Technical Article

Cross-technology OPC UA interface provides one connectivity solution for all GF Machining Solutions technologies

Modern computer numerical control (CNC) machine tools are capable of recording and collecting a vast range of information that can be used to improve both process performance and business performance. However, due to the many different communication protocols used for various technologies and by assorted machine tool manufacturers, manufacturers face significant challenges in accessing, analyzing, and benefitting from that data. GF Machining Solutions today provides a single connectivity solution for all of its manufacturing technologies.

Introduction

Improved production monitoring, key performance indicator (KPI) analysis, maintenance management, traceability, process visualization, and mobile data access are all performance-enhancing, data-enabled benefits. Modern CNC machines are capable of recording and collecting the necessary data, but differing communication protocols and semantics per manufacturing technology and machine tool manufacturer have presented a major—and often costly—roadblock.

Challenges

On shop floors where multiple machining technologies are used, manufacturers encounter significant challenges—and costs—in harnessing, standardizing, and analyzing the data essential to achieving data-driven benefits. Machine-to-machine communication protocols and semantics can vary by technology and by machine tool manufacturer, further complicating a manufacturer's quest to fully exploit the data gathered by CNC machines.

Solutions

Overcoming these hurdles has often required special in-house information technology (IT) expertise or the resources to enlist expert third-party IT support. Users of GF Machining Solutions' Milling, wire-cutting and die-sinking Electrical Discharge Machining (EDM), Laser texturing, Laser micromachining, and Additive Manufacturing products frequently ask how to connect their machines to their existing enterprise resource planning (ERP) systems and manufacturing execution systems (MES) in order to collect machine data and assemble personalized key performance indicators (KPIs) to help improve processes and business performance. Additionally, off-the-shelf, third-party connectivity technologies are available but, unlike the OPC UA platform, they are proprietary and can be costly.

GF Machining Solutions' OPA UA Interface Version 1.0 provides a single connectivity solution for all GF Machining Solutions technologies and represents a first in cross-technology communication. It enables seamless data exchange between the GF Division's products and the user's shop floor environment. Furthermore, it harmonizes protocols and semantics: The content and meaning of each named datapoint is clearly defined. The OPC UA Version 1.0 and its plug-and-play capabilities make it easy to connect GF Machining Solutions machines to existing ERP systems and MES in order to collect and assemble personalized KPI measurements with refined machine state data.

It enables production monitoring, KPI analysis via a Dashboard, maintenance management, traceability, process visualization, and mobile data access. The OPC UA server hosted on the machines provides the data in a secured manner such that authenticated clients on the same network can access the encrypted data. Data goes from the OPC UA server on the machines to the OPC UA clients on the user's intranet. where it empowers these performance-enhancing applications.

The core of GF Machining Solutions' OPC UA Version 1.0 targets read access for five major data groups: machine identity, state information, process information, utilization, and logs (see Figure 1). Moreover, because this solution is based on an open platform, it is backed by a large global community with vast and diverse know-how in manufacturing technologies, connectivity, and security, therefore it is a robust solution as connectivity technology evolves.

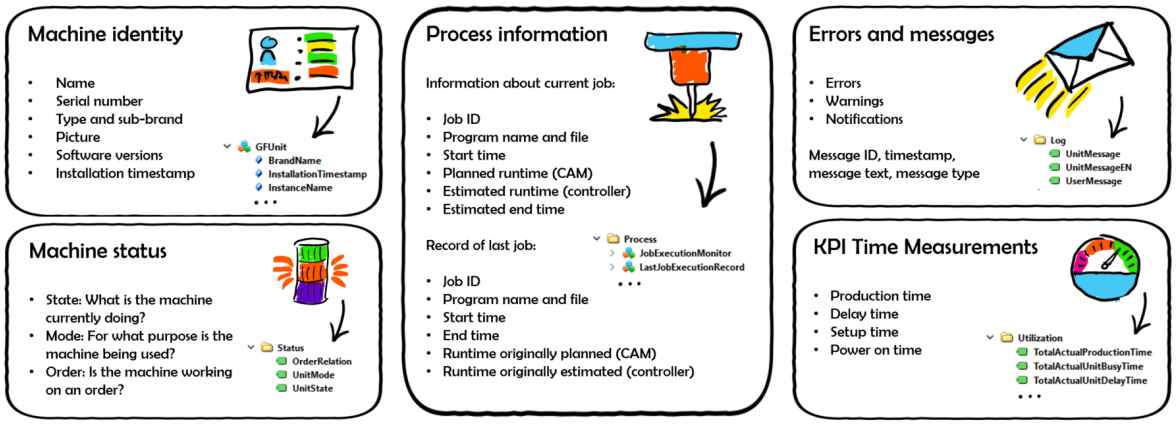


Figure 1: main contents of GF Machining Solutions OPC UA Interface Version 1.0

• Reading **machine identity**: Meta information, such as serial numbers, user-provided nicknames, and software versions for GF Machining Solutions machines, can be retrieved from the OPC UA server.

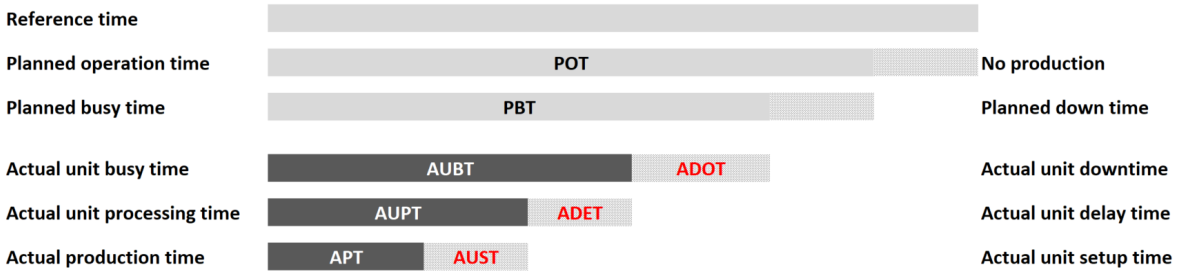
• Reading **machine states**: The three machine state attributes provided by GF Machining Solutions OPC UA provide basic information such as what the machine is actually used for, whether it is working on an order, or what the unit is currently doing. The states' attributes build the foundation for all KPI calculations already provided by the OPC UA server. These machine states can be used by manufacturers to implement their own algorithms for KPI/OEE computing.

• Remote monitoring of machine messages: **Messages** from the machine, such as user messages, warnings, and errors are accessible on the OPC UA server. Subscribing to these messages makes them available to the OPC UA client.

• Reading precomputed **KPIs**: The GF Machining Solutions OPC UA server provides different KPIs since machine installation, including actual production time (APT), actual unit setup time (AUST), actual unit delay time (ADET), actual unit busy time (AUBT), and actual unit processing time (AUPT). In addition to these KPIs, the UnitTime and the UnitOnTime are provided.

• Monitoring **Job information**: The OPC UA server promotes data related to the actual running job on the machine and to the last job that ran on the machine. Monitoring what job is actually running on the machine becomes easy. Start and end times of the actual job can be provided, and jobs can even be tracked by their execution identifier (multiple executions of the same "job recipe"). Key information about the last job such as lead time, start/end time, and the numerical control (NC) program name are provided by the server.

Furthermore, GF Machining Solutions' OPC UA Interface Version 1.0 implementation offers ready computed times according to ISO-22400 (dark grey and red values). The following table contains the descriptions of the time elements and how the values are acquired.



Abbreviation	Time Element	ISO definition	Acquisition
APT	Actual production time	The actual production time is the actual time during which a work unit is producing. It includes only the **value-adding functions**.	Measured
AUST	Actual unit setup time	The actual unit setup time is the time consumed for the preparation of an order at a work unit.	Measured or derived
ADET	Actual unit delay time	The actual unit delay time is the actual time associated with malfunction-caused interruptions, minor stoppages, and other unplanned time intervals that occur while tasks are being completed that lead to unwanted extension of the order processing time.	Measured
AUBT	Actual unit busy time	The actual unit busy time is the actual time that a work unit is used for the execution of a production order. The actual unit busy time is the actual unit processing time plus the actual unit delay time. AUBT = AUPT + ADET.	Measured or derived

AUPT	Actual unit processing time	The actual unit processing time is the time needed for setup and for the production. The actual unit processing time is the actual production time plus the actual unit setup time. AUPT = APT + AUST.	Derived
ADOT	Actual unit downtime	The actual unit downtime is the actual time when the work unit is not executing order production although it is available.	Measured in the context of PBT
PBT	Planned Busy Time	The planned busy time shall be the planned operation time minus the planned downtime.	Specified
POT	Planned Runtime per Item	The planned run time per item shall be the planned time for producing one quantity unit.	Specified or estimated

Secure communication is another challenge answered by OPC UA: It is a proven security concept with authentication for user and application. It ensures protection against unauthorized access. OPC UA security is based on recognized standards such as Secure Sockets Layer (SSL), Transport Layer Security (TLS), and Encrypted Communication Data based on Advanced Encryption Standards (AES). OPC UA provides a robust and reliable communication infrastructure with mechanisms for handling lost messages, failover, heartbeat, etc. With its binary encoded data, it offers a high-performing data exchange solution. Security is built into OPC UA as security requirements become more and more important, especially since environments are connected to the office network or the internet and attackers are starting to focus on automation systems.1

Conclusion

As a single, robust connectivity solution for all of its technologies and machines, GF Machining Solutions' OPC UA Interface Version 1.0 ensures interoperability between equipment and processes and simplifies data analysis by centralizing data collection. Due to its plug-and-play, open architecture, it reduces the cost of integration between the shop floor and higher-level systems such as supervisory control and data acquisition (SCADA), Dashboard, and ERP, and uses one language on a structured data set to allow for reliable reports. Moreover, it is a scalable solution with data modeling delivering data, conditions, alarms, historical machine data, and programs. In contrast to standard product interfaces, OPC UA Interface Version 1.0 guarantees the safety of all data, thanks to password-protected access and built-in, state-of-the-art security. Machine analysis is improved so users gain optimized return on investment

[1] OPC UA Online Reference, https://reference.opcfoundation.org/v104/DI/v102/docs/4.2.1/

(ROI), and it becomes easy to integrate data into the GF Machining Solutions Dashboard as well as ERP systems and MES. At the same time, GF Machining Solutions' OPC UA Interface Version 1.0 simplifies centralization of data and messages for the solution's Dashboard and bigger MES.

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