

# Beyond Boundaries

Transforming Interoperability for the Next Generation  
of Factories

Zach Etier – NGC Enterprise Architect

# GLOBAL PRODUCT DATA INTEROPERABILITY SUMMIT 2023



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# Presenters Bio – Zach Etier

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## 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

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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

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*“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

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*“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

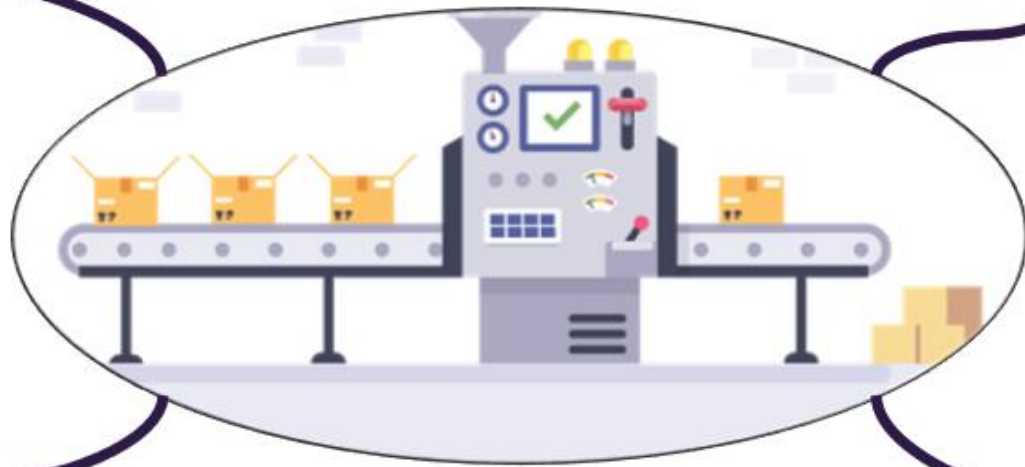
- None
- Serial (Legacy)
- Ethernet (Modern)

## Machine Data

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

## Data Format

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

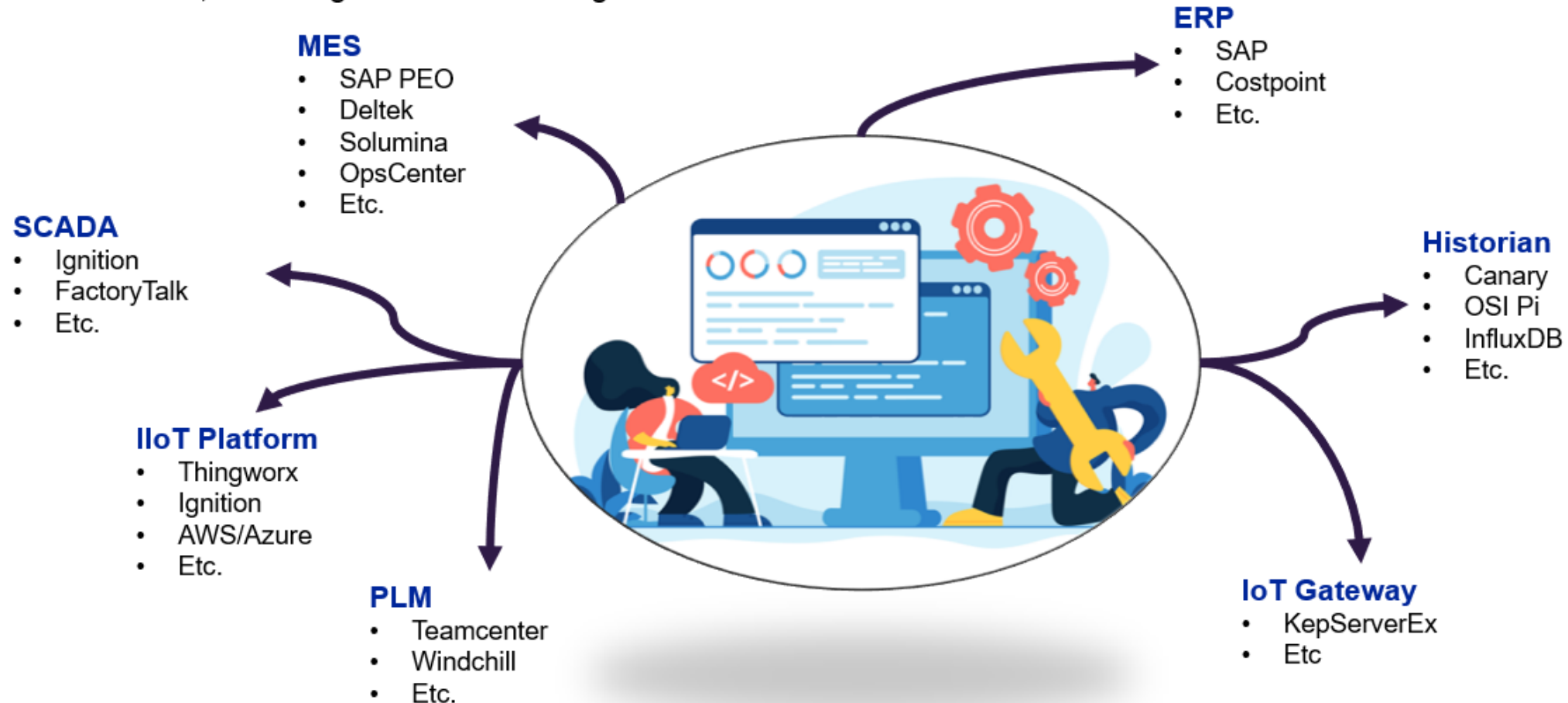




# Interoperability: Applications

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



# Interoperability: Data

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*“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 Format

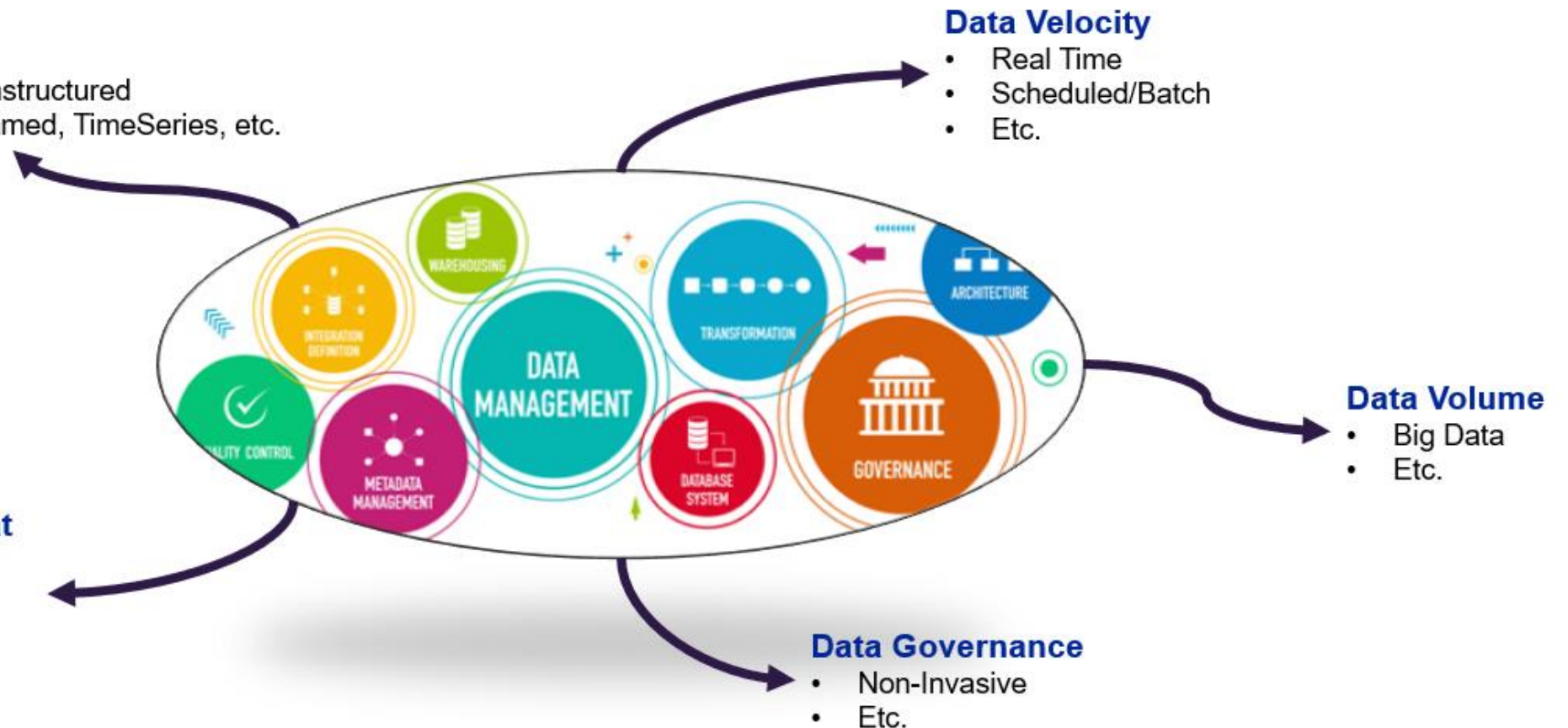
- JSON
- XML
- Object
- Etc.

## Data Governance

- Non-Invasive
- Etc.

## Data Volume

- Big Data
- Etc.





# Interoperability: Processes

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



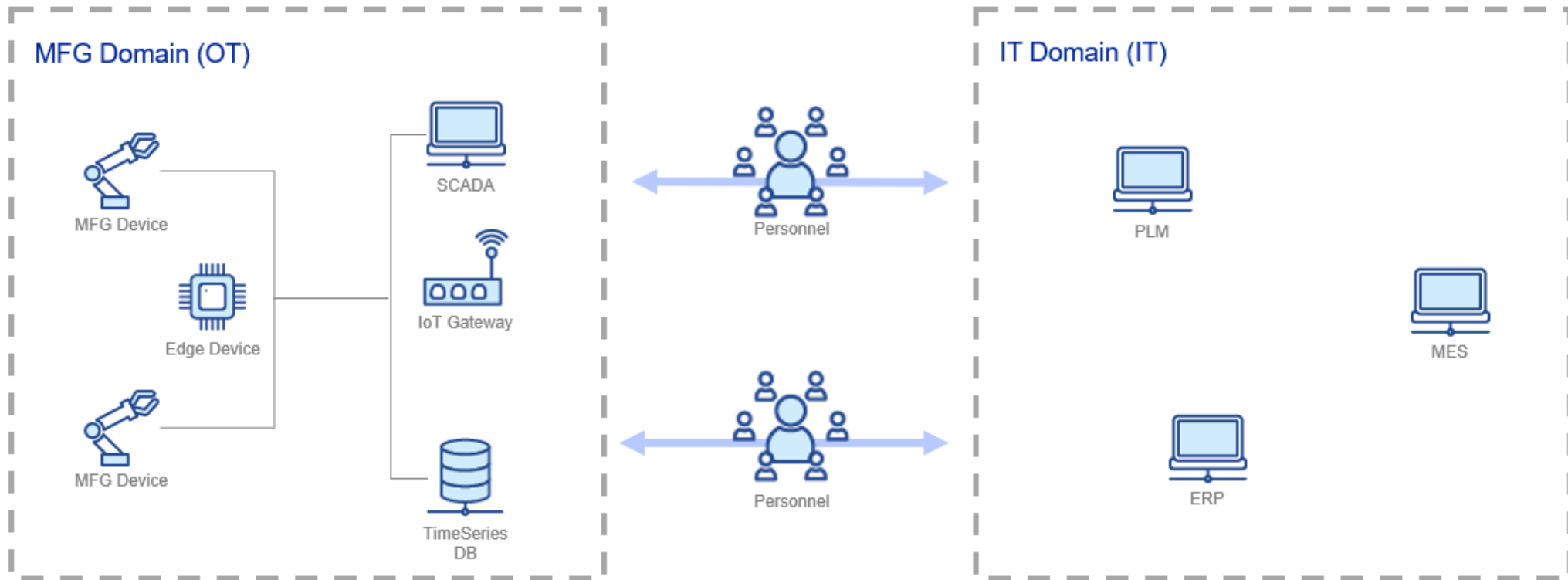
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## Why the focus on interoperability today?

# Industry 3.0

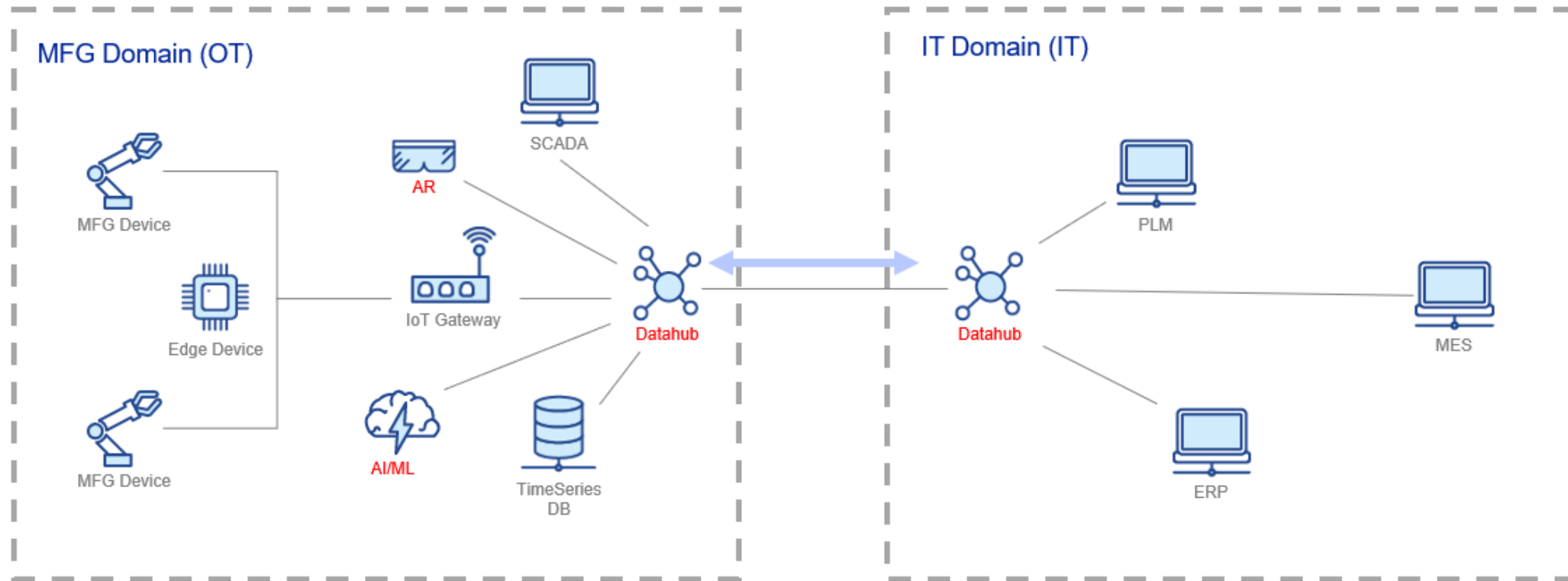
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Automation of OT Systems, requires human intervention to interface with IT Systems

# Industry 4.0

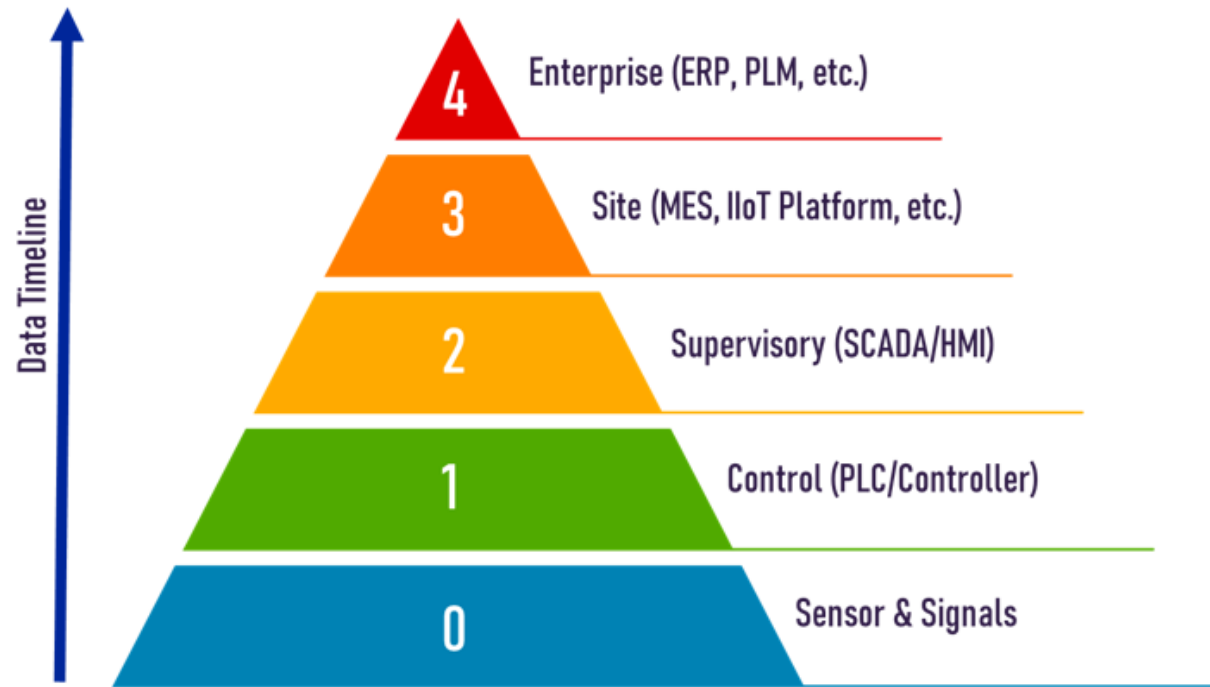
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Digital Factory, aka Integration and Automation of both OT and Business Logic (IT)

# A Change in Design Patterns: Vertical vs Horizontal

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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.

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## Technology Overview: The Datahub



# The Idea of the Datahub

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## Problem Areas around Distributed Architecture:

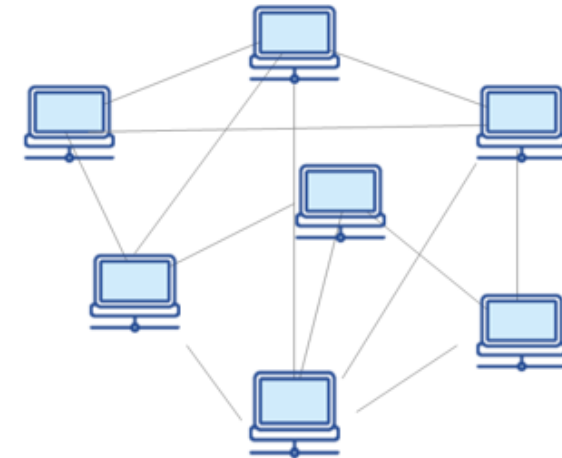
1. Diverse Data Formats
2. Numerous Interfaces
3. Governance
4. Scalability/Maintainability

## What is a Datahub:

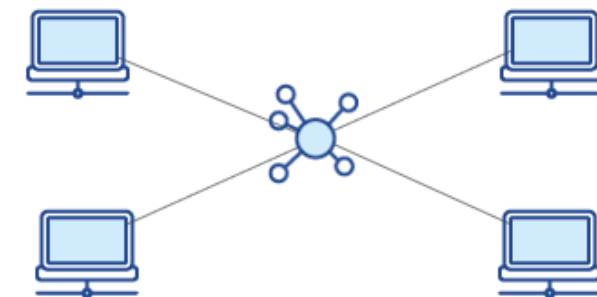
– Serves as a centralized platform designed to consolidate, manage, and distribute data from multiple sources to various applications, it contextualizes and transforms data, offering a single point of integration, enabling interfaces of consumers/producers to go from strong coupling to weak coupling.

## 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

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## Design Philosophy:

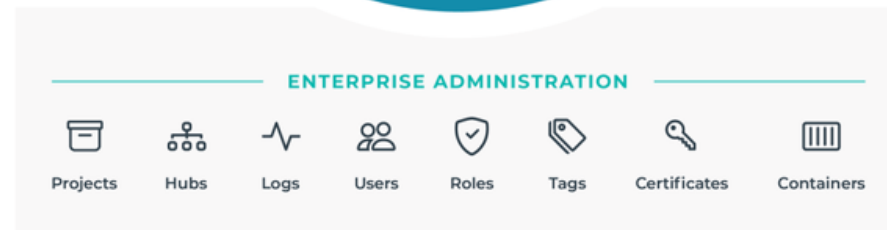
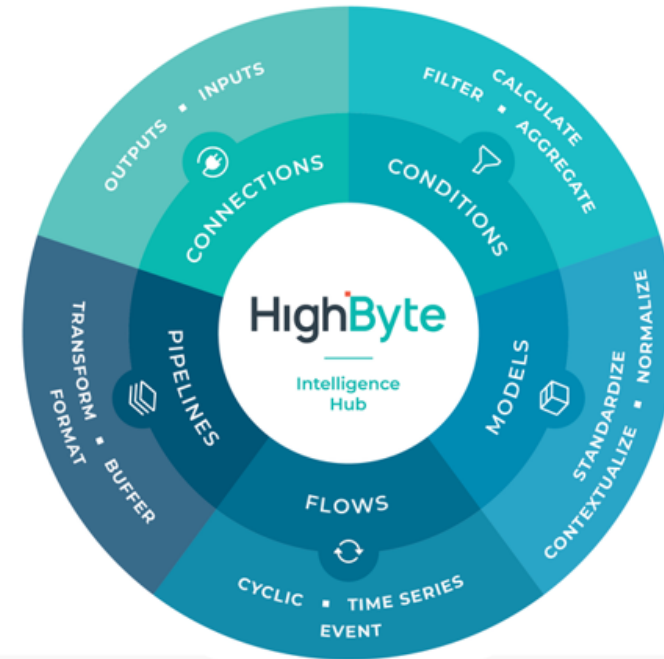
- Edge Driven Data Contextualization
- Focused on the Manufacturing Domain
- Designed for Scale

## 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

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The screenshot displays the 'Connections' page in the HighByte Intelligence Hub. The interface features a dark sidebar on the left with a navigation menu. The main content area shows two connection cards: 'DataServer' (active) and 'DataServer\_Secondary' (inactive). A 'New Connection' button is visible in the top right corner.

**HighByte Intelligence Hub**

VIEW

- Host
- Filter

CONFIGURE

- Connections
- Conditions
- Models
- Instances
- Flows
- Pipelines
- Certificates
- Functions

MANAGE

- Project
- Hubs
- Log
- Users
- Roles
- Tags
- Settings

+ Collapse

## Connections

Filter

HighByte - Enterprise

New Connection

- DataServer**  
OPC UA TCP
- DataServer\_Secondary  
OPC UA TCP

# Intelligence Hub: Model Definition

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The screenshot shows the 'New Model' form in the 'Details' tab. The form includes the following fields:

- Name:** Text input field containing 'Thermostat'.
- Description:** Text area input field.
- Tags:** Dropdown menu with 'Select...' as the current selection.
- Group As:** Dropdown menu.

A red 'Next' button is located at the bottom left of the form. The left sidebar contains navigation options under 'VIEW', 'CONFIGURE', and 'MANAGE'.

The screenshot shows the 'New Model' form in the 'Attributes' tab. It features a table for defining model attributes:

Name	Type	Array	Required
CurrentValue	Real32	Off	Off

Below the table, there is a '+ New Attribute' button. At the bottom of the form, there are 'Previous', 'Submit', and 'Cancel' buttons. The left sidebar is identical to the previous screenshot.

# Intelligence Hub: Instantiation & Data Mapping

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**HighByte** Intelligence Hub

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VIEW

- Host
- Filter

CONFIGURE

- Connections
- Conditions
- Models
- Instances
- Flows
- Pipelines
- Certificates
- Functions

MANAGE

- Project
- Hubs
- Log
- Users
- Roles
- Tags
- Settings

← Collapse

## New Instance

1 Details    2 Model    3 Attributes

Name	Expression	Default
CurrentValue Real32	{{Connection.DataServer.Simulation_Examples_Functions_Ramp1}}	

Previous    Submit    Cancel

# Intelligence Hub: Pipelines

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The screenshot displays the 'New Pipeline' configuration interface in HighByte Intelligence Hub. The interface is divided into two main sections: '1 Details' and '2 Stages'. The '2 Stages' section is active, showing a vertical flow of stages on a grid background. The stages are: Pipeline Start, Buffer10Minutes, ToParquetFile, and WriteNewTarget. Above the grid is a toolbar with 'Add Stage' and dropdown menus for 'Buffer', 'Format', 'Output', and 'Transform'. To the right of the grid is a 'Config' panel with the text 'Select a stage to get started'. At the bottom left of the grid area, there is a '0 Unused Stages' indicator and 'Previous' and 'Submit' buttons. At the bottom right, there is a 'Cancel' button. The left sidebar contains a navigation menu with categories: VIEW (Host, Filter), CONFIGURE (Connections, Conditions, Models, Instances, Flows, Pipelines, Certificates, Functions), and MANAGE (Project, Hubs, Log, Users, Roles, Tags, Settings). The top right corner shows 'HighByte - Enterprise' and a user profile icon.



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## Putting It All Together: NGC Case Study

# Case Study: Background

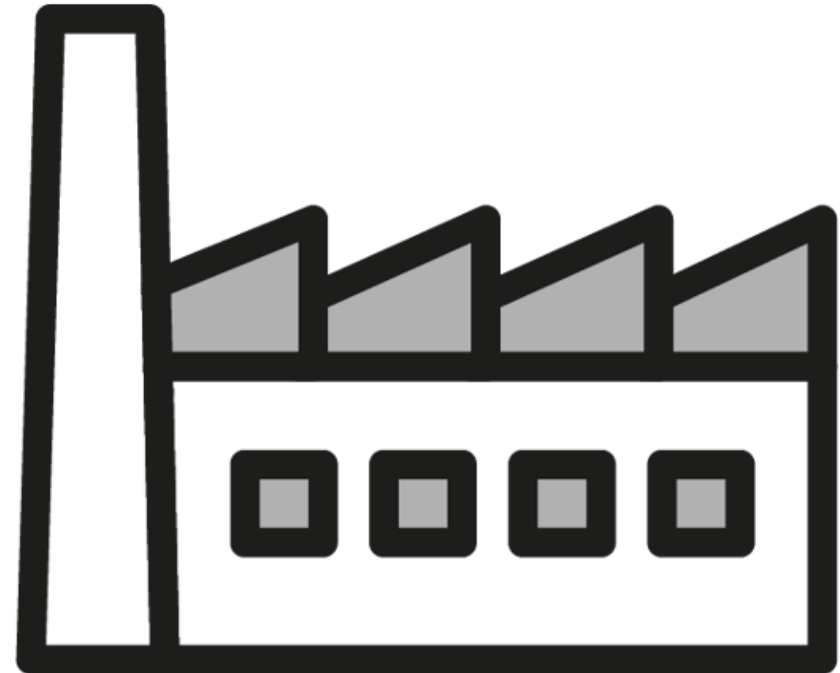
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## Site Topology selected for Digital Transformation

- 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

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- **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**

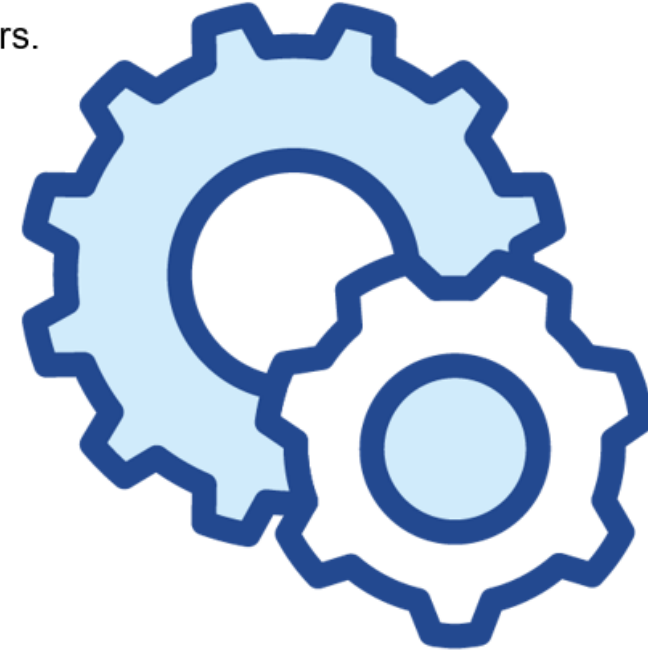
- Some applications required data from multiple sources.

- **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.

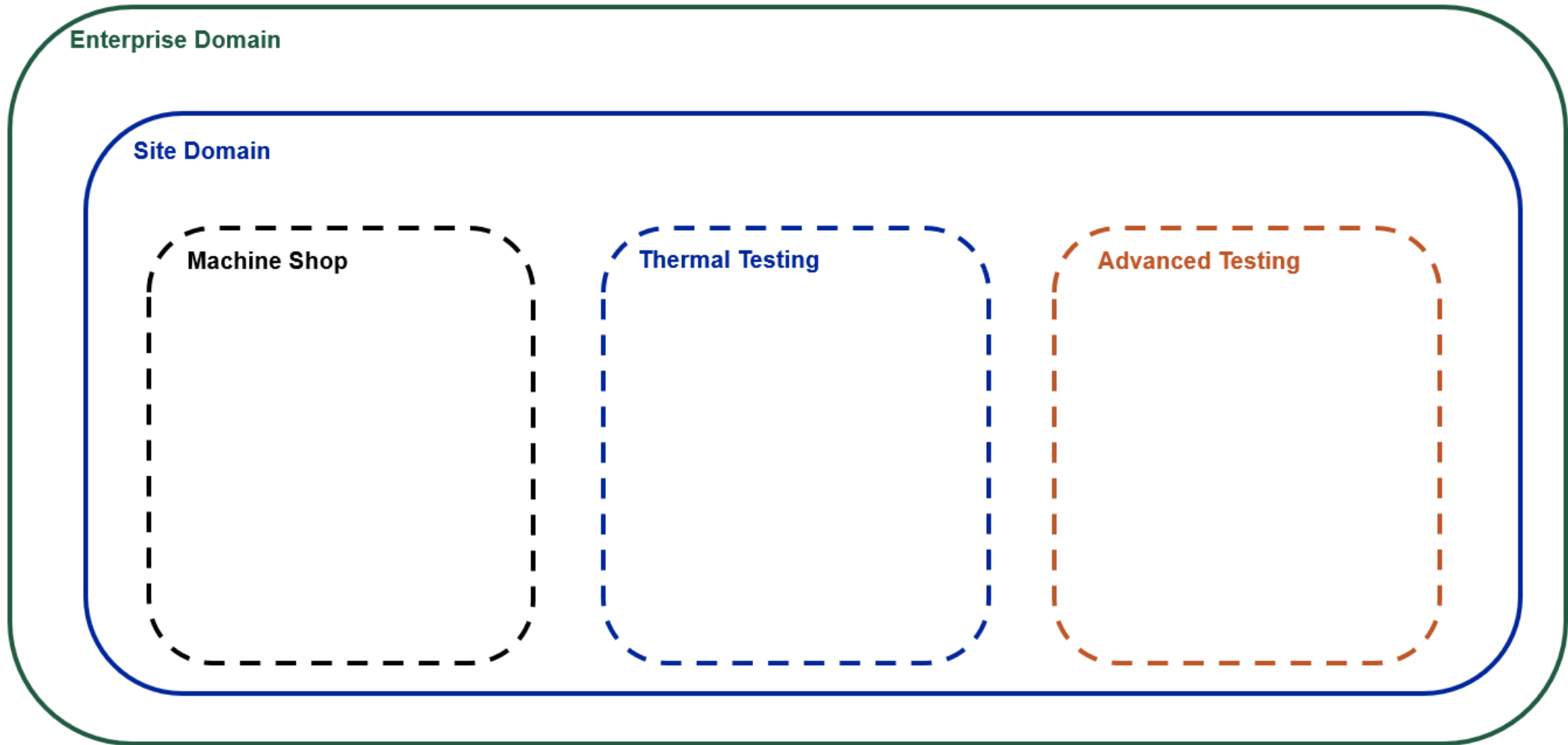
- **Scalability Concerns**

- Site has plans to add another 100 devices in the next 12 months and expand the architecture more applications.



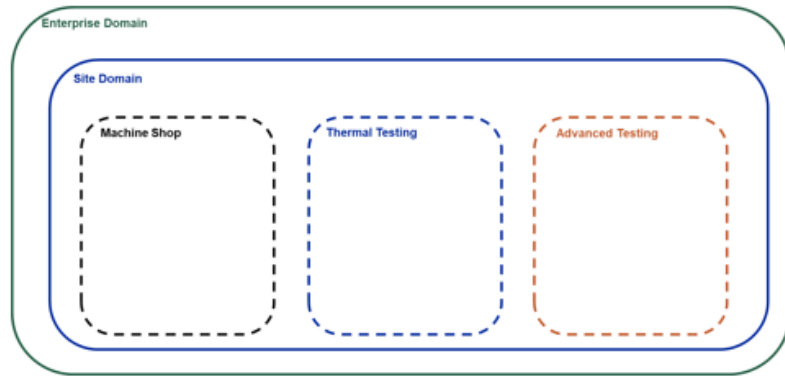
# Case Study: Architecture - Domains

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# Case Study: Architecture - UNS

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## ▪ 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

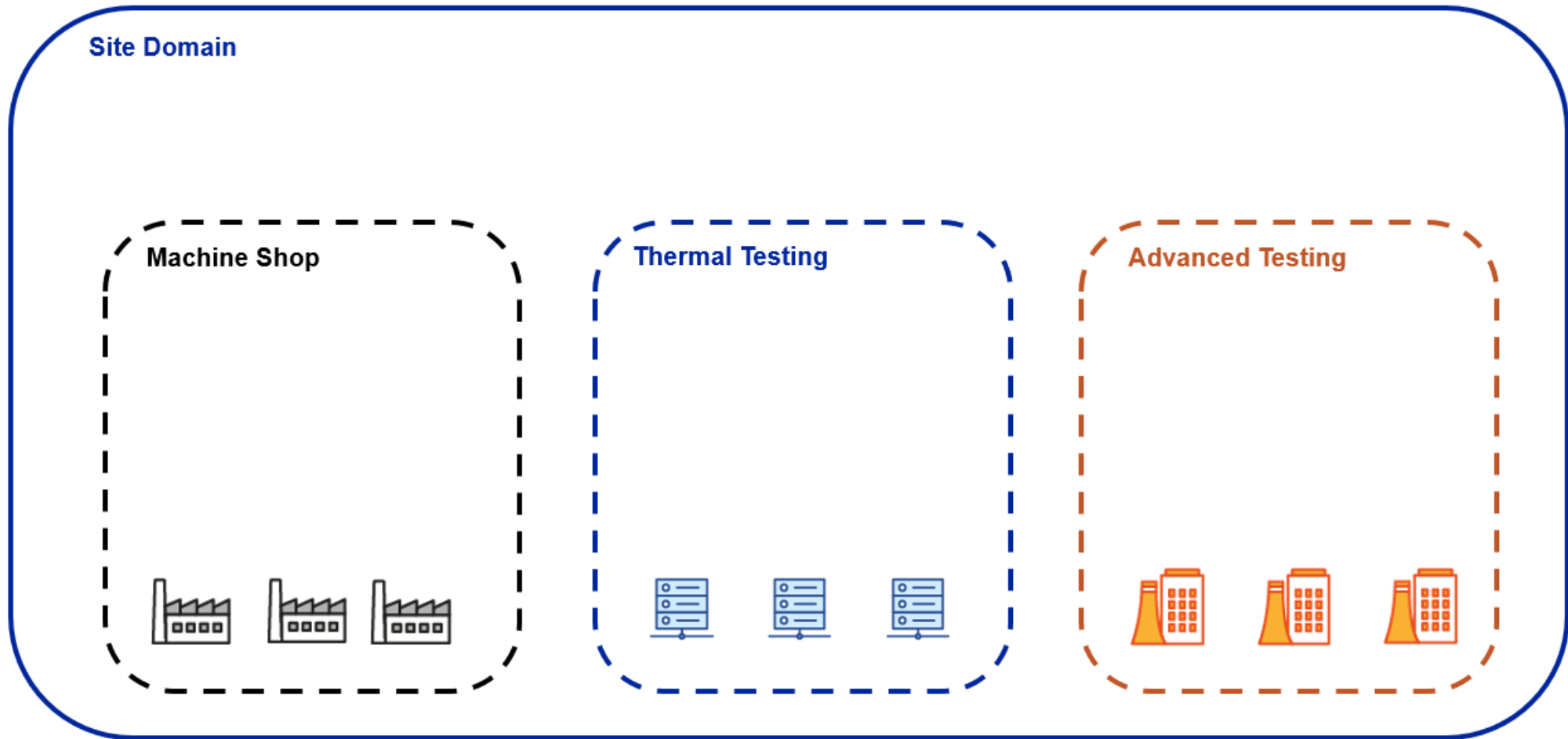
#### ▪ Advance Testing

- 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

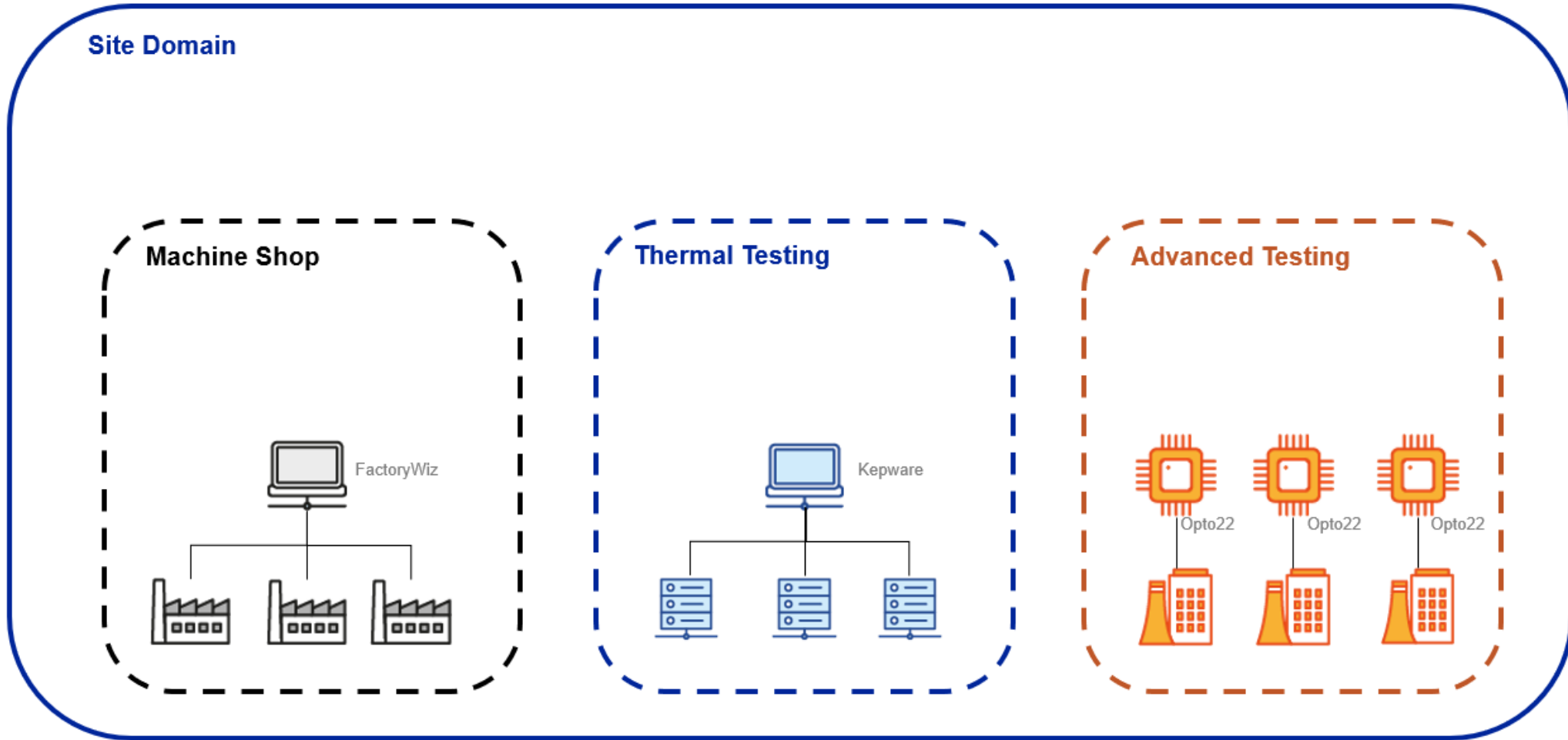
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# Case Study: Architecture – Connectivity

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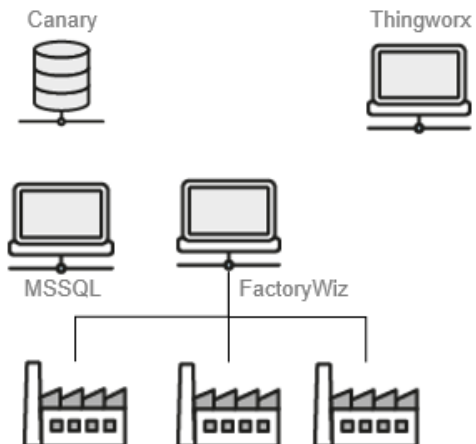


# Case Study: Architecture – Site Applications

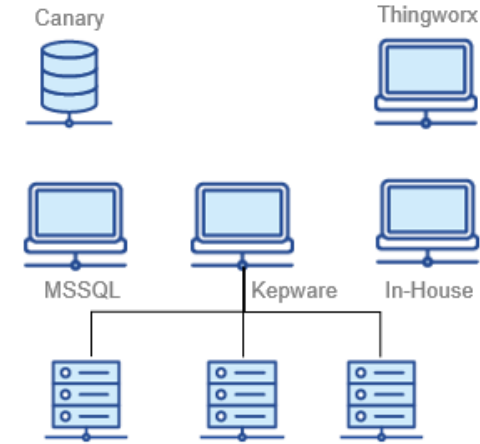
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## Site Domain

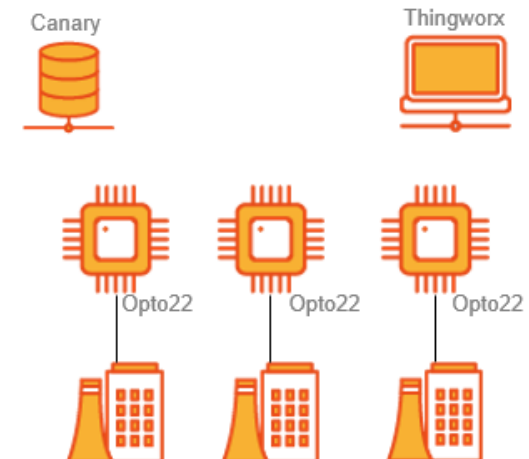
### Machine Shop



### Thermal Testing



### Advanced Testing

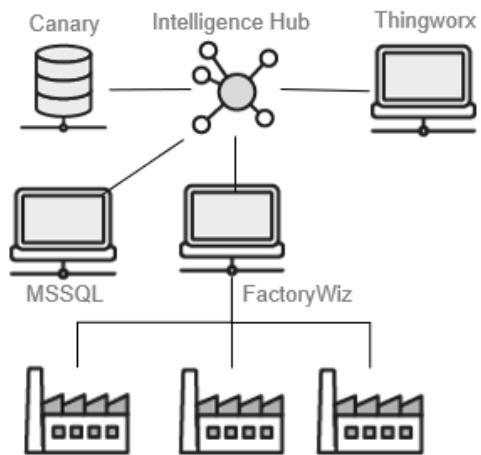


# Case Study: Architecture – Datahub

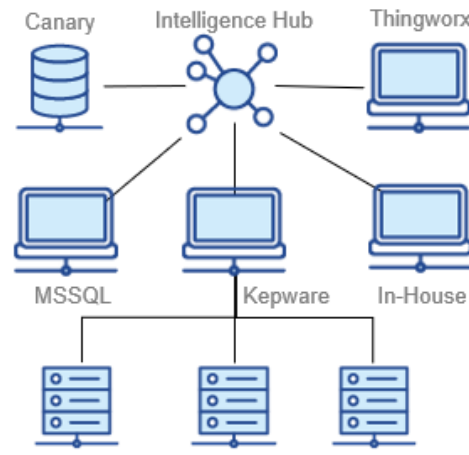
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## Site Domain

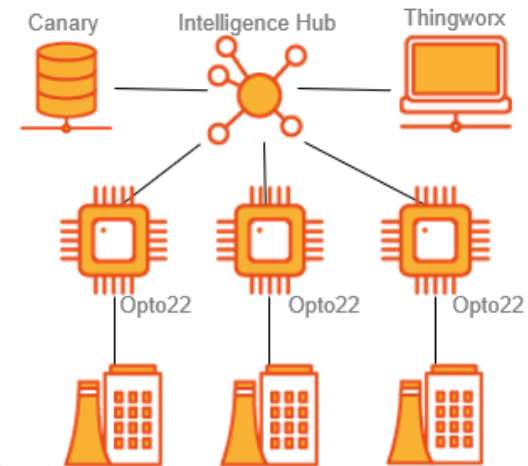
### Machine Shop



### Thermal Testing

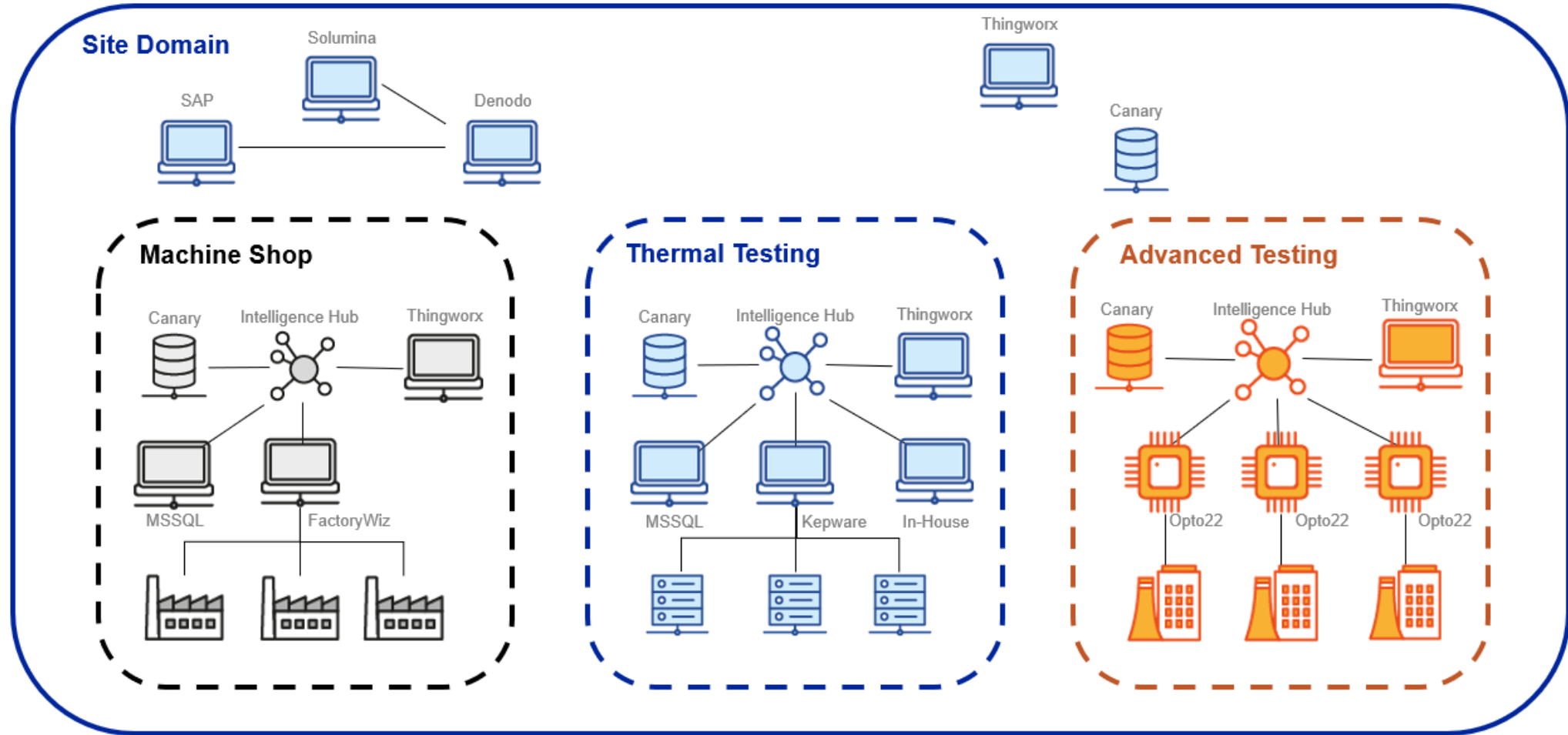


### Advanced Testing



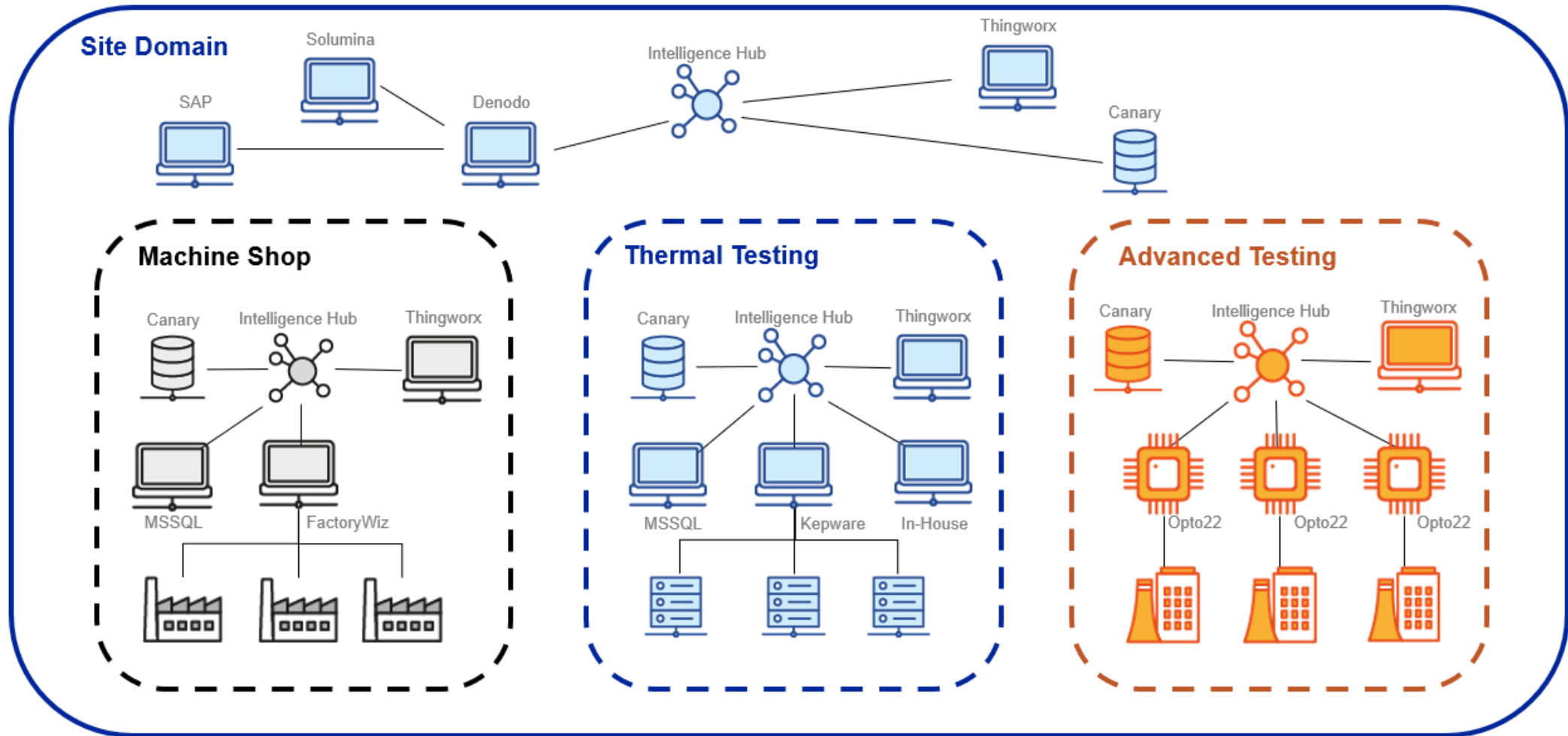
# Case Study: Architecture – Site Rollup

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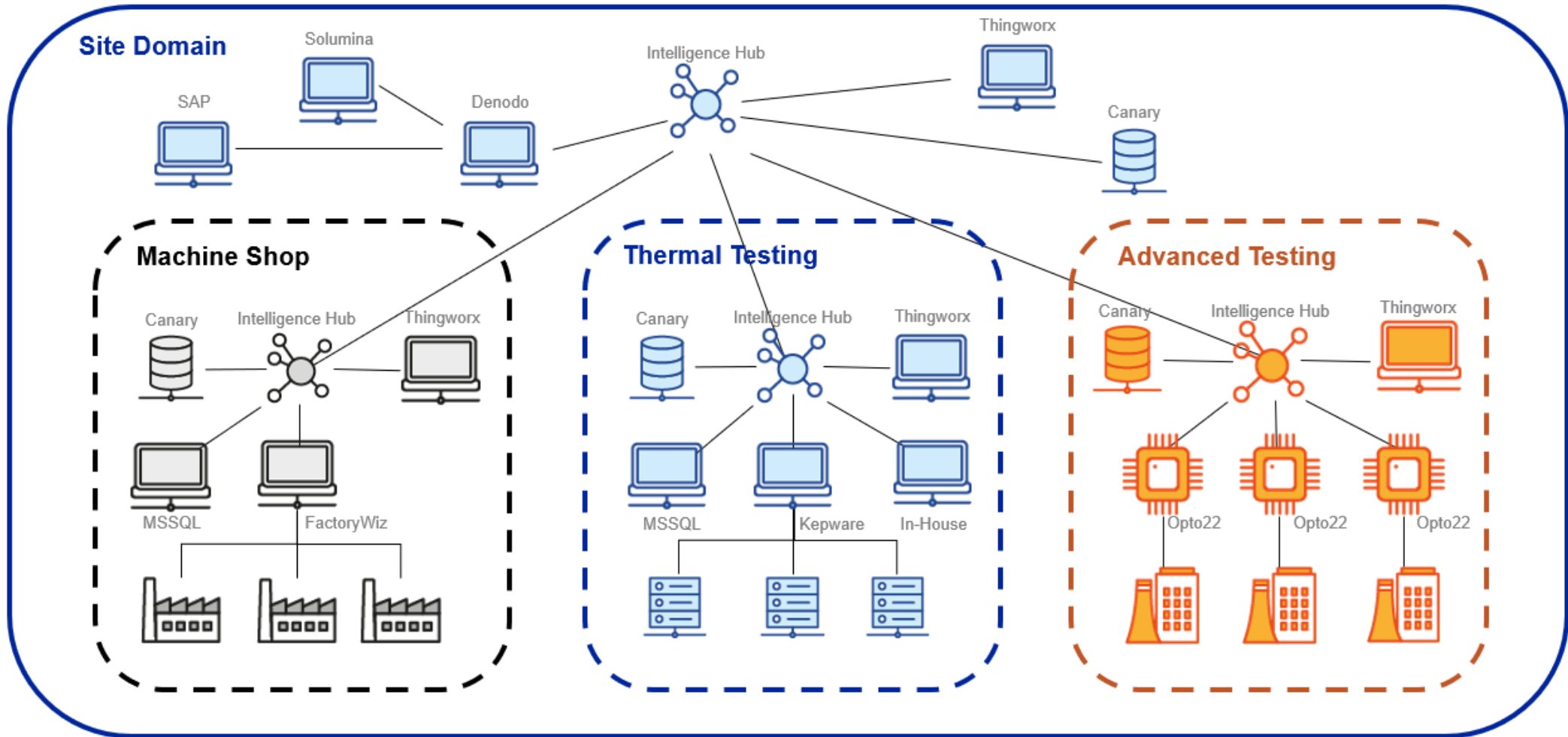
# Case Study: Architecture – Site Integration

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# Case Study: Architecture – Datahub

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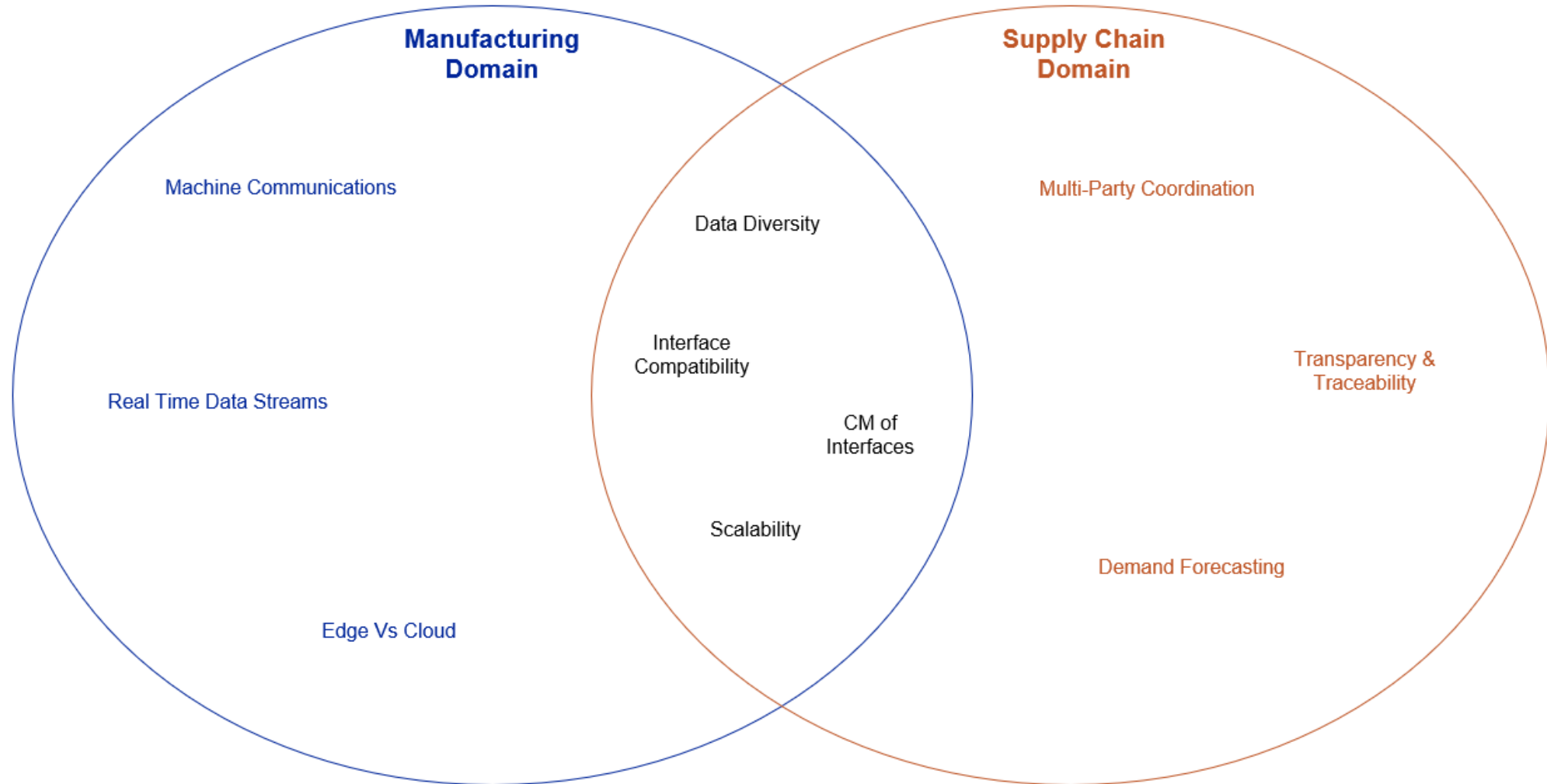


## How do these themes around interoperability apply to Supply Chain?



# Interoperability Themes applied to Supply Chain

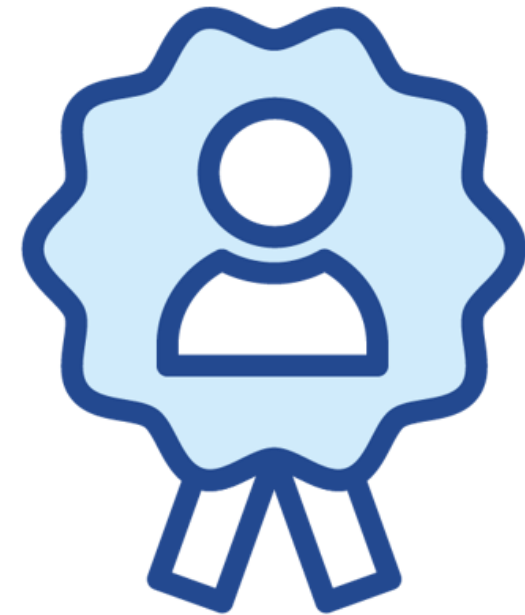
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# Conclusion

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- **Complexities of Interoperability for Manufacturing**
  - Diverse Landscape of devices, applications, data, and processes.
- **Shift in Architecture Design Patterns**
  - Shift from 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.



# Beyond Boundaries

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## Questions / Answers