Semiconductor Manufacturing Digital Twin and Generative AI

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Agenda

01. Digital Twin Industry Growth Trends

02. Digital Twin on AWS

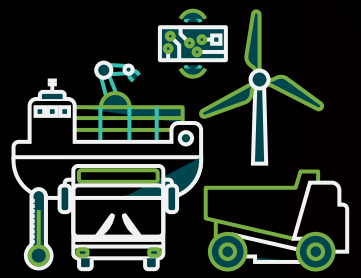
03. Use case, Challenges, Benefits & Advantages

04. Generative AI

05. Factory AI Assistant example

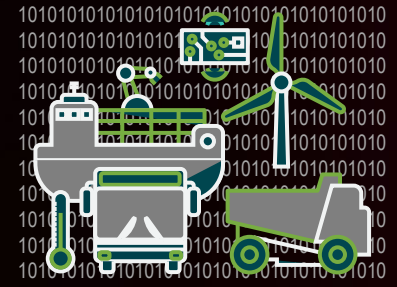
Digital twins

A living digital representation of a physical system that is dynamically updated to mimic the structure, state, and behavior of the physical system to drive business outcomes



PHYSICAL SYSTEMS

CONNECTED WORLD



DIGITAL TWINS

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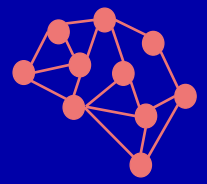
BUSINESS OUTCOMES

Why digital twins now?

Sensors

IoT connectivity

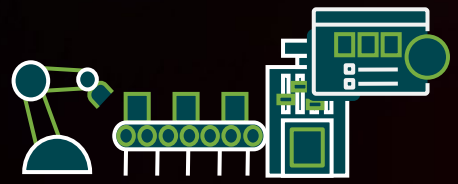


Modeling

At-scale compute

3 keys to unlocking business value

Using data from disparate sources

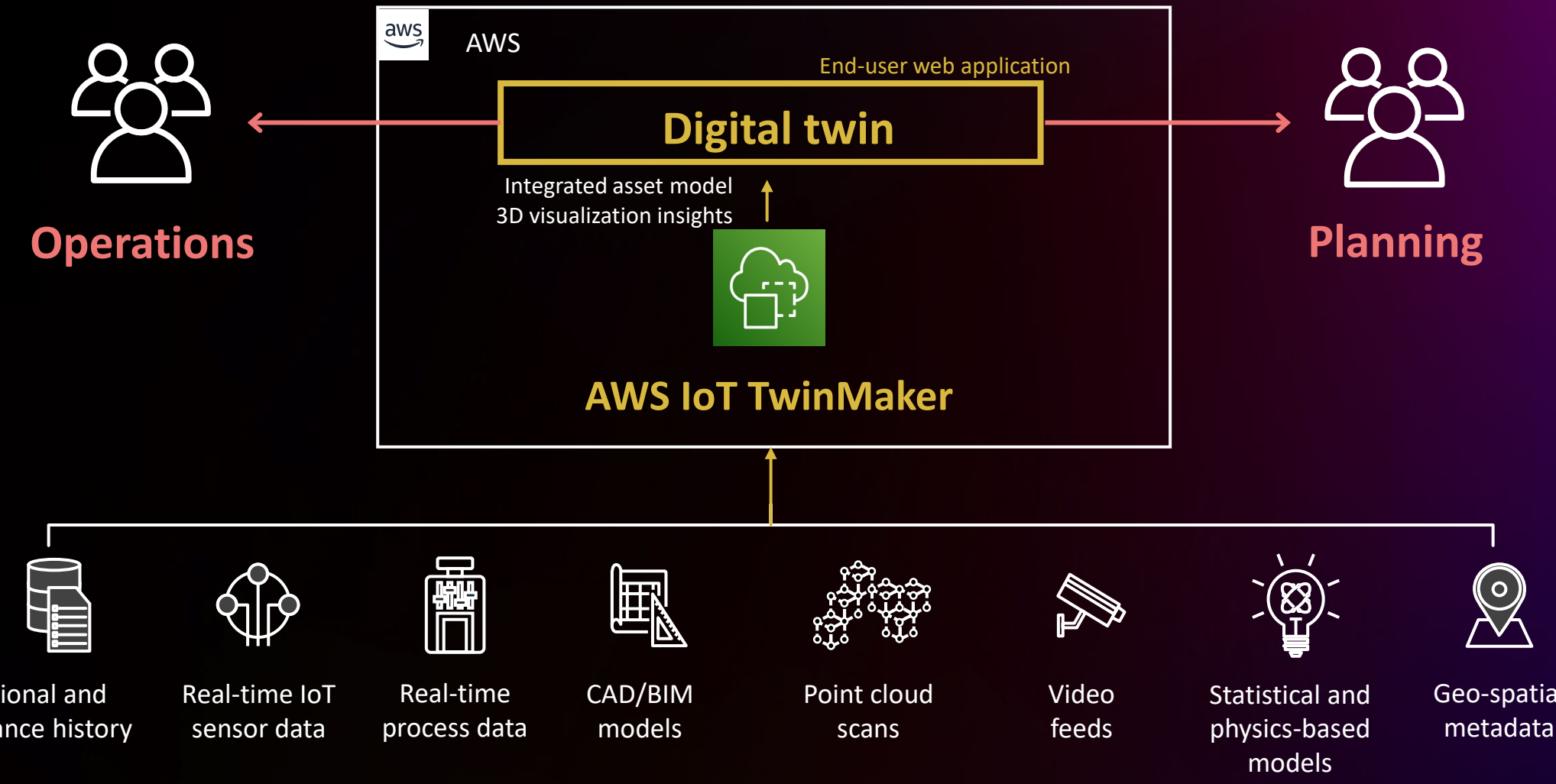


Modeling assets over their lifetime

Creating effective visualizations

Collect factory operations/equipment data → Measure & Monitor over time → Visualize metrics and draw insights to unlock business value using AWS Services/Partner Solutions

AWS IoT TwinMaker – How it works



Digital Twin for Manufacturing Operations – use case and challenges

USE CASE

Semicon/HiTech Electronic Products Manufacturing companies are looking for Digital Twin solutions that enable them to build a spatial view of manufacturing facilities with relevant contextual information to optimize their equipment performance, improve manufacturing operations, connected worker productivity, etc.

CHALLENGES

1. Aging Workforce/Skills Gap
2. Equipment Downtime/Inefficiencies
3. Siloed Data Assets
4. Scaling Expansions

45% of companies are understaffed in high-skilled manufacturing positions.

IDC 2019 Industrial Talent Management Survey

73 percent of respondents say they find it difficult to recruit new maintenance technicians

2022 McKinsey Survey on Asset Productivity

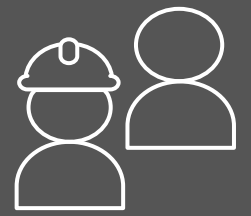
62 percent of respondents report above-inflation increases in maintenance costs during the past year, even though most have adopted modern approaches for tracking workforce utilization

2022 McKinsey Survey on Asset Productivity

Key benefits in deploying Digital Twins for manufacturing operations

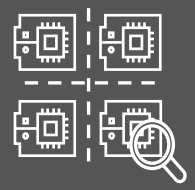
Improve asset performance

Enhance productivity



Connect remote experts

Onboarding and Training



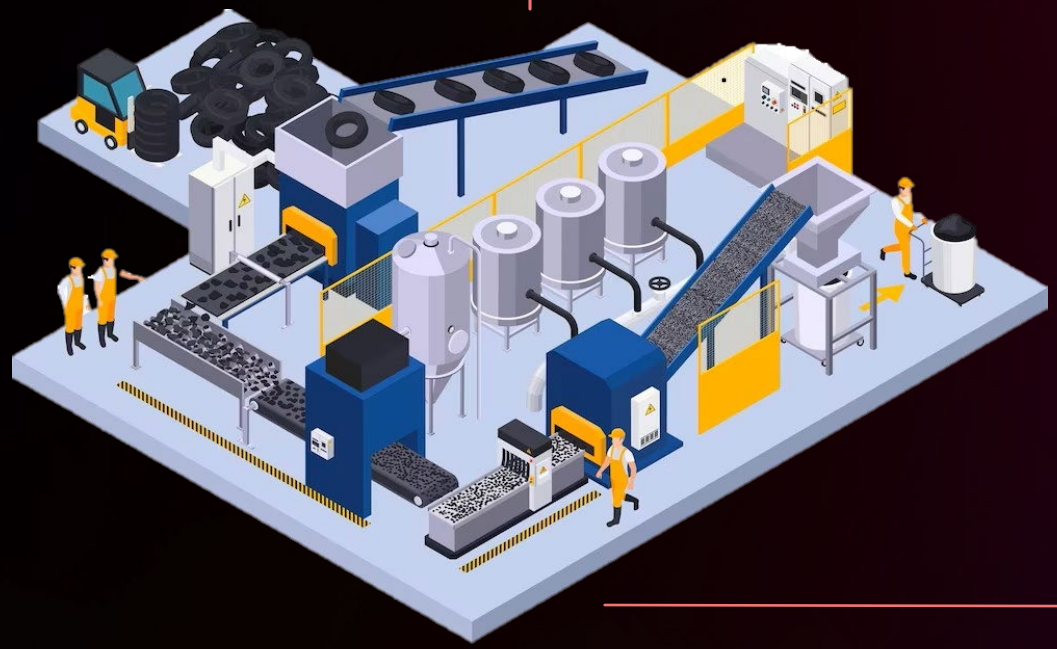
Improve manufacturing operations

Reduce carbon footprint

Semi/HiTech Manufacturing operations with Digital Twins

Production Monitoring

- **Improved equipment performance in real time -** Identify potential problems before they cause significant concern, proactively schedule maintenance, reduce equipment downtime, and extend lifetime, reduce maintenance cost and increase OEE (e.g.; Surface Mount Technology (SMT) machines used in PCB Assembly)
- Factory/Equipment/Line Utilization and optimization - multi-location/multi-department/multi-purpose (e.g.; HiTech Electronics Contract Manufacturers (CM))
- **Process Optimization** - Real-time visibility into manufacturing process, allows operators to identify and resolve bottlenecks quickly



Connected Worker

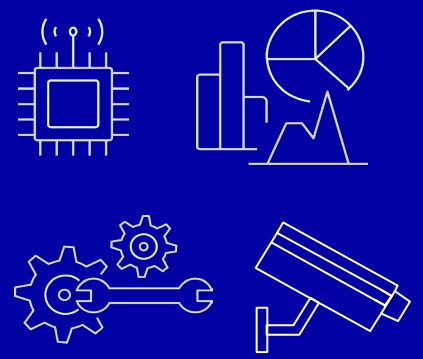
- Remote Monitoring and Control of production processes – Reduce the need for on-site personnel
- **Enhanced safety** - Monitor equipment and production processes to identify potential safety hazards
- Accelerate training and onboarding of new employees by providing immersive and interactive learning experiences within digital twins

Sustainability

- Asset and Facility optimization for energy consumption
- Process optimization to minimize waste, quality defects

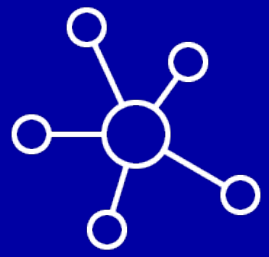
Digital Twin challenges

Data Sources



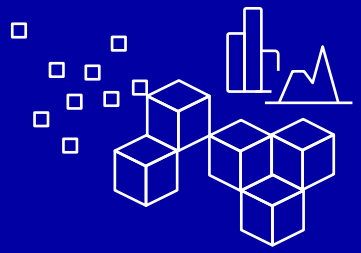
Access data from diverse sources using built-in connectors, or easily create your own connectors to AWS and third-party data sources.

Complex



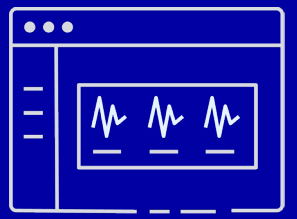
Describe entity relationships and data properties to create a comprehensive Knowledge Graph

Time consuming



Create 3D scenes with spatial anchors for data
from the digital twin graph

Actionable Insights

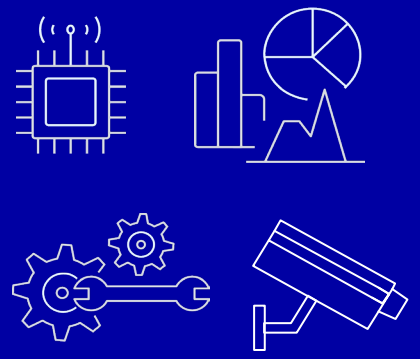


Build user-centric web apps for your digital twin

Generative AI in action..

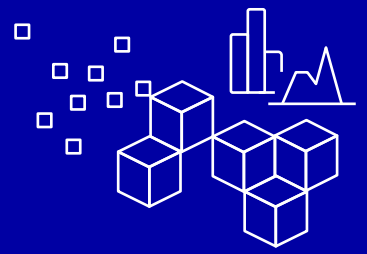
Digital Twin challenges

Improve Shopfloor Productivity



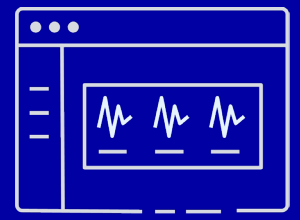
Generate and interact with detailed diagnoses and troubleshooting guides to speed up decision making and asset maintenance processes.

Enhance Product Quality and Defect Detection



Generate synthetic images and augment datasets to develop and train accurate, robust defect detection computer vision models.

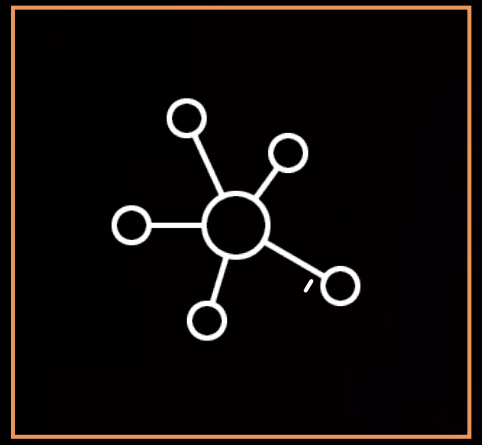
Reduce Personnel training time



Attract, retain and onboarding talent with round-the-clock virtual assistant support, improving confidence and productivity.

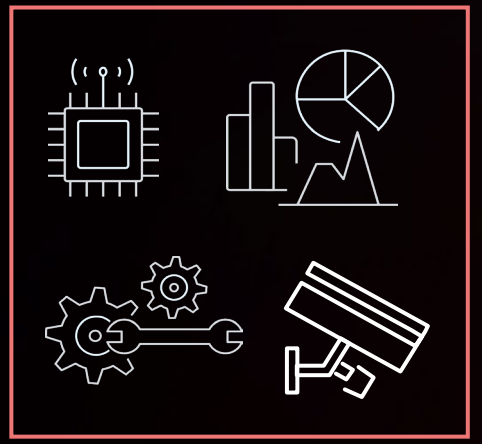
Digital Twins

Model builder



Create entities to virtually represent physical systems, specify relationships between them

Data connectors



Access data from diverse sources using built-in or by creating your own connectors to AWS and third-party data sources.

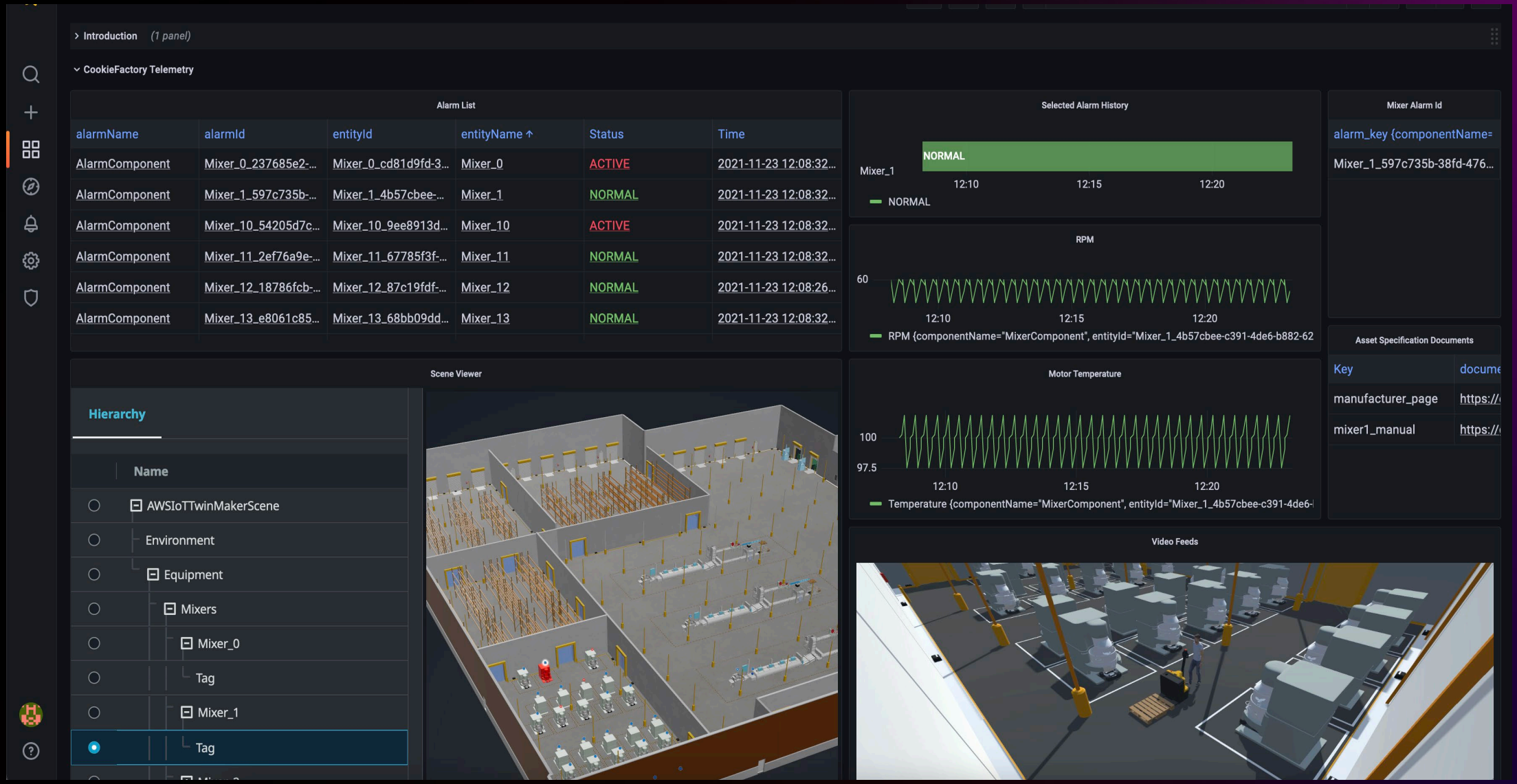
Scene composer

Combine existing 3D visual models with real-world data to compose an interactive 3D view of your environment

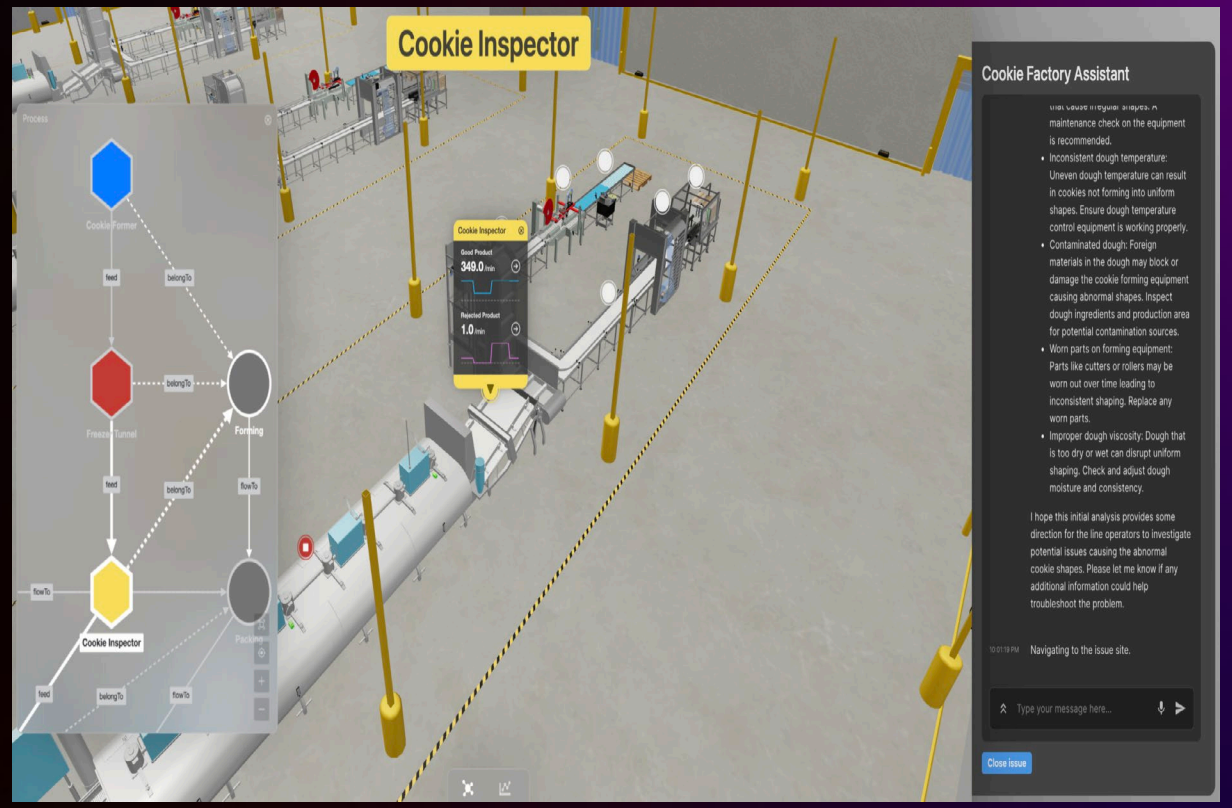
App toolkit

Integrate digital twins into 3D applications using to monitor and improve operations

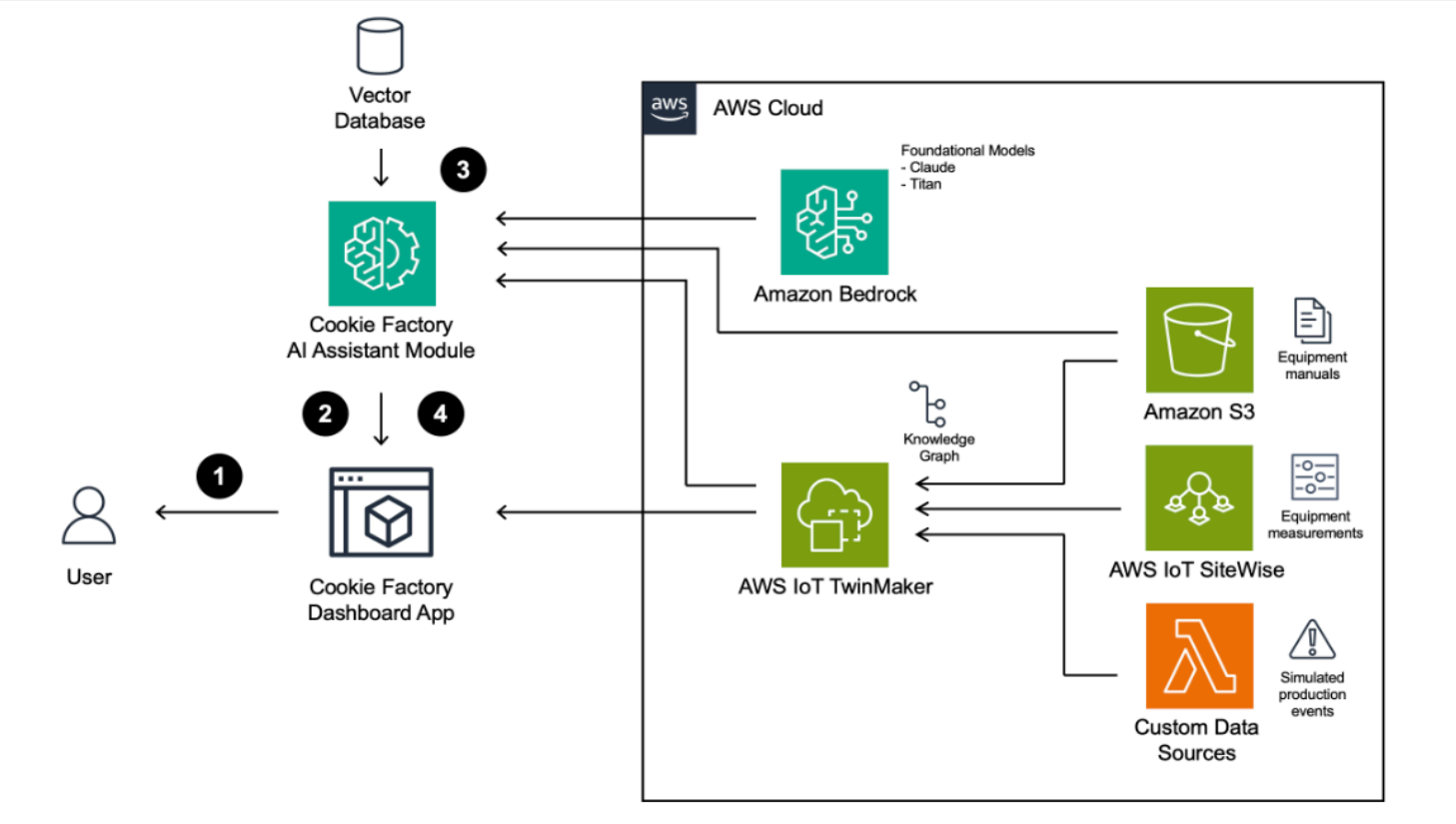
Digital Twins in IoT TwinMaker



Issue Diagnosis



Factory AI Assistant Architecture



1. User inputs though UI
LLM agent responds to user input. LLM agent implemented through LangChain.

2. In memory vector DB like open-source Chroma or Opensearch Service used for Retrieval Augmented Generation (RAG)

3. Amazon Bedrock for Anthropic Claude and Amazon Titan models.

4. Domain specific data like equipment manuals and Knowledge graph generated by IoT TwinMaker provided in S3.

5. AWS Lambda to get simulated alarm events data that are used as input to LLMs and generate issue diagnosis reports or troubleshooting suggestions for the user.

AI Assistant agent workflow

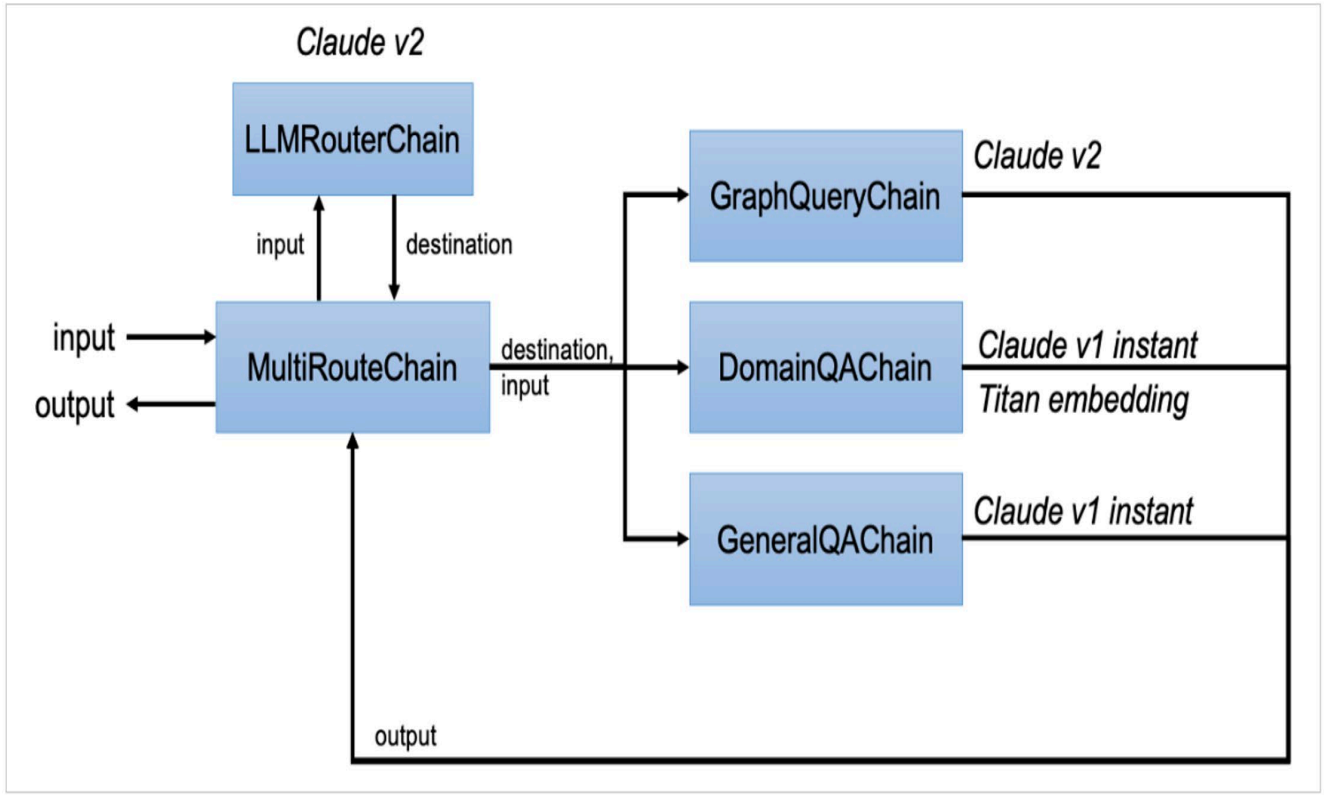


Figure 5: High-level execution flow of LLM agent.

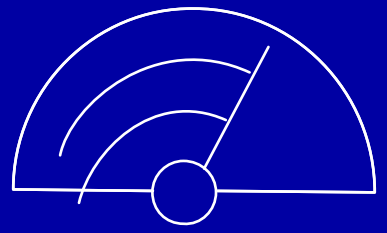
1. The **MultiRouteChain** is the main orchestration Chain. It invokes the LLMRouterChain to find out the destination chain that is best suited to respond to the original user input

2. The **GraphQueryChain** is an LLM Chain that translates natural language into a TwinMaker Knowledge Graph query. We use this capability to find information about the entities mentioned in the user.

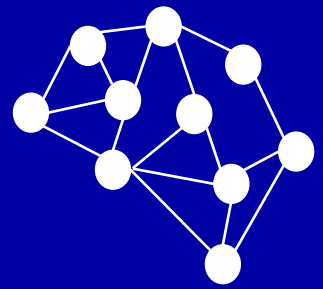
3. The **DomainQAChain** is an LLM Chain that implements the RAG pattern. It can reliably answer domain specific question using only the information found in the documents the user provided.

4. The **GeneralQAChain** is a fallback LLM Chain that tries to answer any question that cannot match a more specific workflow. We can put guardrails in the prompt template to help avoid the Agent being too generic when responding to a user.

Digital Twin and Generative AI



Data collection, transfer, augmentation



Digital Twin Creation

AI Assistant

Thank You!