SAP Manufacturing CNC Machine Integration

Applies to:

- SAP Manufacturing Integration & Intelligence (MII 14.0)
- Plant Connectivity (PCo 2.3)
- SAP ME 6.1
- Predator Software DNC (3rd party product)
- Kepware KepServerEX OPC Server (3rd party product)

Summary

The following document describes the connectivity between SAP Manufacturing and CNC machines using Predator Software's DNC product and Kepware KepServerEX OPC Server.

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CNC MACHINE INTEGRATION REQUIREMENTS

Basic

- **CNC File Transfer Management**
  - Download/Upload/Verify
    - Integrated with MES (BOM, Resource, etc.)
    - Integrated with SAP DMS
- **MES WIP Activity Integration**
  - Start/Complete/Signoff
    - Automatic (external trigger)
    - Semi-Automatic (User request)
  - **MES Resource State Integration**
    - Automatic and Manual State changes

Enhanced (Future)

- OEE Data to MI OEE Reporting
- QM/Non-Conformance Reporting
CNC SHOP FLOOR
Landscape

Solution

- **Partner/Engage a 3rd Party CNC Network Manager (Predator Software)**
  - Provides Communication and Interface protocols natively
  - Provides standard messaging format for CNC machine integration

- **Implement bi-directional PCo OPC Agent to support CNC Network Manager**
  - Utilize KepServerEX UCON device driver for bi-directional Socket Communications
  - Standard OPC Tag interface to PCo

- **PCo Agent Instances to support Machine Integration interface to MII/ME**
  - NC File Management
  - WIP
  - OEE (Future)
CNC DEMO SYSTEM ARCHITECTURE

Landscape

- OPC DA COM
- Native Interface
- http/web service
- TCP Sockets
- File Transfer

PCo 2.3 ↔ MII 14 ↔ ME6.x

Third Party OPC Server: KepServerEX OPC Server

Third Party DNC Controller: Predator DNC

TOYODA FH400J ↔ DMG DMU 50
SAP ME INTEGRATION COMPONENTS

Expose CNC Infrastructure to MES

- **SAP MII CNC Transaction**
  - Exposed as a Web Service to ME for CNC Machine Browsing

- **SAP ME System Rules Setup**
  - Configure MII CNC Transaction Web Service
  - Configure CNC Server access
SAP ME RESOURCE MAINTENANCE
Links Physical and Logical Equipment

CNC Browse window:
SAP ME CNC PROGRAM MAINTENANCE

Forms logical link from NC Program to Material to Machine

In the example shown below, an NC file ‘blade.nc’ is attached to the following:

- Material: WIDGET1 Rev A
- Operation: MILLING
- Resource: HMILL
- CNC Resource: TOYODA_FH400J (As was assigned to Resource in Resource Maintenance)

You can assign multiple attachments for a given CNC Program Reference, so this file could be attached to other Material/Operation/Resource as well.
PLANT CONNECTIVITY AGENTS AND INSTANCES
Forms connectivity from ME layer to PLC and DNC servers

The basic requirements for PCo Agent Instances are:

- One FileMonitor Agent Instance to handle the file transfers from MII to DNC
- One or more OPC Agent Instance for handling the Barcode and State Notifications; number of Agent instance will be dependent on the number of Machines to be integrated and the granularity of the configuration required.
- One OPC Agent Instance to provide the connection to write the data from MII to KepServerEX to send each command message to DNC.

Note: Planned future enhancements to PCo and MII will allow direct connectivity between the DNC TCP Ports and PCo, using the Socket Agent, such that the OPC Server component will not be required.
PREDATOR SHOP FLOOR TO OPC INTERFACE EXAMPLE

This diagram shows the data flow between the Predator DNC software and the Kepware OPC Server’s UCON devices.

Each object in Predator DNC that sends data to Kepware does so through a TCP Port assigned and monitored in the specific UCON device.

Each object in KepServerEX that sends data to Predator DNC does so through a TCP Port assigned and monitored in the DNC object.
DEMONSTRATION
Process Step Sequence details

- **Barcode scan of SFC**
  - TCP from DNC to OPC, Notification to PCo
  - PCo Notification sends SFC, Operation, Resource to MII Transaction
- **MII Transaction process request**
  - Validates SFC and that it is In Queue at Operation
  - Determines Material from SFC
  - Retrieves defined NC Filename from ME (Defined in CNC Maintenance)
  - Copies File from secure store to machine directory via PCo FileMonitorAgent
  - Builds DNC Command String (set PS <Material>, set OS <Operation>, LOAD <filename>, CS)
  - Writes DNC Command string to Command Tag in PCo to Write to DNC via OPC
- **DNC Cycle Start Command sent**
  - TCP from DNC to OPC, Notification to PCo
  - PCo Notification sends Operation, Resource, Last Barcode to MII Transaction
- **MII Transaction processes request**
  - Starts SFC and persists Start Record for Resource and Operation and SFC (updates ME)
- **DNC Cycle End Command sent**
  - TCP from DNC to OPC, Notification to PCo
  - PCo Notification sends Operation, Resource, Last Barcode to MII Transaction
- **MII Transaction processes request**
  - Completes SFC (updates ME)
- **Future support for other state to manage Resource State for OEE support (and OEE on HANA)**
  - Planned Downtime, Unplanned Downtime, Setup, Idle, etc.
Trigger Barcode Scan of UNIT (SFC)

The Barcode object in Predator sends the barcode MILL00002 to the KepServerEX UCON device.
Preview NC Program

After MII has received the Barcode notification from PCo, it found the Material associated with the SFC, then retrieved the filename attachment from ME based on the Material, Operation, and Resource defined for the filename in CNC Program Maintenance. Once the filename is found, MII copies the file to the defined Predator CNC directory path, shown below.

MII then constructs the command to have DNC send the file to the machine. After this command is sent through PCo and KepServerEX to DNC, the file is transferred to the machine as shown below.
WIP in ME updated after Cycle Start sent

DNC detects that the CS command has been received as part of the command string sent to it, and sends this command to the machine. DNC also detects this command and sends the CS message back to PCo through KepServerEX to MII. MII then executes a transaction that executes an ME Start Request to place the SFC in Work at the specified Operation/Resource in ME.
SUMMARY

We have demonstrated the capability to integrate shop floor CNC machinery with SAP Manufacturing. The design of the integration will allow it to scale to dozens of CNC machines on the shop floor with only KepServerEX, PCo, MII, and ME configuration; no programming is required to implement.
RELATED CONTENT
The SAP SDN MII Wiki
https://wiki.sdn.sap.com/wiki/display/xMII/Main

The SAP SDN MII Forum

The SAP MII Help Documentation
http://help.sap.com/mii

The PCo Help Documentation
http://help.sap.com/pco