RE4DY

MANUFACTURING DATA NETWORKS

RE4DY TOOLKIT

Name of the Tool	**Realtime Digital Twin Model (RDTM)**
Tool Owner	Industry Commons Foundation
Version	1.0
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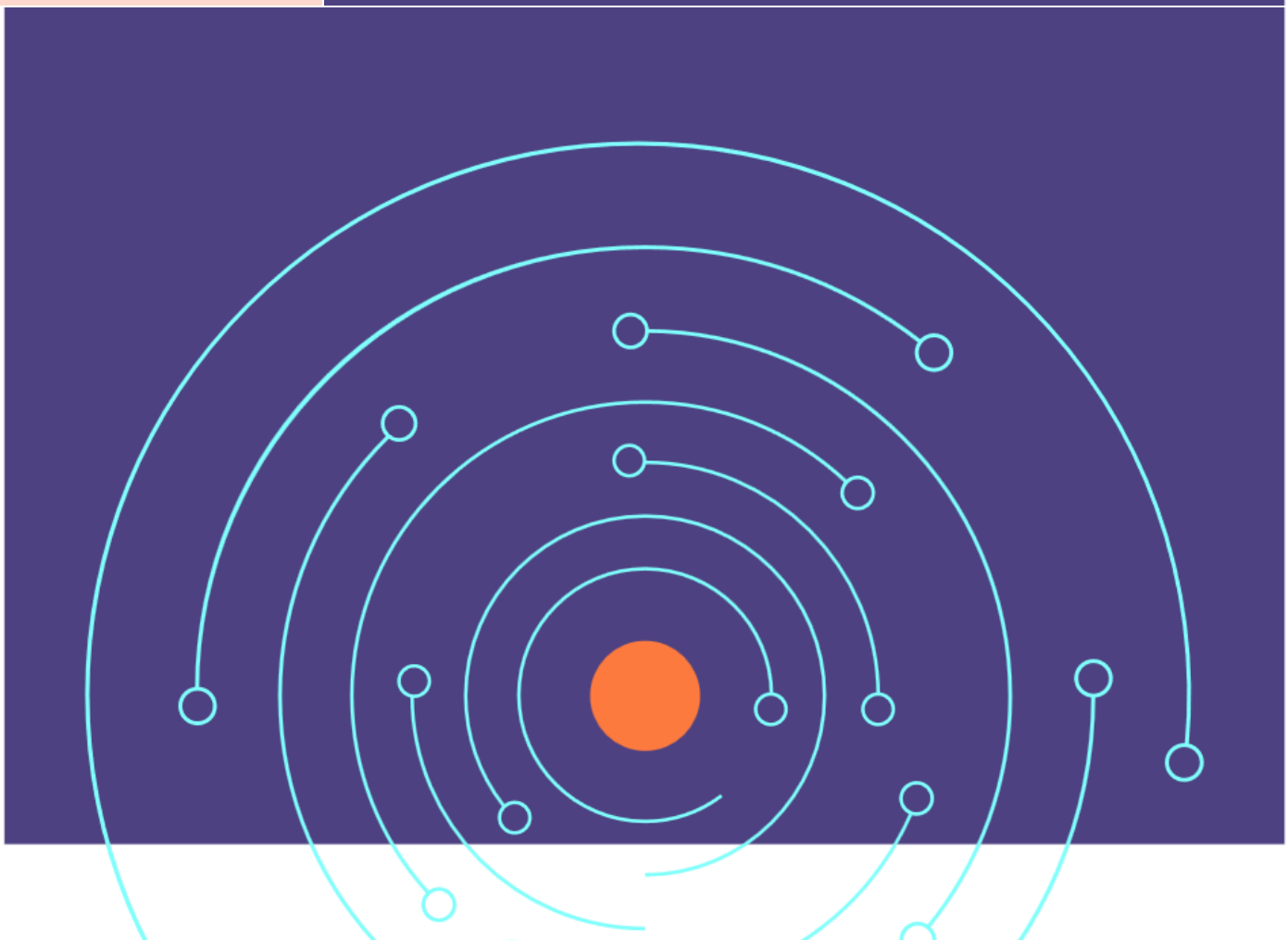
Version	V1.0



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1. Component Description

The Realtime Digital Twin Model is a comprehensive digital illustration of a real machine tool. It contains all the key aspects and components of a real-world machine tool, including the numeric controller, operator station, and various other subsystems. In comparison to a physical machine tool, the Realtime Digital Twin Model utilizes software and a screen to simulate the fabrication of a virtual part, rather than actually manufacturing a physical part.

This component requires a seamless connection between the IT (information technology) and OT (operational technology) architectures within the manufacturing environment. On the IT side, the part design is created using a CAD (computer-aided design) program. The work preparation process is then handled by a postprocessor, which generates the necessary numerical control code that can be directly interpreted and executed by the CNC (computer numerical control) controller.

The integration of the Realtime Digital Twin Model into the manufacturing workflow offers several key benefits. It allows for virtual testing and optimization of the part design and manufacturing process before committing to physical production. This can help identify and resolve potential issues early on, reducing costly errors and delays on the shop floor. Additionally, the real time digital twin model provides a realistic simulation environment for operator training, enabling personnel to become proficient with the machine tool controls and procedures without disrupting actual production.

2. Input

Post processor

The post-processor converts the generic NC (Numerical Control) code generated by NX CAM into the specific syntax and format required by the target CNC controller, such as Sinumerik. This ensures that the NC code can be correctly interpreted and executed by the machine tool's CNC controller.

Virtual machine

This component uses a simulation to demonstrate a virtual fabrication of the virtual part. To give the operator a more realistic understanding of the process, the real machine can be created as a digital twin and be integrated into the simulation.

3. Output

The computerized numerical control system runs the NC code, the main output is the control of the Realtime Digital Twin Model to perform the desired manufacturing operations. The CNC controller translates the NC code instructions into precise movements of the machine tool's axes (e.g., X, Y, Z, A, B, C). This includes controlling the speed, acceleration, and deceleration of the axes to execute the programmed tool paths. Moreover, The CNC controller continuously monitors the machine tool's performance, including axis positions, spindle speed, and other relevant parameters. It provides feedback and error messages to the operator, allowing for real-time monitoring and troubleshooting of the machining process.

4. Information Flow

Running the Realtime Digital Twin Model (RDTM)

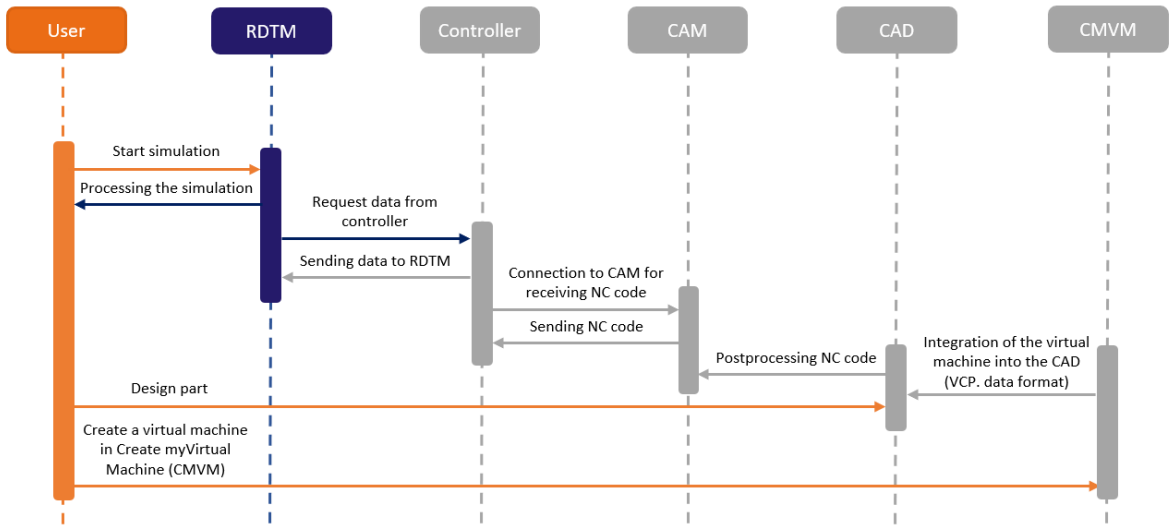

Figure 1 Running the Realtime Digital Twin Model

The user must initiate the simulation of the Real-time Digital Twin Model. After launching the simulation software, which is connected to the CNC controller, the NC code is executed. In the case of the Real-time Digital Twin Model, the controller integrated into the model is connected to a manufacturing station. The purpose of the manufacturing station is to create a virtual part using a CAD program. By employing Computer-Aided Manufacturing (CAM) software that includes a post-processor, a numerical control (NC) code of the virtual part can be generated.

As long as the CNC controller is connected to the CAD/CAM software, the NC code can be transmitted from the IT level to the shop floor where the Real-time Digital Twin Model is situated. While the controller receives the NC code, it can commence transmitting the data to the Real-time Digital Twin Model.

5. Internal Architecture

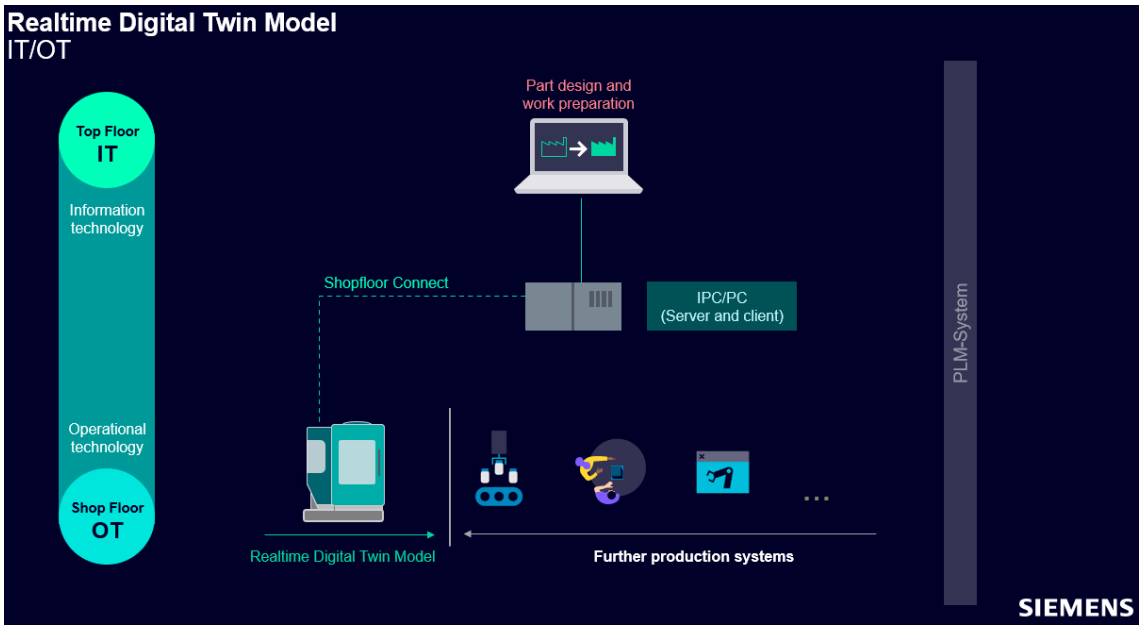

Figure 2 Internal architecture IT – OT

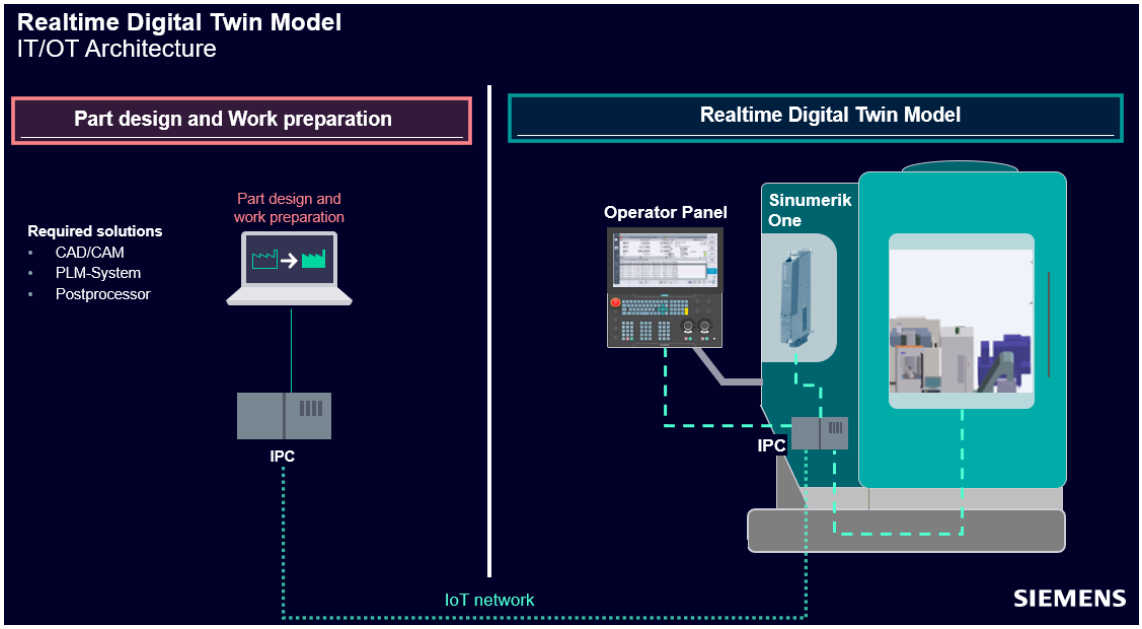

Figure 3 Internal network architecture

6. API

Open architecture:

The Sinumerik ONE controller offers an open architecture that allows integration with various software and hardware components. This open API enables users to develop custom applications and integrate the controller with third-party systems. The open architecture supports standard interfaces like OPC UA, PROFINET, and Ethernet/IP for seamless communication.

7. Implementation Technology

Sinumerik One

Sinumerik One is a CNC system for machine tool applications. This flexible, modular platform combines powerful real-time control, an intuitive touchscreen interface, and comprehensive software tools to help manufacturers boost productivity, quality, and flexibility across a wide range of applications, from milling and turning to additive manufacturing.

Operator Panel

An operator panel provides an interface for machine operators. With its large touchscreen display, the panel enables efficient control and monitoring of the CNC system. Operators can easily access critical production data, program machines, and make real-time adjustments to optimize performance and quality.

IPC

Industrial PCs (IPC) are rugged, specialized computers designed for use in harsh industrial environments. They are built to withstand vibrations, temperature extremes, dust, and other challenging conditions that standard commercial PCs cannot reliably operate in. IPCs are commonly used in manufacturing, process control, automation, transportation, and other industrial applications.

8. Comments

This component is part of TEF (SIPBB) setup and the experiment “Scalable industrial IoT Solution.”