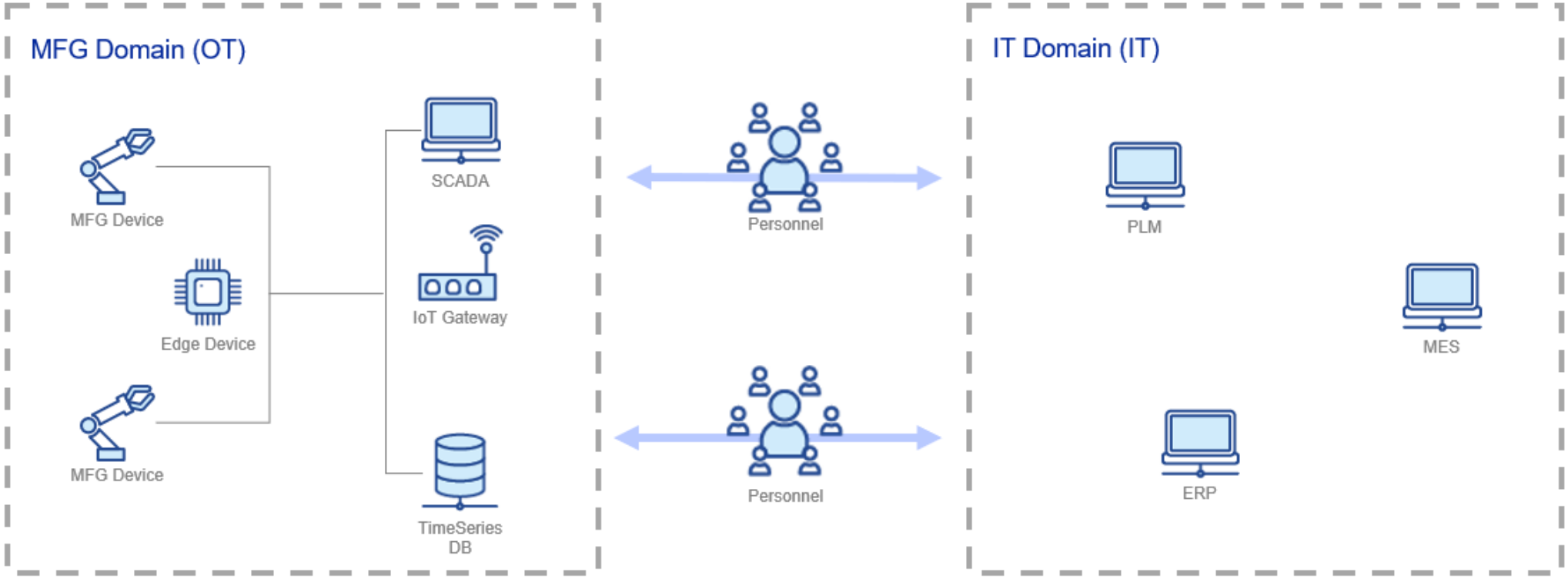
Data
- What data support the process?

Start / End Conditions
- What state do we need to be in to start?
- What state do we need to be in stop?
- How is this process related to other processes?

Alternate Paths
- What happens if we hit an error state?

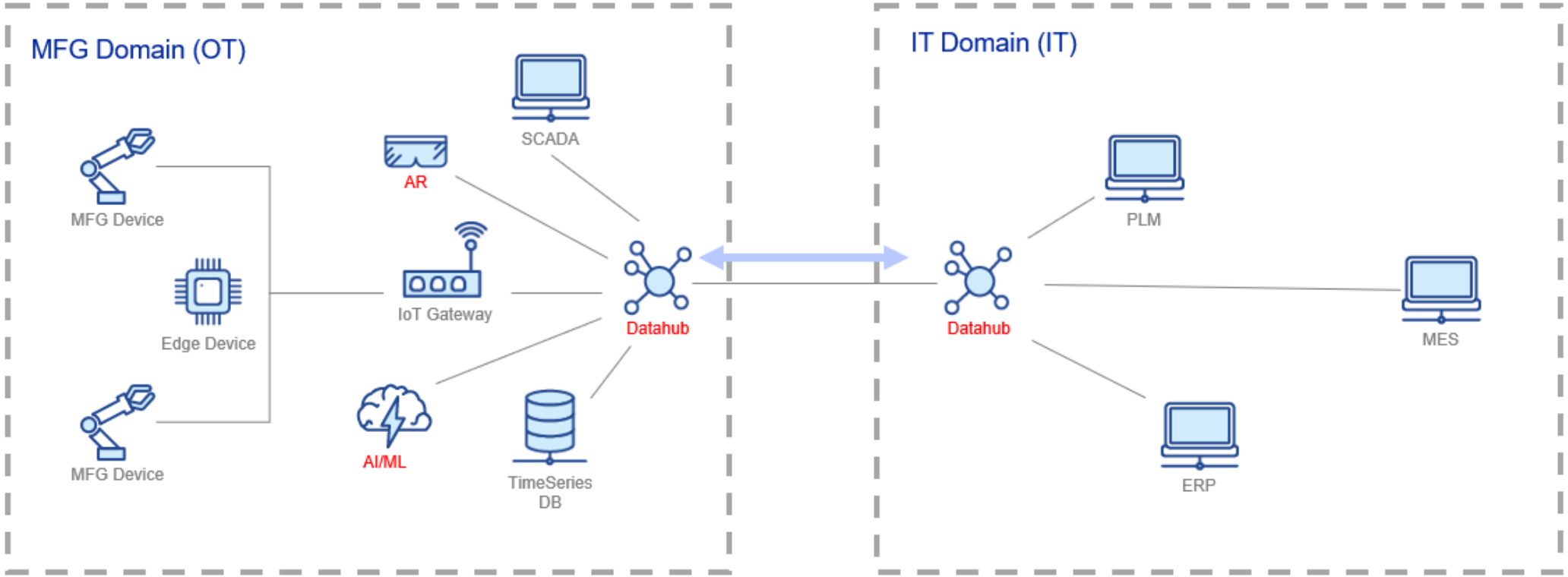
Why the focus on interoperability today?

Industry 3.0



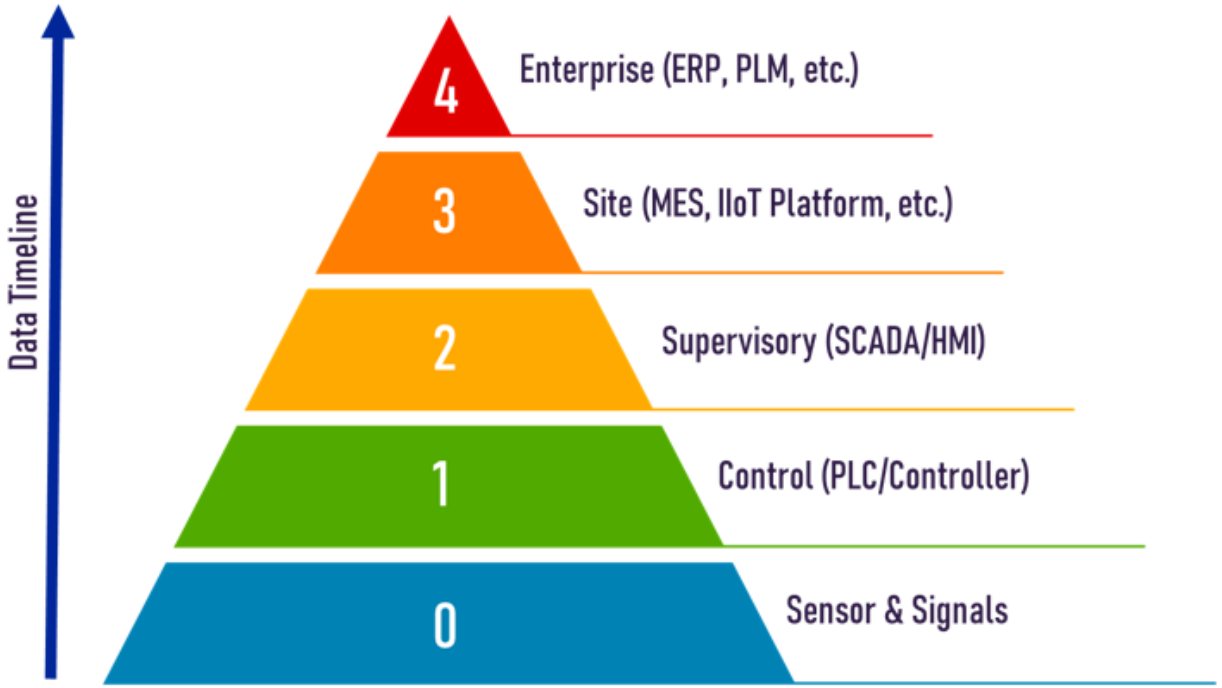
Automation of OT Systems, requires human intervention to interface with IT Systems

Industry 4.0



Digital Factory, aka Integration and Automation of both OT and Business Logic (IT)

A Change in Design Patterns: Vertical vs Horizontal



Industry 4.0 Architecture resembles Micro Service Architecture

	Vertical/Monolithic	Horizontal/Distributed
Scope of Solution	Covers multiple layers.	Single Responsibility.
Integration	Integration between layers typically easier.	Integration at scale more complex, requires CM of interfaces.
Flexibility	Limited offerings, possible limitations based on vendor partners.	High Flexibility, each component can be selected based on specific need.
Cost	Often significant upfront investment.	Scaling Cost.
Deployment	May need to update multiple components.	Only need to update component that change.
Vendor Lock	If vendor only supports partner integrations, hard to move away when invested.	Reduced vendor lock in. Easy to swap components for best in class.
Scalability	May need to scale everything even if only one layer requires it.	More granular scalability, only need to scale what's being used.

Technology Overview: The Datahub

The Idea of the Datahub

Problem Areas around Distributed Architecture:

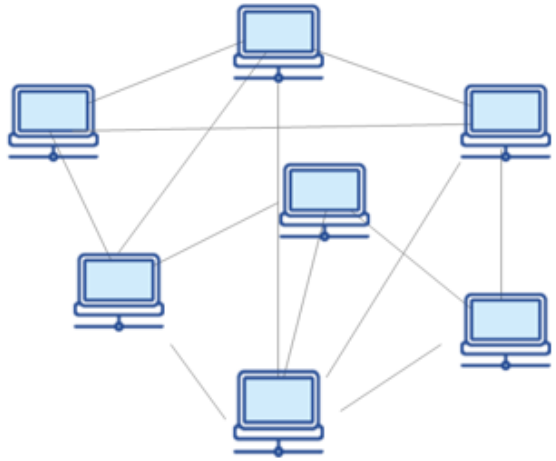
1. Diverse Data Formats
2. Numerous Interfaces
3. Governance
4. Scalability/Maintainability

What is a Datahub:

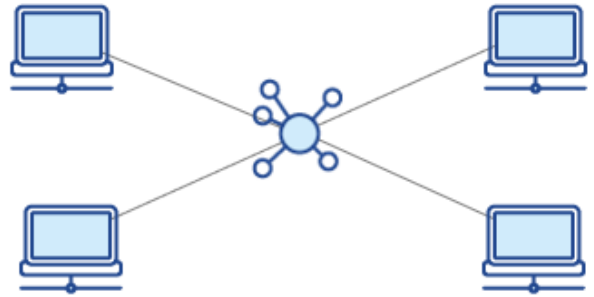
– *Serves as a centralized platform designed to consolidate, manage, and distribute data from multiple sources to various applications, it contextualizes and transforms data, offering a single point of integration, enabling interfaces of consumers/producers to go from strong coupling to weak coupling.*

How Datahubs Mitigate Problem Areas:

1. Data Modeling / Data Management
2. Single Integration Point
3. Decouples Consumers/Producers
4. Centralized Management



Distributed Architecture – w/o a Datahub



Distributed Architecture – w/ a Datahub

Intelligence Hub

Design Philosophy:

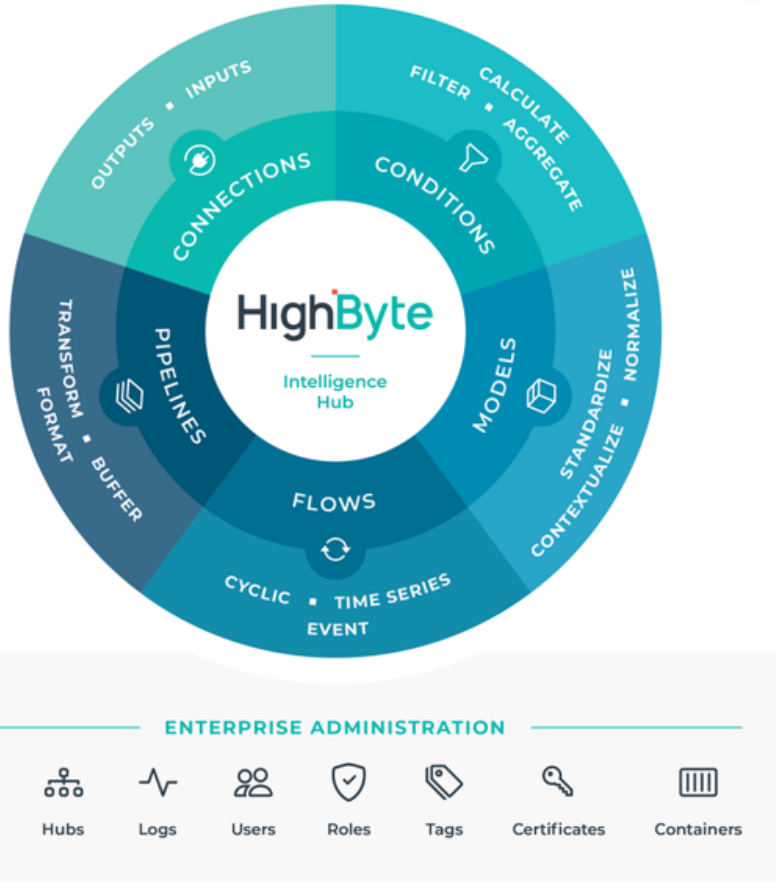
- Edge Driven Data Contextualization
- Focused on the Manufacturing Domain
- Designed for Scale

Capabilities:

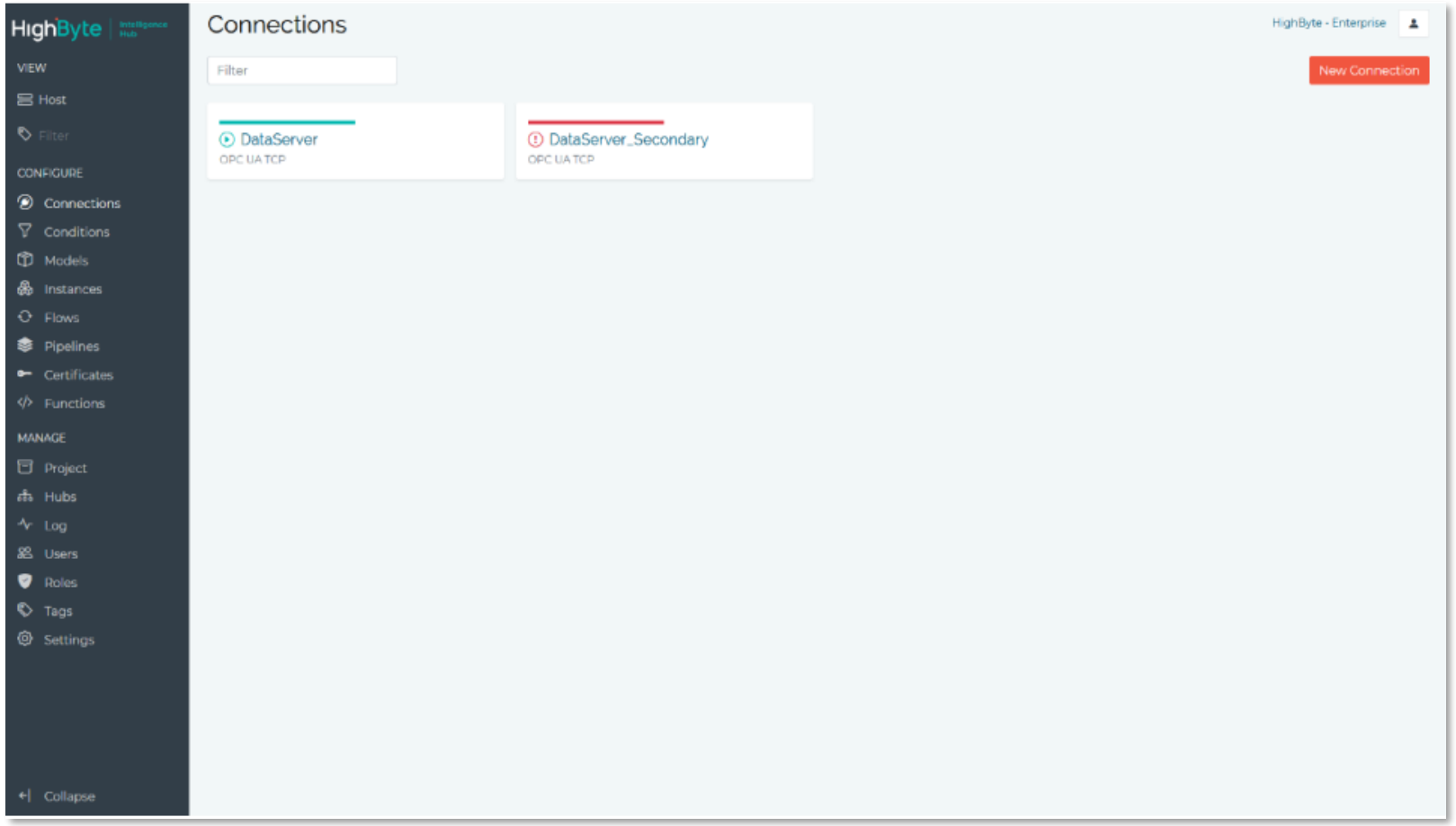
- Variety of Connections/Interfaces Supported
- Data Conditioning and Alarming
- Data Modeling and Data Mapping/Instantiation
- Flows to enable Event Driven Architecture
- Data Pipelines

Deployment Options:

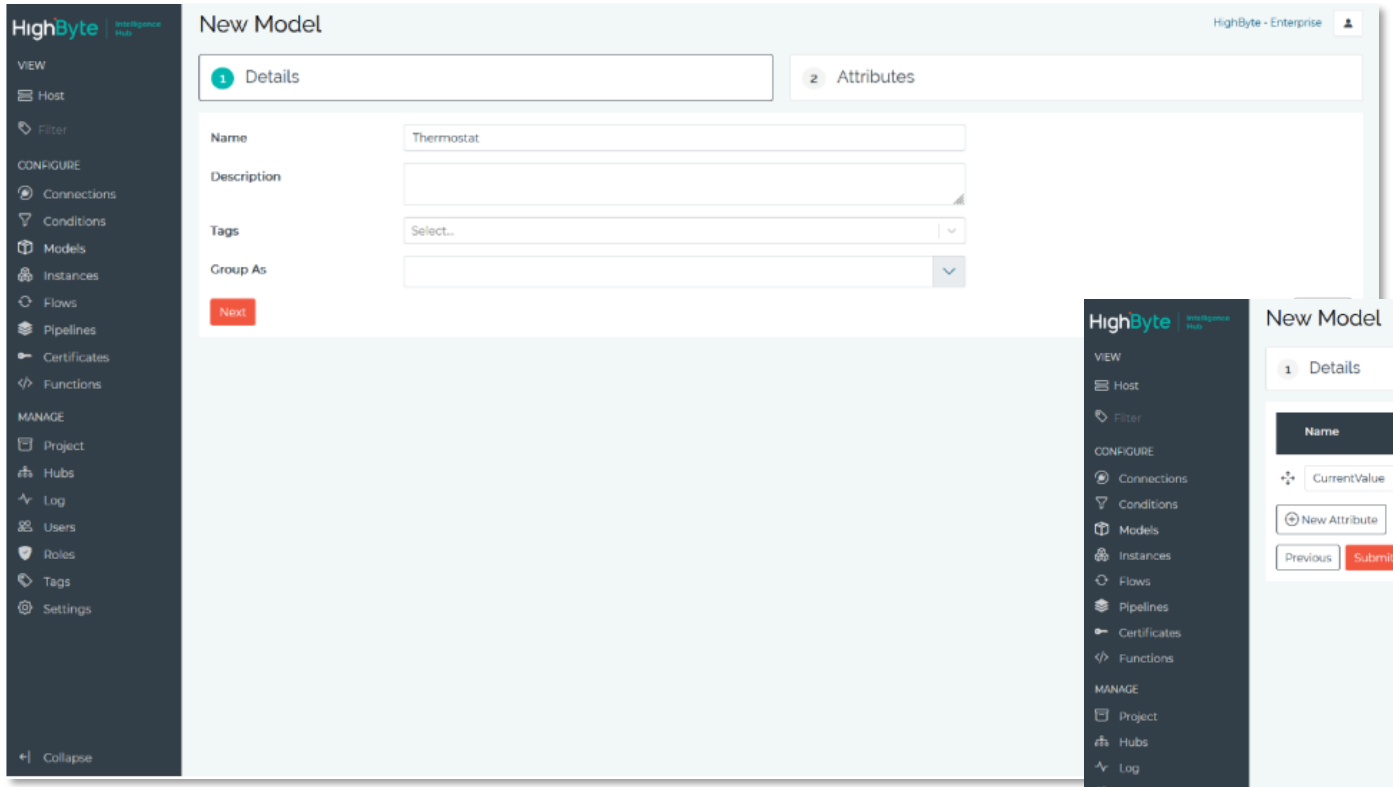
- Docker
- Windows
- Linux

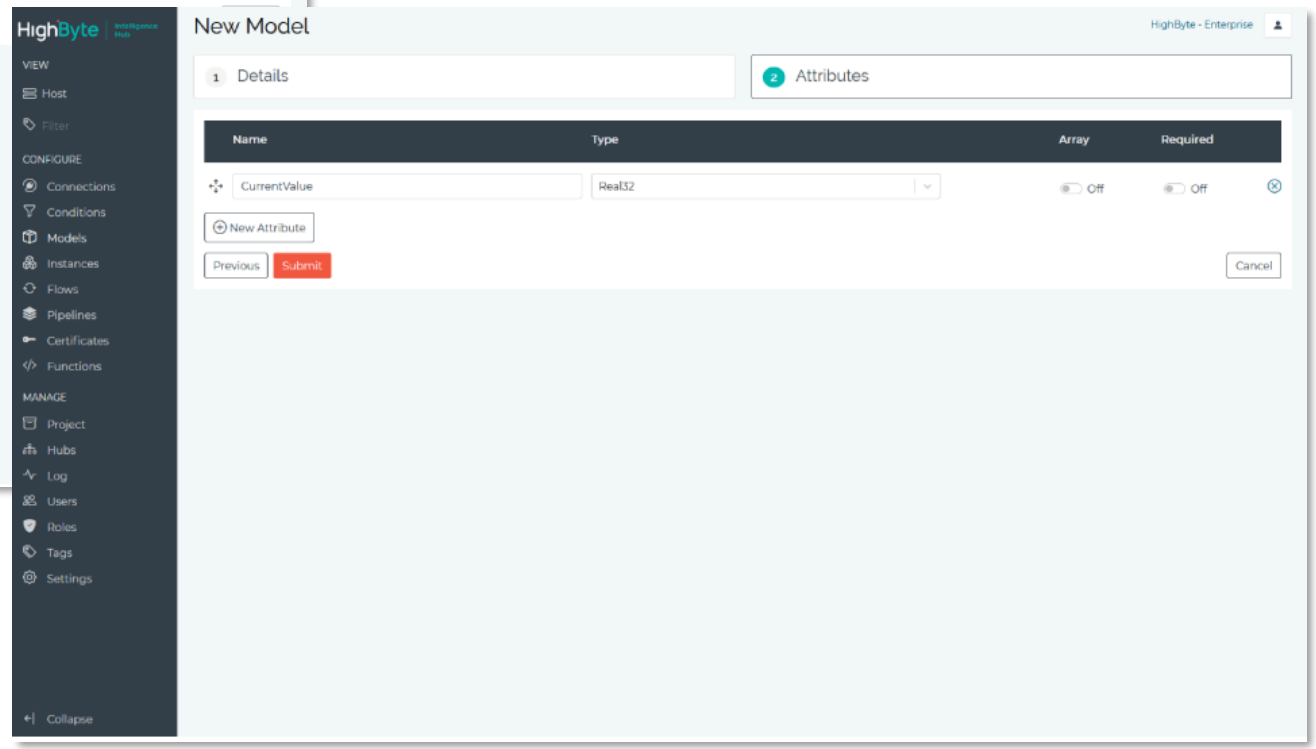


Intelligence Hub: Interfaces

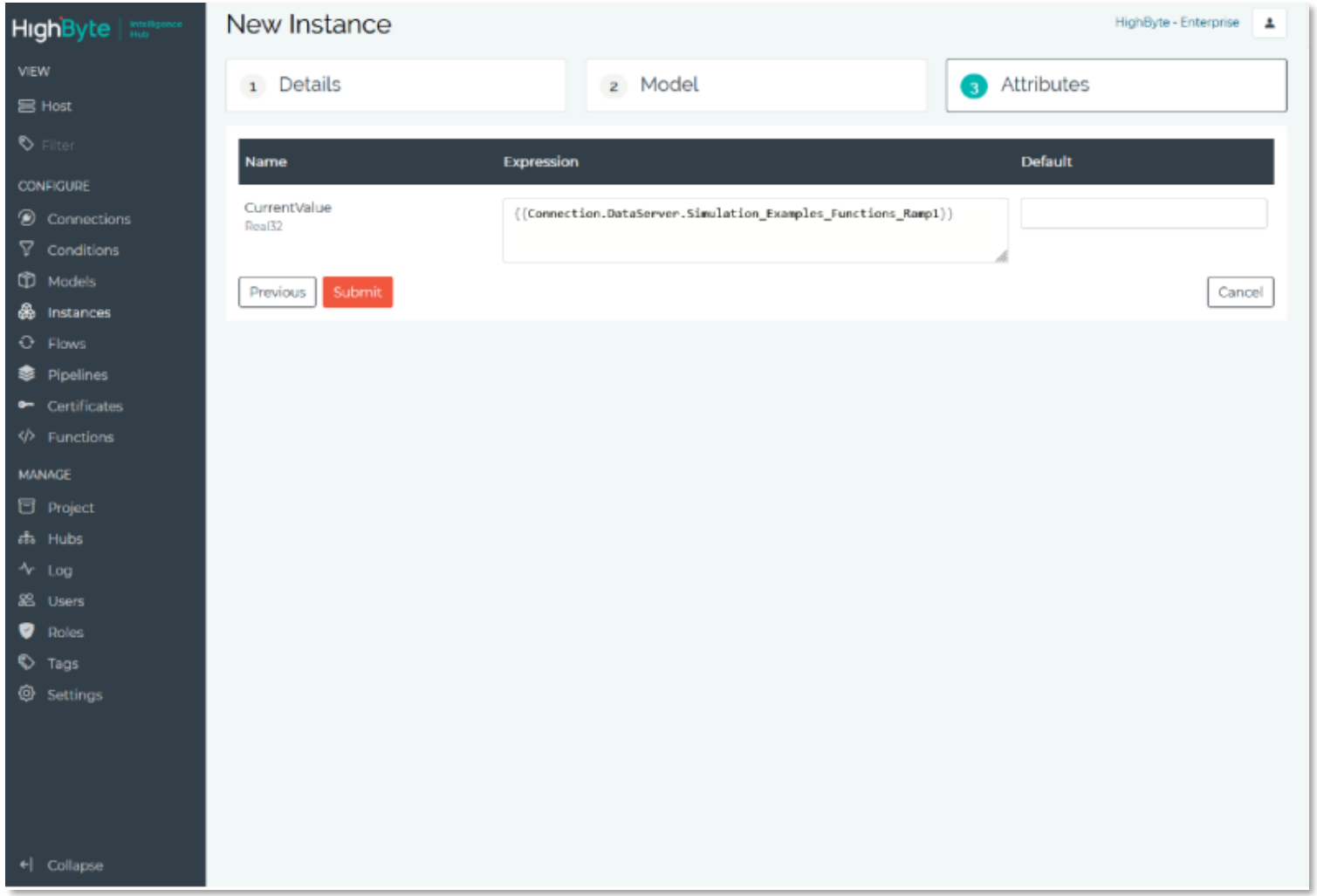


Intelligence Hub: Model Definition

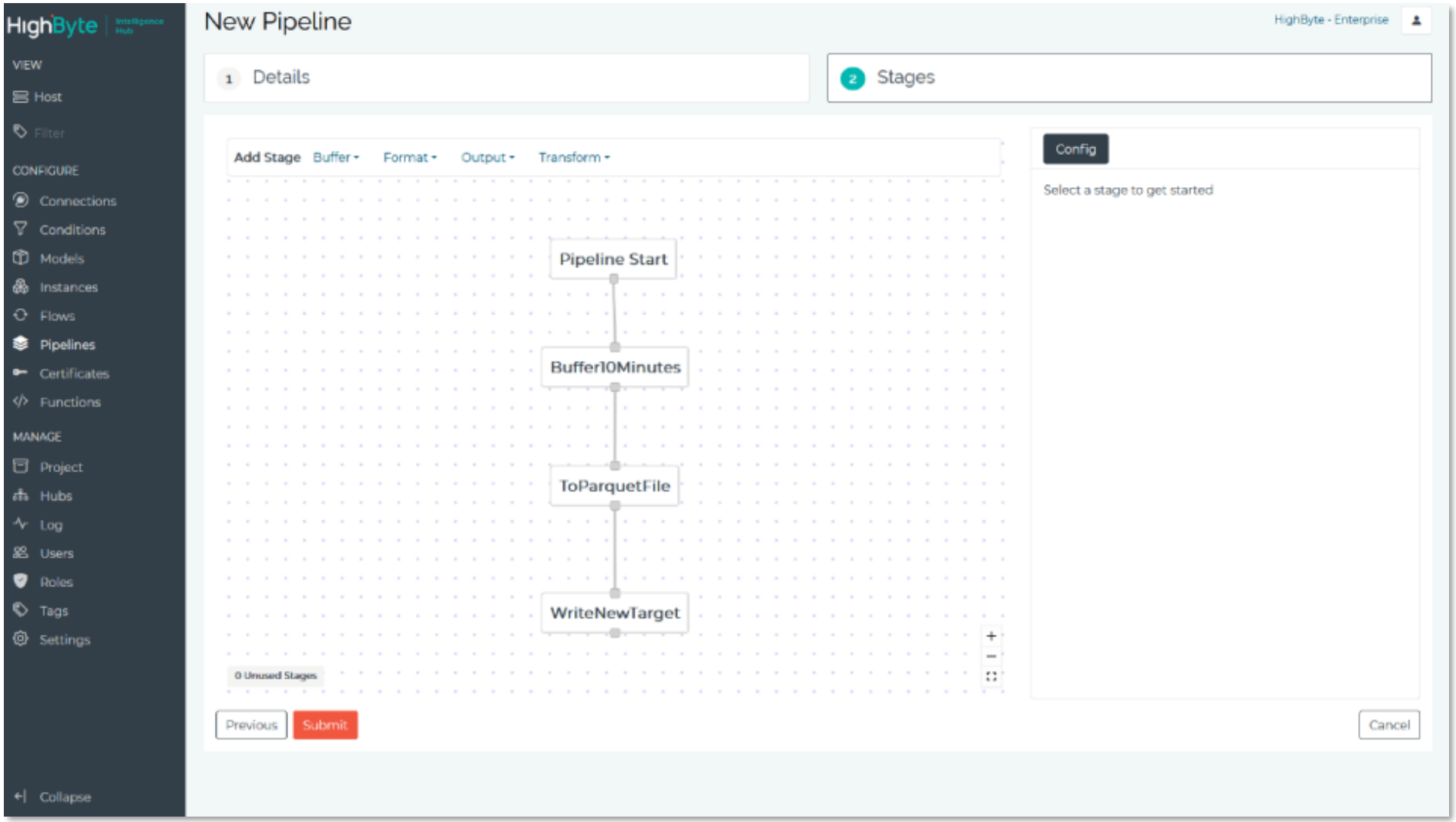




Intelligence Hub: Instantiation & Data Mapping



Intelligence Hub: Pipelines

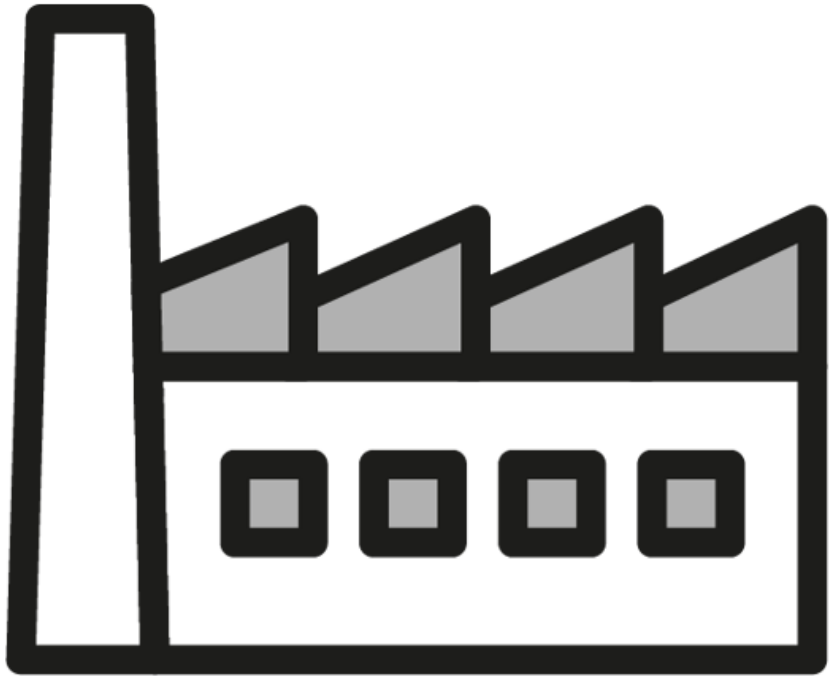


Putting It All Together: NGC Case Study

Case Study: Background

Site Topology selected for Digital Transformation

- 3 Separate Manufacturing Areas :
  - Machine Shop: 10-20 CNC's
  - Thermal Testing: 50-100 Thermal Chambers
  - Advanced Testing: 5 Mechanical Devices (No connectivity)

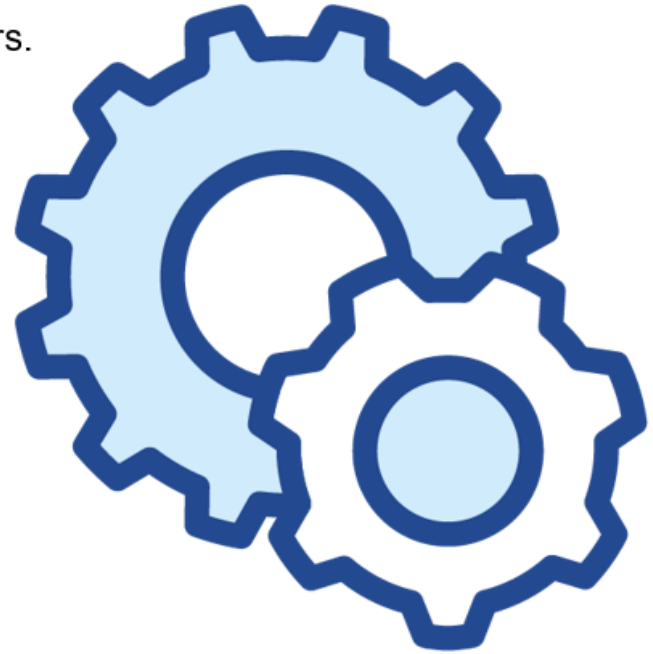


Types of Applications required to support Operations

1. IoT Gateway
2. Numerous types of Data Stores
   1. Time Series
   2. Relational
3. SCADA
4. MES
5. Visualization
6. In-House Tools (Report Generation)
7. DNC

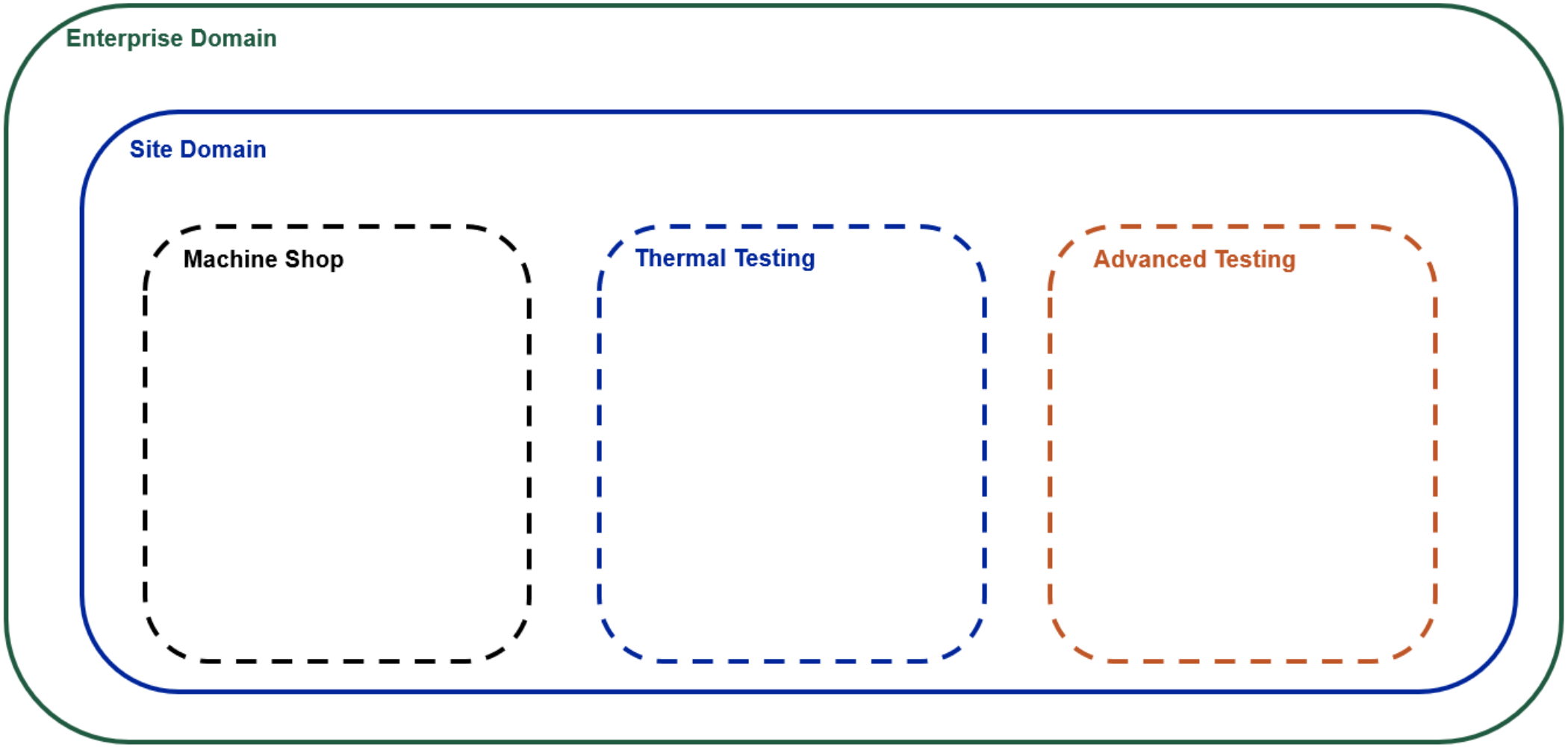
Case Study: Challenges

- **Data Diversity**
  - Variety of data formats delivered by producers and expected by consumers.
- **Interface Compatibility**
  - Not all interfaces between Consumers and Producers supported:
    - Modbus
    - SQL
    - MQTT
    - WebSocket's
    - Rest (HTTPS)
    - Etc.

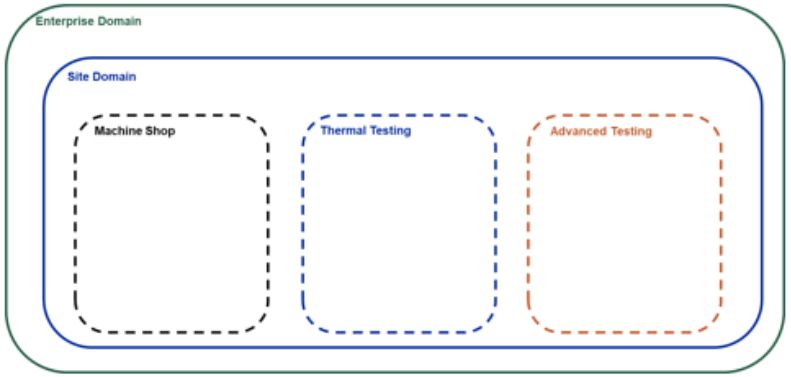


- **Configuration Management of Interfaces**
  - Some applications required data from multiple sources.
- **Data Integration across all MFG Areas**
  - Each individual mfg. area needed the ability to structure data how they need/want.
  - Needed the ability to map mfg. area data into a public data structure (UNS) to represent the entire site.
- **Scalability Concerns**
  - Site has plans to add another 100 devices in the next 12 months and expand the architecture more applications.

Case Study: Architecture - Domains



Case Study: Architecture - UNS

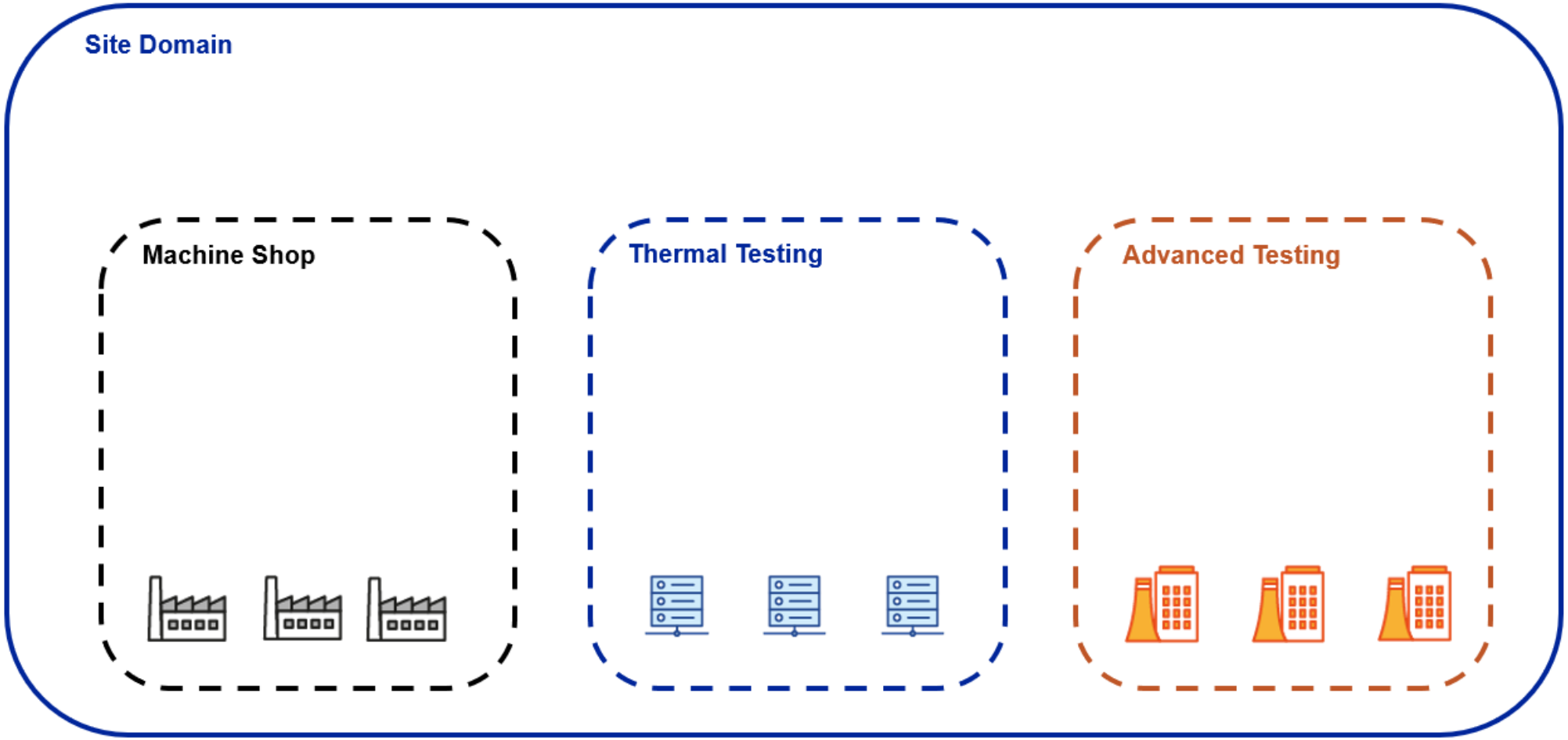


- Enterprise Namespace
  - Functional Namespace
  - Informative Namespace
  - Definitional Namespace
  - SITE
    - Functional Namespace
    - Informative Namespace
    - Definitional Namespace
    - AREA
      - Functional Namespace
      - Informative Namespace
      - Definitional Namespace
      - MFG Device
        - Functional Namespace
        - Informative Namespace
        - Definitional Namespace

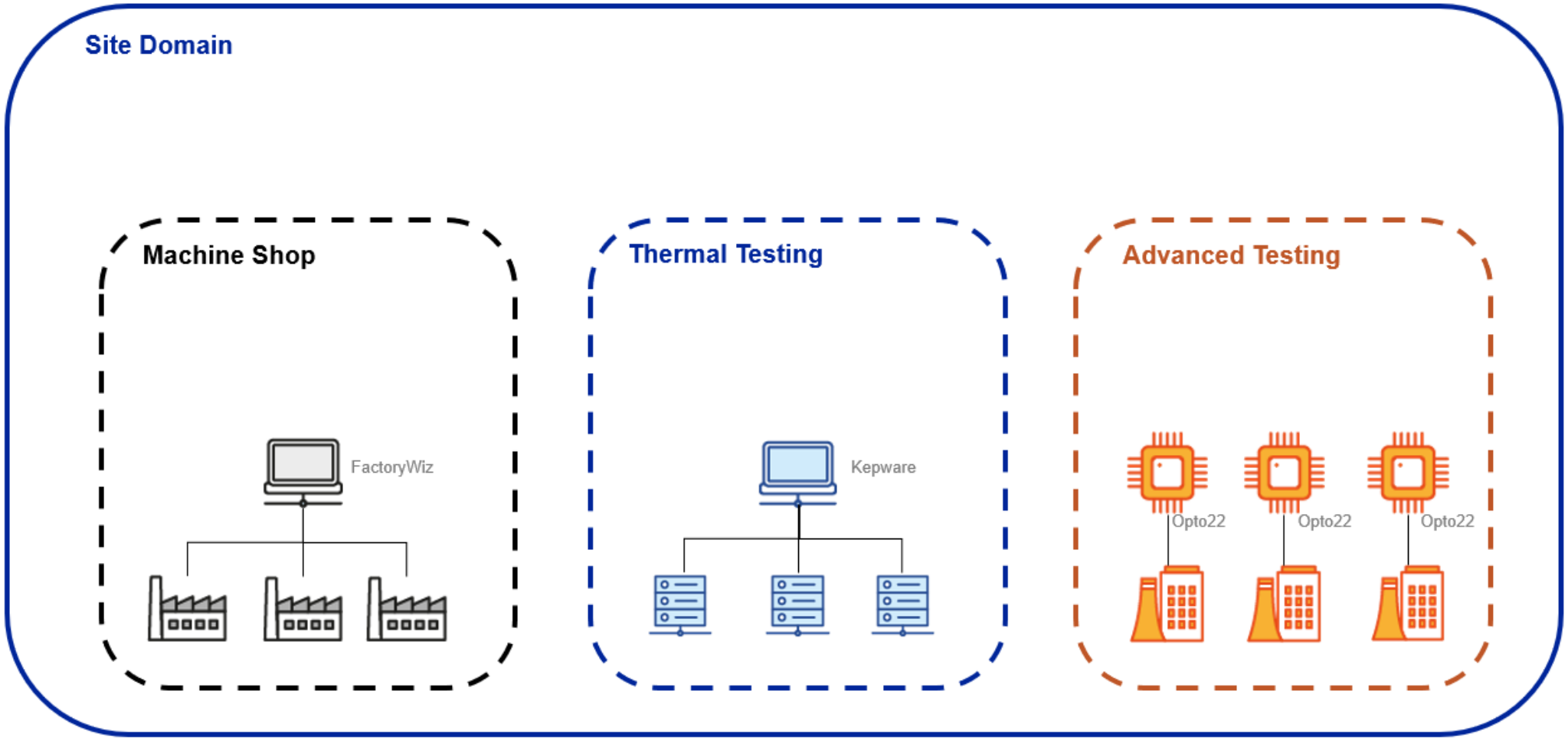
- NGC Namespace
  - Case Study SITE Namespace
    - Machine Shop
      - CNC 1
      - CNC 2
      - CNC …N
    - Thermal Testing
      - Thermal Chamber 1
      - Thermal Chamber 2
      - Thermal Chamber …N
    - Advance Testing
      - Test Set 1
      - Test Set 2
      - Test Set …N

A UNS implemented with MQTT enables an implicit schema that enables scale.

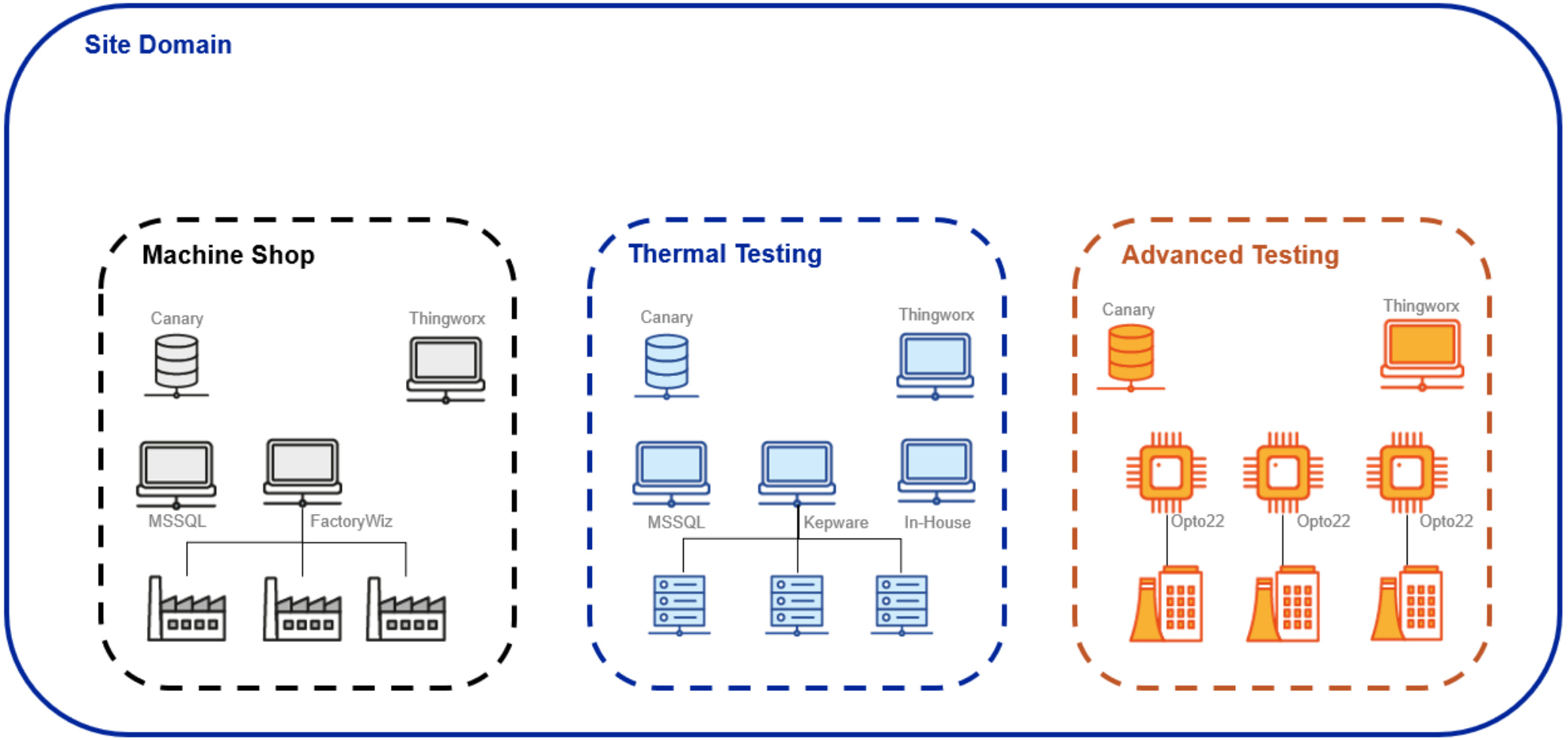
Case Study: Architecture – MFG Devices



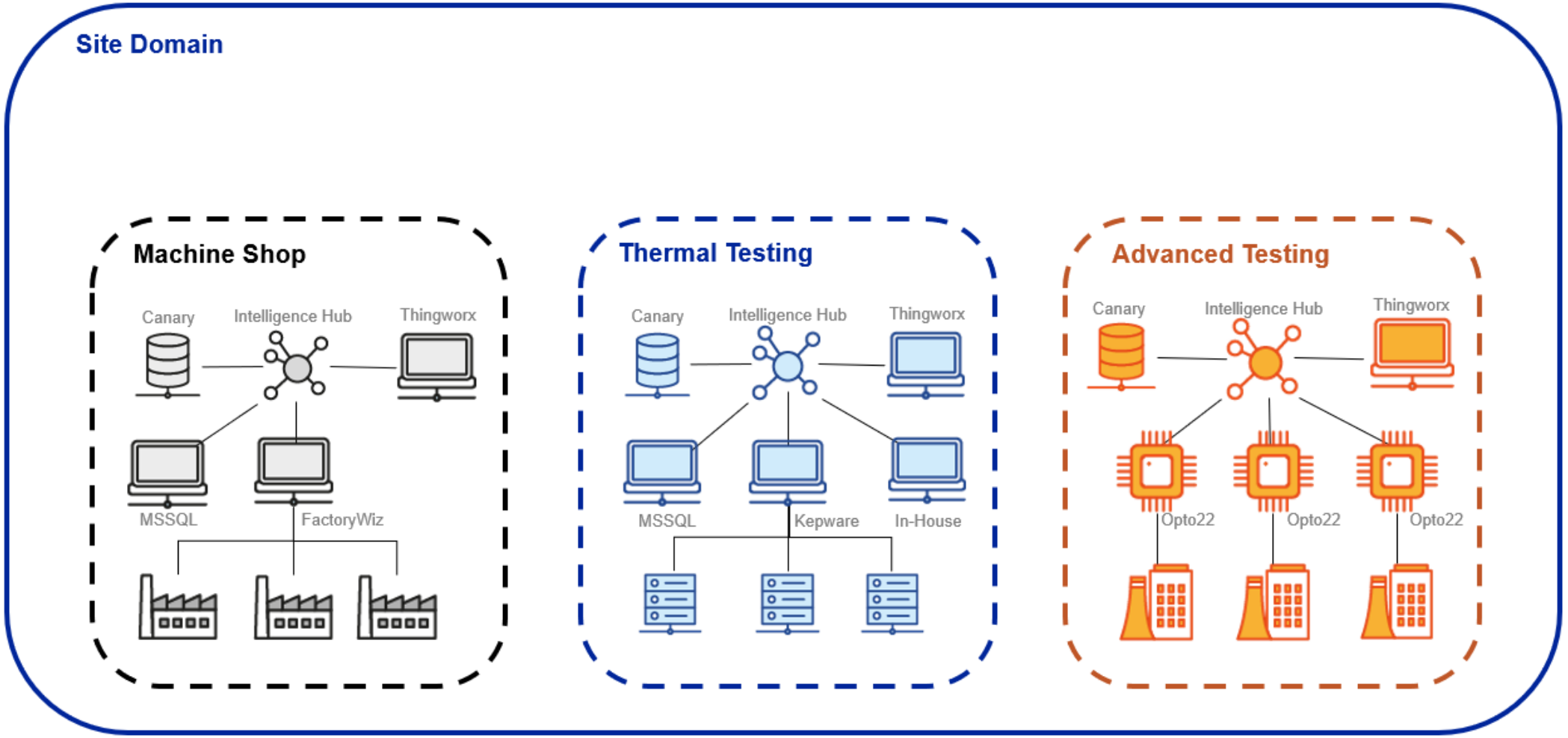
Case Study: Architecture – Connectivity



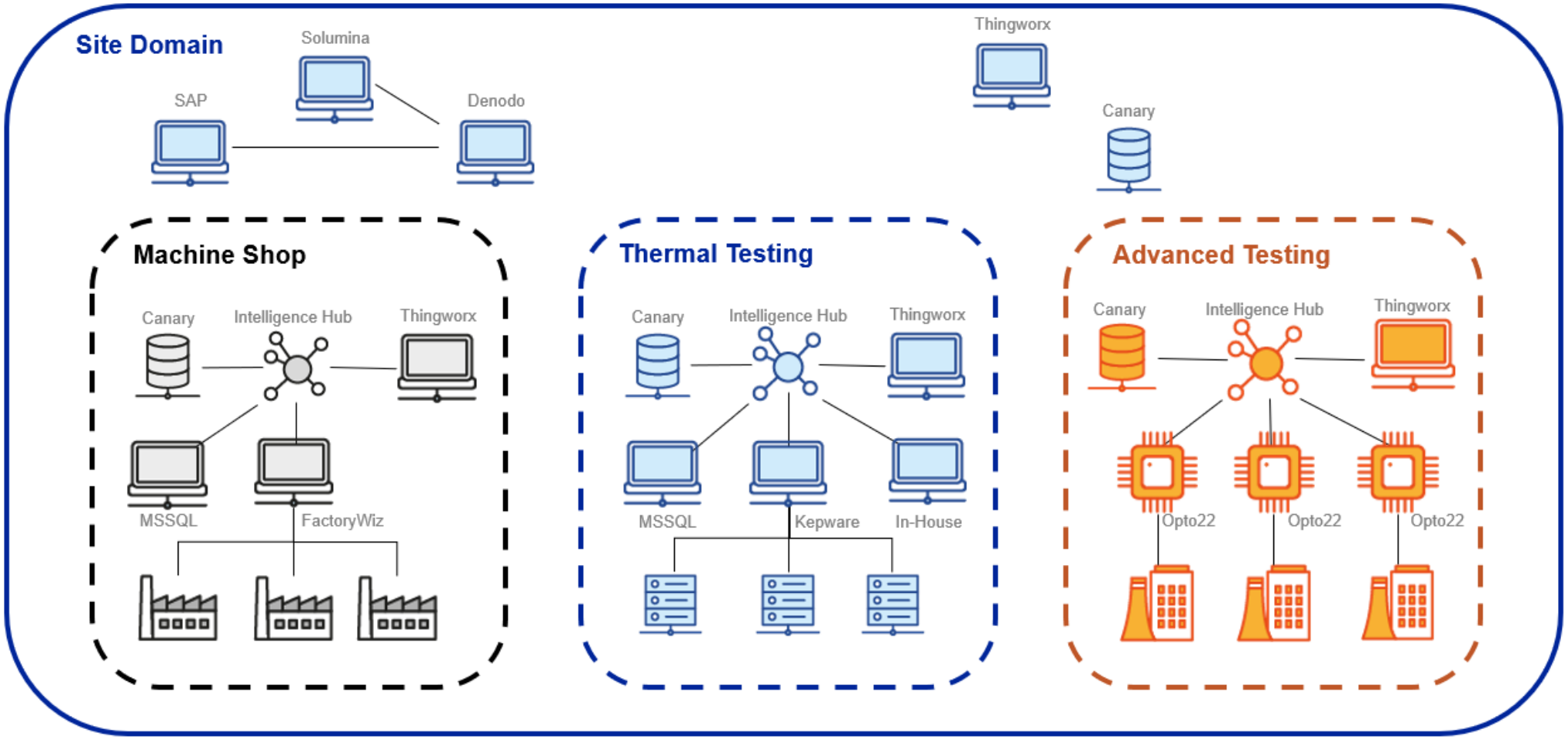
Case Study: Architecture – Site Applications



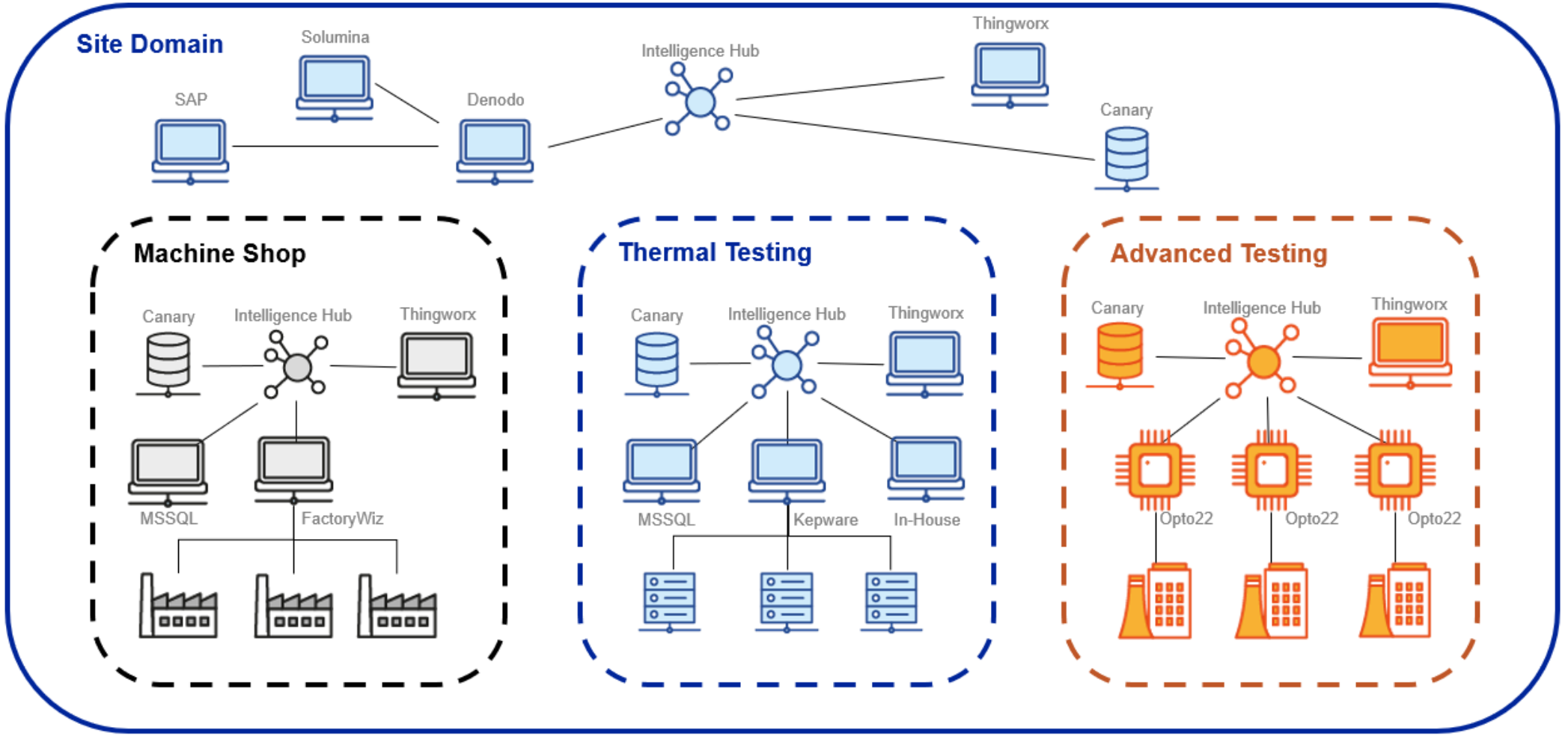
Case Study: Architecture – Datahub



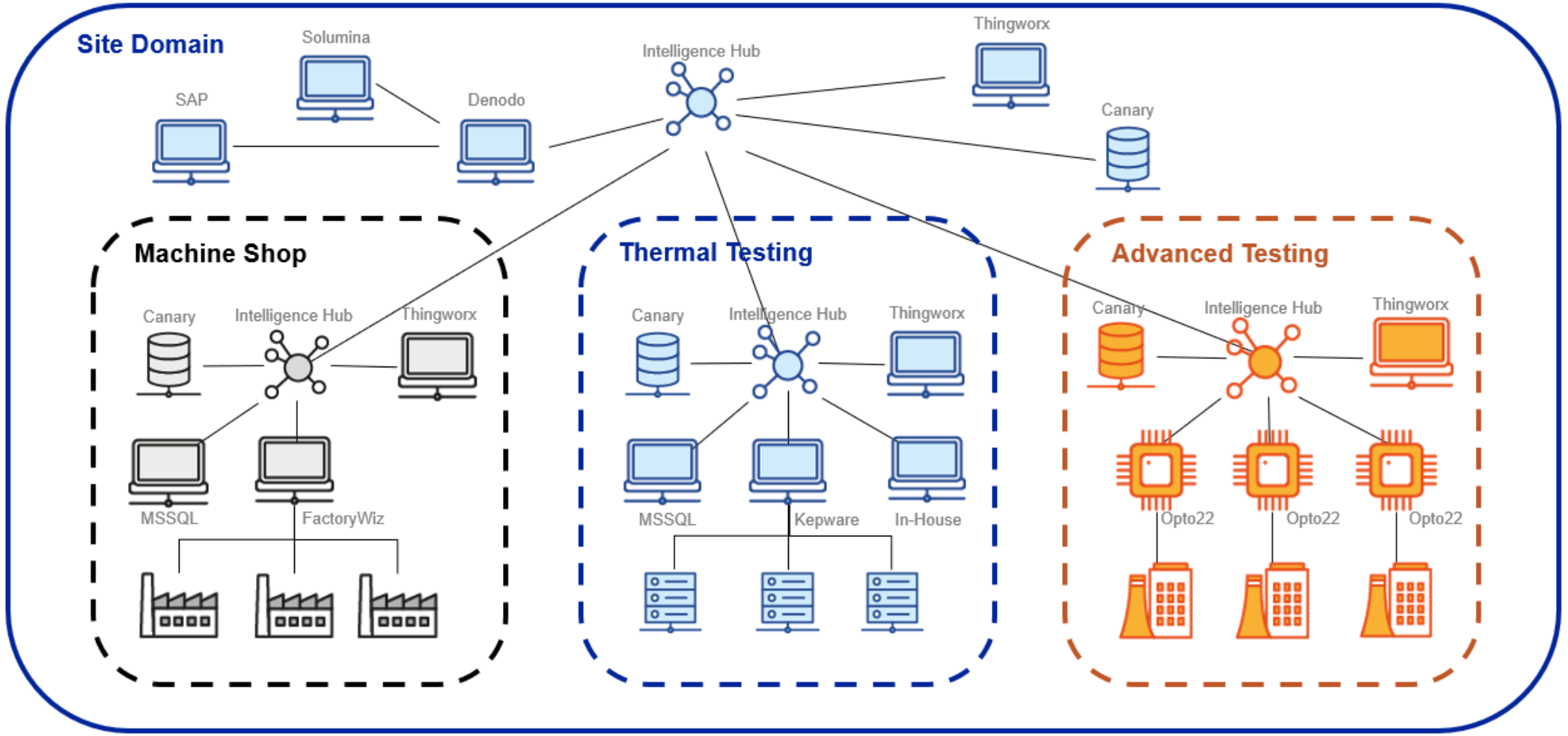
Case Study: Architecture – Site Rollup



Case Study: Architecture – Site Integration

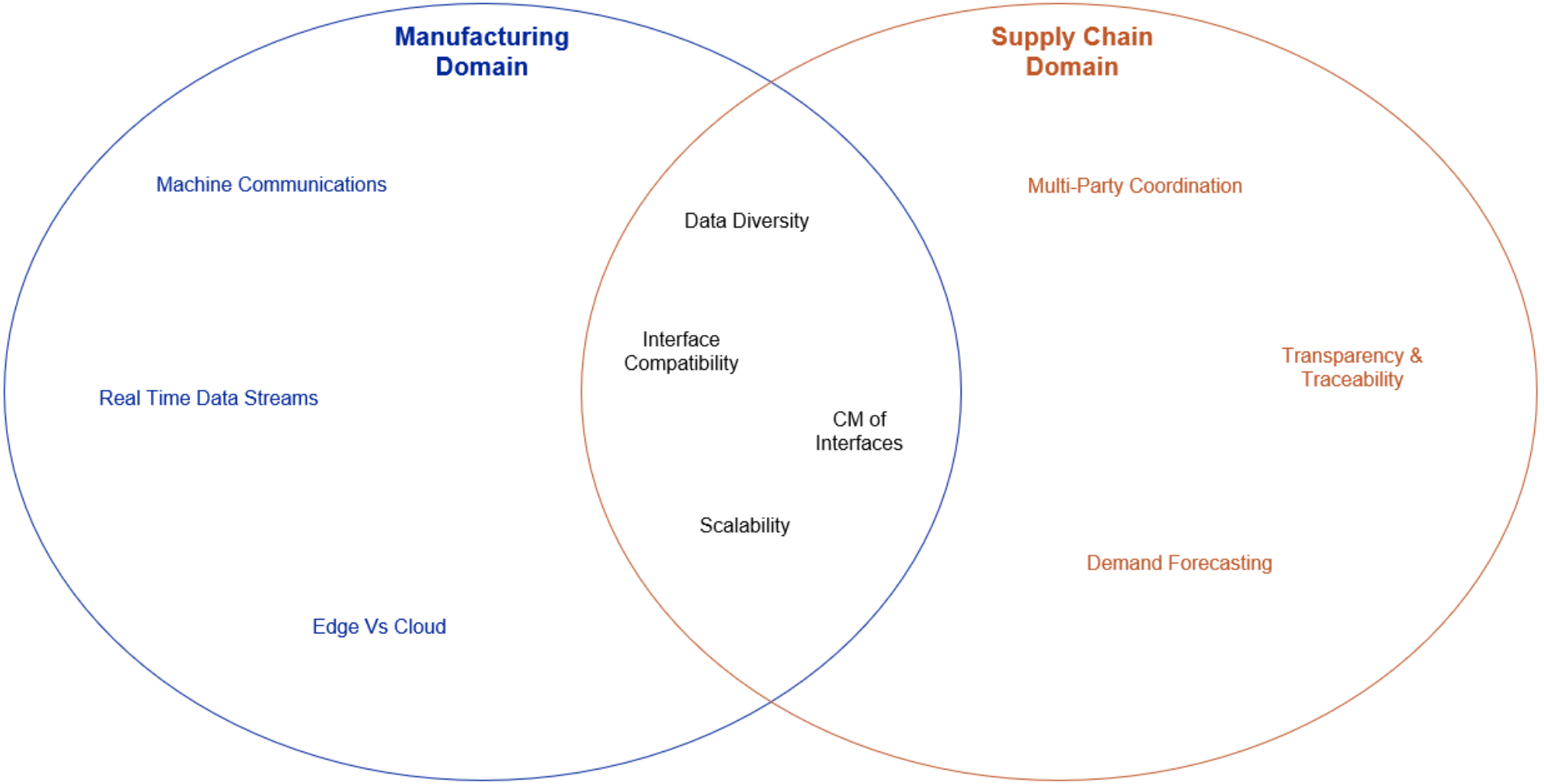


Case Study: Architecture – Datahub



How do these themes around interoperability apply to Supply Chain?

Interoperability Themes applied to Supply Chain



Conclusion

- **Complexities of Interoperability for Manufacturing**
  - Diverse Landscape of devices, applications, data, and processes.
- **Shift in Architecture Design Patterns**
  - Shift form I3.0 (Focus on automation of OT) to I4.0 (Automation of Business Processes with OT integration aka Digital Factory)
  - Transition from vertical, single-vendor architectures to more flexible, horizontal integrated approach
- **The Power of Datahubs**
  - Technology that enables interoperability by allowing the modeling and contextualization of data.
  - Overview of Intelligence Hub as a industry leader in datahub technology for the manufacturing domain.
- **Key Takeaway**
  - Navigating the challenges of distributed architecture is complex, However, leveraging tools like Datahubs is the key to unlocking efficient interoperability and shaping the future of digital factories and supply chains.

Questions / Answers