NEXCOM
The Intelligent Systems

White Paper

Turn Machine Data into Revenue with Digital Manufacturing

Machine data can increase energy savings, production efficiency, and productivity for manufacturers while raising the value of industrial machines and creating revenue-generating services for machine makers.

Machine markers are exploring new ways of utilizing digital manufacturing to better serve manufacturing clients. Using machine data, digital manufacturing can increase energy savings, production efficiency, and productivity for manufacturing clients while raising the value of industrial machines and creating revenue-generating services for machine makers. To expedite the digital adoption, the role of industrial machines must expand from machine control to machine-to-machine communication and real-time data integration; the time and effort associated with solution implementation must also be taken into account for the sake of smooth transition of the next generation of industrial machines (Figure 1).

This article considers a complete Industry 4.0 solution based on NEXCOM's PC-based controller NIFE 105 featuring Intel® Atom® processor x5-E3930. The solution can equip the next generation of industrial machines with computing, control, and connectivity functions so every machine can become a cyber-physical system (CPS) capable of interacting with both physical and cyber worlds. Moreover, the solution can interoperate with legacy standalone industrial machines by breaking information silos imposed by industrial communication protocols and catalyze the convergence of operational technology (OT) and information technology (IT) to attain the efficiency advocated by Industry 4.0.

The Need to Increase Overall Equipment Effectiveness

In the past, client service engineers are deployed to clients' factories inspecting machine status, replacing worn machine parts, and calibrating machines for optimal performance. For clients who are contract manufacturers relying the production on around-the-clock operation of tens, if not hundreds or thousands of machines, the time-based

Figure 1. Using the NIFE 105, machine makers can raise the value of machine data and create revenue-generating services.

With the aim of increasing overall equipment effectiveness (OEE) for clients, machine makers need to obtain a firm grip of machine health status.

inspection could result in unnecessary machine downtime and be seen as a drag on the production. For clients running small factories, the regular visit could translate into delayed maintenance in regard to the absence of client service engineers between visit intervals. Neither was optimal. With the aim of increasing overall equipment effectiveness (OEE) for clients, machine makers need to obtain a firm grip of machine health status and power off a machine only when maintenance is required (Figure 2).

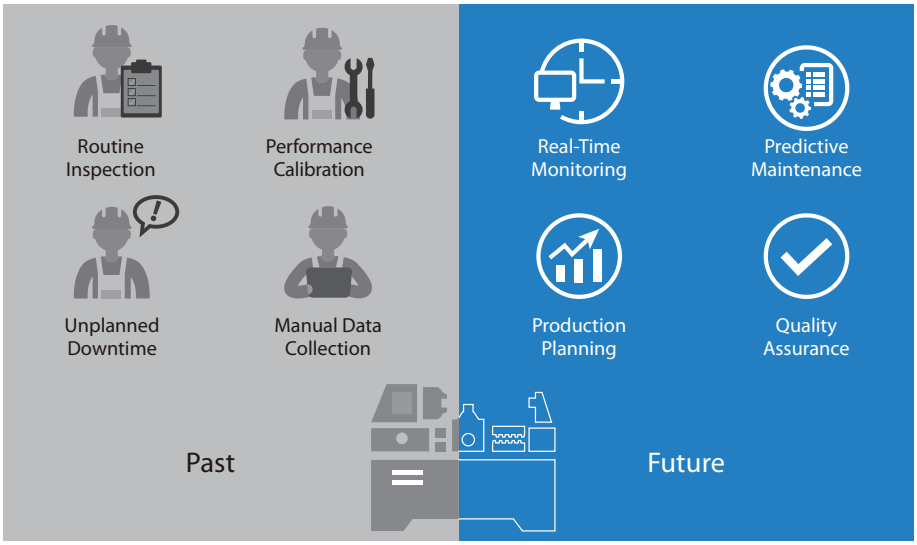

Figure 2. To increase overall equipment effectiveness (OEE) for clients, machine makers need to obtain a firm grip of machine health status.

Having a strong grasp of machine status is also of great significance for production planning and quality control. In today's factories, most industrial machines are standalone equipment, and machine data, including machine yield rate, output, and uptime, is commonly collected and compiled manually. This practice is obsolete; the data is not real-time. And factory managers may lack adequate information for decision making. In the need to fulfill an urgent order, mobilizing or reallocating available machines and other resources is never easy.

Transform Industrial Machines into Smart Machines

To eliminate unwanted machine downtime and to allow more efficient use of machines, NEXCOM's PC-based solution can connect industrial machines across the factory floors and all the way up to the cloud to allow for machine-to-machine communication and real-time data integration. The solution, pivoting on the NIFE 105, includes Intel® Atom™ processor, IEC 61131-3 compliant CODESYS Runtime, fieldbus and network communication, and NEXCOM Industrial IoT Studio.

The PC-based NIFE 105 has multiple uses, including machine controller, human-machine interface (HMI), and IoT gateway (Figure 3). Firstly, as a machine controller powered by the dual-core Intel Atom processor x5-E3930, the NIFE 105 can dedicate one computing core to processing threads related to control tasks which can be planning tool paths in CNC machines or coordinating multiple axes of motion in generation motion control systems. Meanwhile the non-real-time operating system (non-RTOS), HMI, and gateway applications are executed on another. When a less-critical application crashes, the NIFE 105 can prevent controlled axes from moving intermittently, guaranteeing high machining quality.

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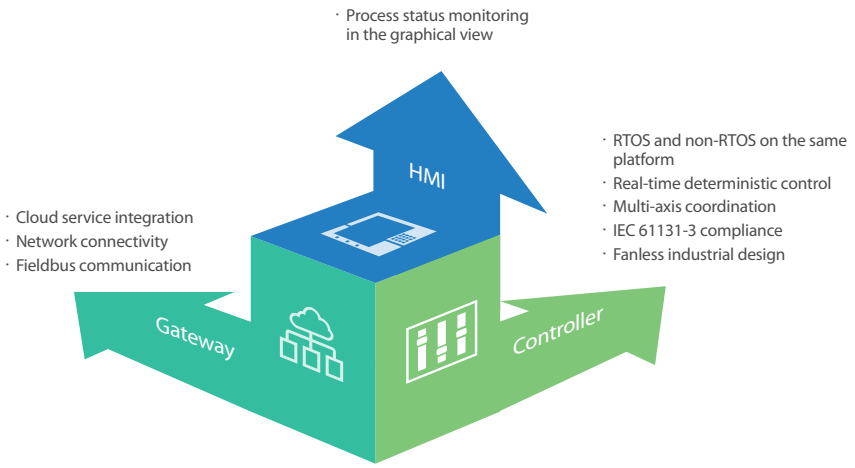

Figure 3. The NIFE 105 can serve as a machine controller, HMI, and IoT gateway, transforming industrial machines into smart machines.

As to applications with strict real-time requirements, the NIFE 105 can provide machining precision and shorten machine cycle time. Integrating EtherCAT master, a real-time industrial communication protocol, and Intel® Time Coordinated Computing Technology (Intel® TCC), a technology which can reduce time synchronization to within 1 microsecond (μs), this PC-based controller can synchronize controller, cutting tools, and auxiliary axes for consecutive, fluid movements, improve real-time deterministic control of time, temperature, speed within industrial machines, and therefore attain the repeatability—ability to reproduce high-quality products—required of automation control. To accelerate the buildup of controller functions, machine makers can take advantage of IEC 61131-3 compliance to replicate existing control schemes to the NIFE 105, putting the controller into motion in no time.

The extended temperature range of -40°C to 85°C is another remarkable feature of Intel Atom processor x5-E3930. The feature is worth mentioning because it enables the fanless sealed housing of the NIFE 105 and enhances the reliability of the controller for use in heat treatment industrial machines, heat-generating manufacturing processes, and harsh factory environments. One application that can demystify the value of the housing is a CNC project implemented four years ago. In this project, regardless of the vapor-filling inside of a CNC machine, the printed circuit board (PCB) of a four-year-old, fanless, sealed NIFE controller looks dust- and grease-free new as opposed to other CNC components and devices, securing machining productivity and efficiency for NEXCOM's client.

Secondly, machine makers can consolidate HMI functions onto a single unit of the NIFE 105 to streamline the system architecture. Leveraging the built-in graphics engine of the Intel Atom processor, the NIFE 105 can provide previews of machining processes in 3D simulation and process flow diagrams for operational status monitoring.

Moreover, the NIFE 105 can function as an IoT gateway for data collection and preliminary data analysis. To facilitate data collection and analysis, NEXCOM Industrial IoT Studio is a cloud configuration tool with a graphical user interface (GUI) pre-integrated with fieldbus communication, network connectivity, and cloud support. With a few drag-n-drop operations, NEXCOM Industrial IoT Studio can automate data

NIFE 105 can gather machine data to help track machine health status, production progress, and overall equipment effectiveness.

acquisition and protocol conversion, and upload data to designated receiving clouds, eliminating the burden of configuration programming for machine makers.

Minimize Downtime with Predictive Maintenance

In a predictive maintenance scenario, the NIFE 105 can maintain a log to track the health of industrial machines, email or text client service engineers a summary report through web services at regular intervals, and notify the engineers when a monitored parameter falls outside a specific range. Instead of swamped by minute-by-minute data of every machine, the engineers can tap into machine statistics and periodic patterns to diagnose machine health status, look for signs of performance degradation, and schedule a maintenance visit, if necessary, before a machine malfunction (Figure 4).

Machine makers can further raise the value of machine status data by using 3rd-party machine learning tools to refine predictive maintenance models, or using data visualization service platforms to create a virtual war room in which data is plotted as comprehensible charts and diagrams. With a virtual war room, client service engineers can easily oversee all machines situated in individual client's factories while manufacturing clients can monitor production progress and overall equipment effectiveness for production planning and quality control.

Standalone industrial machines can also benefit from the NIFE 105. With a broad support for fieldbus and proprietary protocols—PROFIBUS, PROFINET, EtherNet/IP among others—the NIFE 105 can harvest machine data encapsulated in fieldbus frames and convert the data into TCP/IP packets so the machine data can be recognized by cloud service platforms for further analysis and archive. Since the NIFE 105 in this application scenario merely performs gateway functions, it can provide a cost-effective gateway solution to connect up to twenty machines to the cloud.

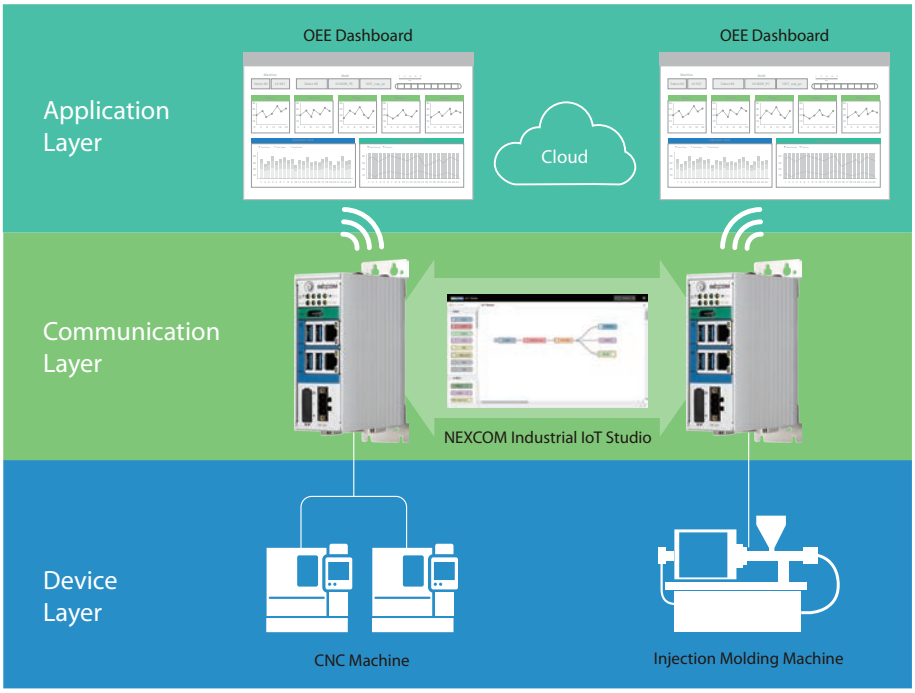

Figure 4. Machine data can be translated into machine status, historical trends, and operation reports, creating new revenue generators with smart services.

NEXCOM's Industry 4.0 solution has been adopted to help machine makers elevate customer satisfaction and generate recurring revenues with value-added after-sales services.

One of NEXCOM's machine building clients has adopted the NIFE 105 to develop smart injection molding machines and online diagnostic services. In a real case implementation, the NIFE 105 is used to control and monitor end-to-end processes from mold clamping, injection of raw plastic materials, plastification-cooling, to ejection of end products. Incorporating NEXCOM Industrial IoT Studio and Microsoft® Azure, the client is able to capture clamping forces, injection speeds, cooling temperatures along with process status data of every smart machine and show all information in a cloud-based war room with a custom dashboard designed with interactive data visualization BI tools, Power BI.

The client also uses the NIFE 105 to serve its CNC customers. Despite the fact that its CNC machines use Fanuc FOCAS Ethernet Communications which is a vendor-specific protocol, the client has successfully employed the RESTful web service supported by the NEXCOM Industrial IoT Studio to inquiry CNC configurations and performance of critical machine parts, such as spindle and bearing, to create various online diagnostic services covering tooling management, failure time analysis, and OEE optimization (Figure 5).

Conclusion

Industry 4.0 illuminates the direction for future industrial transformation and innovations. With predictive maintenance reflecting only a microcosm of services that OT-IT convergence makes possible, gains in energy savings, productivity, and production efficiency that smart machines can provide are tremendous. NEXCOM is supporting the early adoption of Industry 4.0 innovations with holistic solutions to accomplish the factory infrastructure which consists of the device, communication, and application layer, from the bottom up. With a combination of controllers, IoT gateways, fieldbus communication technologies, and cloud configuration tool, NEXCOM can help machine makers elevate customer satisfaction and generate recurring revenues with value-added after-sales services and push production growth for manufacturers.

Figure 5. NIFE 105 has been adopted to help machine makers develop remote monitoring and online diagnostic services.

Founded in 1992, NEXCOM integrates its capabilities and operates six global businesses, which are IoT Automation Solutions, Intelligent Digital Security, Internet of Things, Intelligent Platform & Services, Mobile Computing Solutions, and Network and Communication Solutions. NEXCOM serves its customers worldwide through its subsidiaries in five major industrial countries. Under the IoT megatrend, NEXCOM expands its offerings with solutions in emerging applications including IoT, robot, connected cars, Industry 4.0, and industrial security.

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