

## Components of a Digital Twin in Production Lines

A digital twin in manufacturing is a virtual representation of a production line, a machine, or even the entire process. To achieve this, multiple data sources and tools must interact in real-time.

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### Data Sources in a Digital Twin

In a real manufacturing environment, data can come from:

1. IoT Sensors (Internet of Things)
    - Examples: Temperature, vibration, pressure, energy consumption, motor speed.
    - Common Protocols: MQTT, OPC-UA, Modbus, REST APIs.
  2. ERP (Enterprise Resource Planning) → SAP, Oracle, Microsoft Dynamics
    - Orders, inventory, costs, personnel, and planning are managed here.
    - If the company uses SAP, it can be connected via APIs from the SAP Business Technology Platform or internal databases.
  3. SCADA (Supervisory Control and Data Acquisition)
    - Systems that control real-time machines in factories.
    - It can be connected to the dashboard via industrial protocols such as OPC-UA.
  4. PLCs (Programmable Logic Controllers)
    - They control automated machines.
    - They integrate with the digital twin using OPC-UA, Modbus, Profibus.
  5. Databases
    - Historical production records stored in PostgreSQL, MySQL, or NoSQL databases (MongoDB, InfluxDB for time-series data).
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### Software Requirements for a Digital Twin Dashboard

A functional dashboard requires:

1. Backend
  - Python (Flask/FastAPI for API, Dash for visualization).
  - SQL Databases (PostgreSQL, MySQL) or NoSQL (MongoDB, Redis).
  - Real-time communication (MQTT, WebSockets).
2. Frontend
  - Dash, Streamlit, Shiny in R, or an enterprise solution like Power BI.
  - For SAP integration, use Fiori UI5 or Tableau (which has SAP connectors).
3. Infrastructure and Deployment
  - On-premise servers (Linux/Windows Server) or in the cloud (AWS, Azure, GCP).
  - Kubernetes or Docker for scalable containers.
  - Grafana if advanced monitoring is required.

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## SAP Integration

If the company uses SAP, there are several ways to connect it to the dashboard:

1. SAP OData Services
    - o SAP exposes REST APIs with real-time production data.
    - o We can consume them in Python (using requests) or from Power BI.
  2. Direct Connection to SAP Database (HANA, Oracle, SQL Server)
    - o If access is available, we can make SQL queries to extract manufacturing data.
  3. Middleware (SAP PI, SAP Cloud Platform)
    - o SAP can send real-time data to our dashboard using events and webhooks.
  4. Integration with SCADA/PLC
    - o SAP can receive production orders from the dashboard and send them to SCADA/PLC.
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## Implementing a Dashboard in Industry

It is an ideal way to optimize performance in every way. It also transforms the monitoring of processes in real time in a friendly and secure way, allowing you to focus on strengths and weaknesses in the processes.

### Digital Twin Workflow

1. IoT sensors on the production line
    - o Capture temperature, voltage, errors, power consumption.
    - o Send real-time data to an InfluxDB database (time series).
  2. SCADA & PLCs
    - o Control machines and report status.
    - o Connects to SAP and dashboard.
  3. SAP ERP
    - o Manages orders, materials, costs, inventory.
    - o The dashboard uses SAP APIs to extract information.
  4. Dash Dashboard
    - o Displays real-time data (status of machines, energy consumption, defects, etc.).
    - o Can receive orders to adjust machine parameters.
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## Deploying Dashboards in an Industrial Environment

For production deployment, an example of a basic flow would be:

1. On-premise development and testing
  - o Dashboards are created with Dash or Streamlit and simulated data.
2. Deployment on a Server
  - o Use Docker + Kubernetes if the company has cloud infrastructure.
  - o Or it is installed on an on-premise server (Windows/Linux Server).
3. Connection with the Industrial Environment
  - o APIs with SAP, SCADA, PLCs and databases are configured.
4. Security and Monitoring
  - o Access roles are added.
  - o Grafana or Prometheus to monitor performance.

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## Implementation in Aeronautical Production

An aircraft sensor manufacturing company could implement this system:

Component	Tool
Sensor IoT	MQTT + InfluxDB
SCADA	Siemens WinCC, Ignition
PLC	Siemens S7, Allen Bradley
ERP	SAP HANA
Dashboard	Dash/Power BI/Tableau
Infraestructur	Docker + Kubernetes en AWS

The dashboard would receive real-time data from the machines, showing:

- Real-time production.
  - Errors and predictive maintenance.
  - Costs and inventory
  - Efficiency analysis (OEE, KPIs)
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## Conclusion

In a real environment, a digital twin not only simulates data, but interacts with real equipment, ERP, sensors and databases. **The important thing about this is that it provides the necessary environment where you can make decisions based on up-to-date data.**

This is a scalable solution that connects factory data, management and analytics. The key is to connect everything with APIs, databases and industry protocols.

If any company already uses SAP, it can also be integrated via APIs with many benefits, databases or middleware. If it is a modern production line, SCADA and PLCs can be connected to the dashboard with MQTT or OPC-UA.