INCREASE MACHINE PERFORMANCE

Achieving the perfect **performance**

How can you increase machine performance? Standardized, scalable automation solutions are key to achieving this goal. They help make optimum use of resources and increase productivity in engineering and operation. As a result, machine manufacturers and operators can respond better to current market trends and design their processes to be more effective.

SIEMENS

Machine performance is vital for increasing machine productivity

Machine performance is a key factor in production processes. In today's market environment, however, it is becoming increasingly difficult to further improve machines or plants, not least because of increased market pressure. Machine builders have to develop, deliver, and commission new solutions faster and faster without compromising on performance and quality. And machine operators must make their processes increasingly flexible in order to be able to react to new market or customer requirements, all while remaining cost- and resource-efficient.

Intelligent solutions for systems automation are needed to meet all these requirements. An optimal design for the automation solution can not only significantly increase machine performance but also enable existing resources to be used optimally.

This white paper offers specific use cases to show how machine builders and operators can harness the progress controller technologies have made in the areas of communication, cycle time, and storage capacity, and how machine performance can be increased through scalable controller systems, real-time communication, high-level language applications, and decentralized intelligence.

Contents

Scalable and flexible solutions increase performance

Regardless of whether it's an existing machine or a new investment, what counts is more performance. But how exactly can the performance of a machine be optimized? Optimally aligned components for automation play a key role.

Performance as the key to greater efficiency and productivity

Ever shorter time to market on the one hand, growing demands on the flexibility of machines and systems on the other: The requirements for the performance of a machine are becoming both more demanding and more diverse. What's more, machine manufacturers and operators focus on different aspects of machine performance:

- The mechanical engineer:
  - must meet the requirements for the number of cycles/units from the specification (design performance),
  - must adapt to different environmental conditions and regional standards and regulations, and
  - requires solutions that can be efficiently adapted to different performance requirements, put into operation, and supported throughout operations.
- The systems operator:
  - wants to achieve the maximum number of pieces/products/cycles per hour (operational performance),
  - must make optimum use of existing assets or increase their performance, and
  - requires solutions that offer sufficient power reserves or can be efficiently upgraded.

Scalable performance with scalable automation

In order to increase the performance of machines, use resources efficiently and effectively, and thus work more productively overall, powerful automation is essential.

Choosing the right systems design is crucial for increasing and optimizing machine performance.

With a standardized, scalable automation solution, both machine manufacturers and operators can ensure the higher performance, availability, and reliability of their machines, make optimum use of resources, and increase their productivity. Machine builders in particular also benefit from improved engineering efficiency. However, it is crucial that each automation solution is tailored to its specific performance requirements. And central to this goal is the question of how resources are distributed and used both in the central programmable logic controller (PLC) and in the automation peripherals, so that the load on the PLC cycle is reduced and the performance available can then be optimally used for the machine program.

The optimum set-up for every application

Three factors are essential for the performance of automation solutions: data communication, cycle time, and memory.

Optimal use of resources

Put simply, the faster the controller's CPU and the more memory it has, the better. However, there is another factor that significantly influences the systems and automation design: budget. So the real job when selecting the right automation solution is solving the machine performance requirements within a specified budget—which means making optimum use of automation resources. This requires effective management of computing power: available resources for communication, program execution, and execution must be allocated and dimensioned in such a way that the process can be executed with high performance and without bottlenecks. To optimize computing power, it is important to identify the factors that determine machine performance.

- Performance factor communication
  With the growing complexity of systems and machines, the demands on communication are also increasing, both within the machine and with higher-level systems. These additional communication tasks can add up to significant computing load. In this case, it makes sense to allocate or maintain dedicated resources for data processing and communication within the control system, if communication requirements are likely to increase.

- Performance factor cycle time
  The cycle time of a PLC is the time required by the CPU to process the cyclical program and to update the process image of the inputs and outputs, as well as of all program parts and systems activities that interrupt this cycle. The cycle time is not the same for every cycle: for example, different program runtimes (e.g., program loops, conditional commands, conditional block calls, or different program paths) or interruptions (e.g., time-controlled alarm processing, handling process alarms or communication) entail varying cycle times. If a shorter cycle time is required for the desired performance, either a more powerful processor must be selected, or the CPU must be relieved of additional tasks.

- Performance factor memory
  The automation data are stored in the automation system in various memory areas: load memory (memory card), integrated program memory, and working memory. The memory of the CPU must be dimensioned to match the complexity of the program and the times required to access the memory.

Different use cases have different performance requirements

Finding the right systems configuration—that is, one that meets performance requirements with an optimal cost-benefit ratio—depends heavily on the specific use case and the requirements of the application. Developers must find the right controller, as well as consider other automation requirements. In addition to a suitable controller portfolio for all machine requirements, decentralized, intelligent systems can also increase the performance of the automation.

Harnessing the **technological progress**

The performance gains in processors and storage systems also benefit automation. Current controllers are many times more powerful than previous generations.

Performance boost: New, more powerful hardware

Controllers have undergone enormous performance improvements. The processing speed for bit operations today can be a factor of 10 or more of the values possible 10 years ago. Among other factors, this advance has been made possible by:

- faster processors,
- optimized firmware, and
- multicore architectures.

Not only high-end applications benefit from these advances, but also controllers in the medium performance range, as the SIMATIC S7-1500 family shows (Figure 1). However, current controllers such as the SIMATIC S7-1200 G2 also deliver a significant performance boost in Basic Automation: Compared with its predecessor, bit performance has more than doubled here (37 ns for G2 instead of 85 ns).

In order to meet the requirements for overall machine performance, there are other aspects that should be considered in addition to CPU performance. It is important to have the performance available at all times for the most essential tasks. The following use cases show examples of the different criteria that are important here.

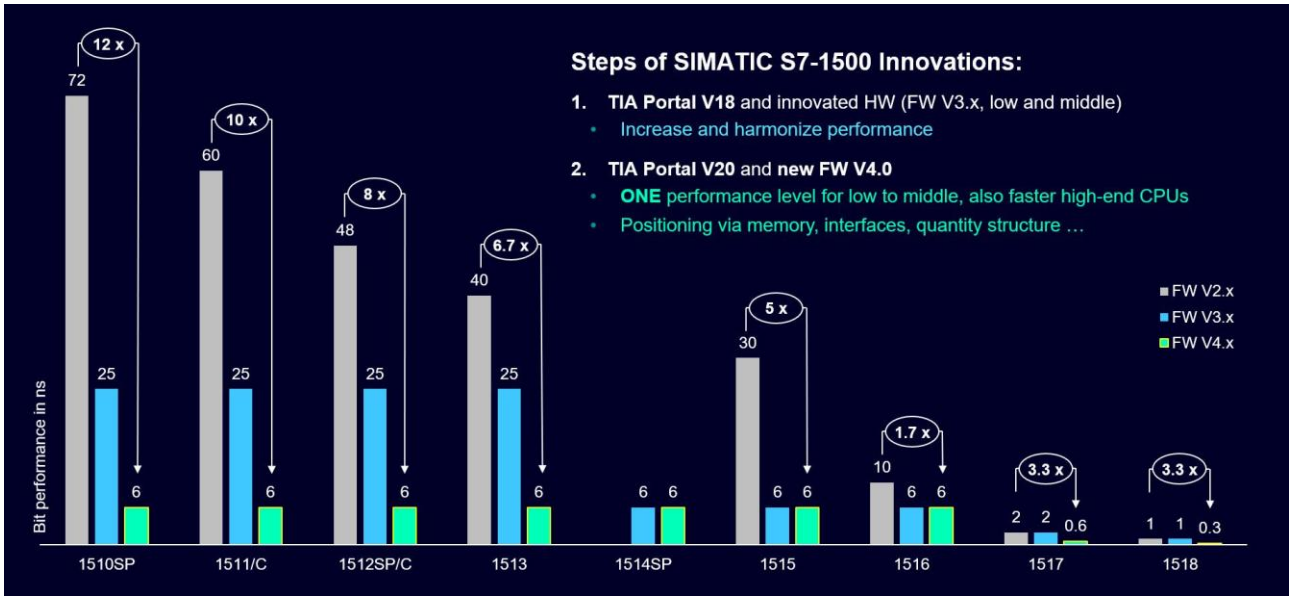


Figure 1. Performance increases in processing speed (bit performance in ns), selected CPUs of SIMATIC S7-1500 controllers to date, 2024 (FW V4.0).

Increasing output through **scalable performance**

How can the operating performance of machines be increased? The answer: controllers that are designed for increasing requirements.

Challenge

To enhance the production performance and capacity of an existing line, the performance of the automation system must also be extended. To achieve this, the existing hardware and software should continue to be used as much as possible, and, where necessary, should be supplemented with additional IO signals and new functions.

Solution

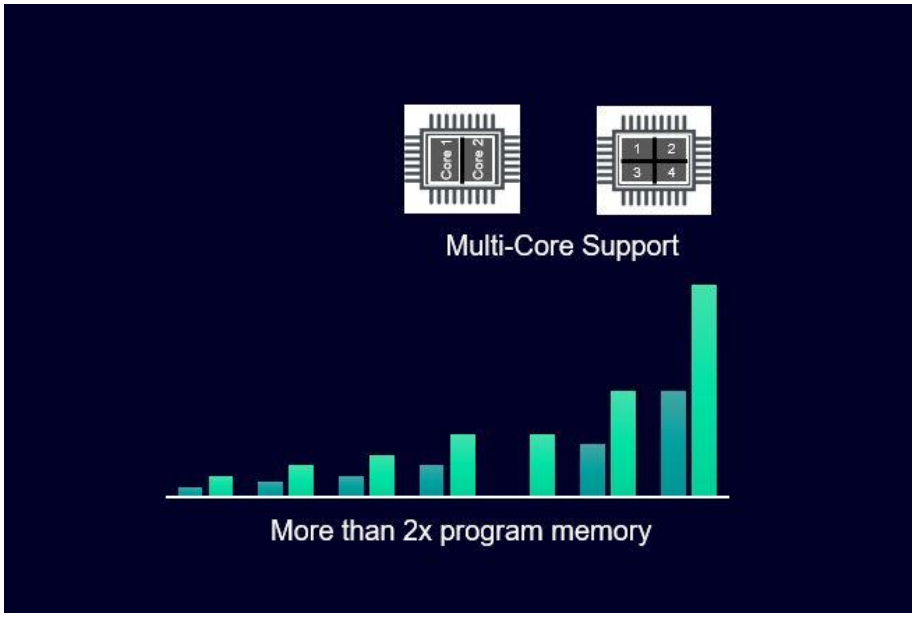
When specifying the machine, there should be sufficient and, if necessary, expandable performance available in terms of processing power, communication, and memory. Scalable automation systems make it possible to integrate the latest controller generation into existing systems, for example, by using multicore instead of single-core controllers. Sufficient reserves of program and data memory make it easy to implement modular machine concepts for flexible production.

Benefits

Automation systems that are designed for increasing requirements and performance expansions offer several advantages for the user:

- Compatibility within the system families protects investments (existing hardware and software can be reused).
- A common engineering platform and standardized interfaces enable easy integration.
- End-to-end diagnostics options ensure the overall availability of the automation solution.
- Flexible options and universal communication enable applications such as safety and motion control.

Scalable portfolio
With the aligned and scalable SIMATIC controller portfolio, users benefit from an interoperable systems platform and standardized engineering for a wide range of performance requirements.
siemens.com/simatic-controller



Enhancing performance in **Basic Automation**

How can even simple automation tasks benefit from more performance? The answer: a powerful controller specially designed for Basic Automation.

Challenge

The need for more performance, scalability, functionality, and data transparency no longer affects only high-end applications. Functionality and flexibility requirements are also increasing when automating basic systems and machines: Faster product changes, fluctuating production volumes, and new materials or dimensions are all challenges for Basic Automation, as well. At the same time, cost and pricing pressures in this segment remain high, challenging machine and systems manufacturers to find a cost-efficient yet scalable, flexible, and powerful solution for systems automation.

Solution

With a scalable and cost-effective hardware portfolio for Basic Automation, price-sensitive applications benefit from more computing power for faster program execution. In addition, these solutions also offer dedicated communication performance for high-performance data communication. PROFINET Isochronous Real Time (IRT) enables isochronous communication, so that users can also implement advanced motion control applications, in addition to further applications. Integrated safety functions also enable flexible, cost-efficient, and scalable solutions for machine safety.

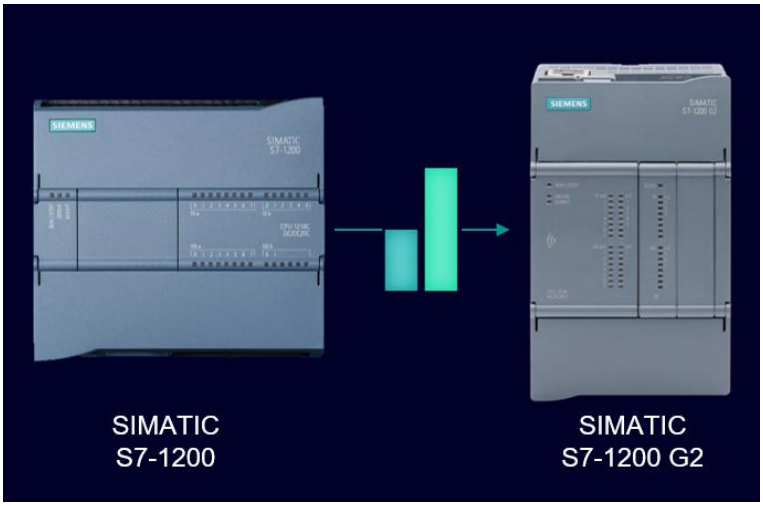
Benefits

With the right controller solution, it is possible to design an automation solution that is cost-efficient yet offers considerable performance, and that also features a modular system design for enhanced flexibility. Even compact, simple applications benefit from many possibilities that previously took considerable effort to realize, such as:

- higher productivity thanks to efficient motion control functions,
- maximum flexibility through integrated solutions for machine safety and scalable performance thanks to an integrated systems and tool landscape, and
- lower downtime costs thanks to better data transparency with an excellent price-performance ratio of the controller.

Basic Automation with SIMATIC S7-1200 G2

SIMATIC S7-1200 G2 controllers offer significantly higher computing and data communication power, more memory and enhanced scalability. These functions ensure greater productivity, efficiency, and flexibility for your automation system. Find out more here: SIMATIC S7-1200 G2.



Increasing performance with **isochronous real-time communication**

Isochronous real-time (IRT) communication enables consistent response times as well as equidistant and synchronous signal processing—and therefore reproducible machine behavior.

Challenge

For time-critical applications in particular, it is important that the response time from signal acquisition to signal output is always constant—that is, the same length of time—and therefore defined and jitter-free. This consistency in response times is the only way to ensure recurring, invariable machine behavior and therefore consistent process quality.

Solution

IRT communication ensures that data are transmitted at regular and predictable intervals (clock-synchronized or isochronous), evaluated, and put out with predictable and guaranteed latency (in real time). This allows functions such as signal recognition and output as well as signal transmission to be transmitted at consistent time intervals and the program in the CPU to be coordinated with the IO signals.

Benefits

IRT communication ensures better performance for all applications that require precise and deterministic data transmission. It enables:

- reproducible response times thanks to total synchronization of all components,
- fast detection/response through dedicated components that are synchronized together via a reserved bandwidth, and
- fast data processing synchronized with the user application.

IRT communication thus ensures a constant and reproducible program sequence—and a reproducible process result.

Real-time communication with PROFINET IRT

PROFINET IRT provides a reserved bandwidth in which IRT data can be transmitted at synchronized intervals.
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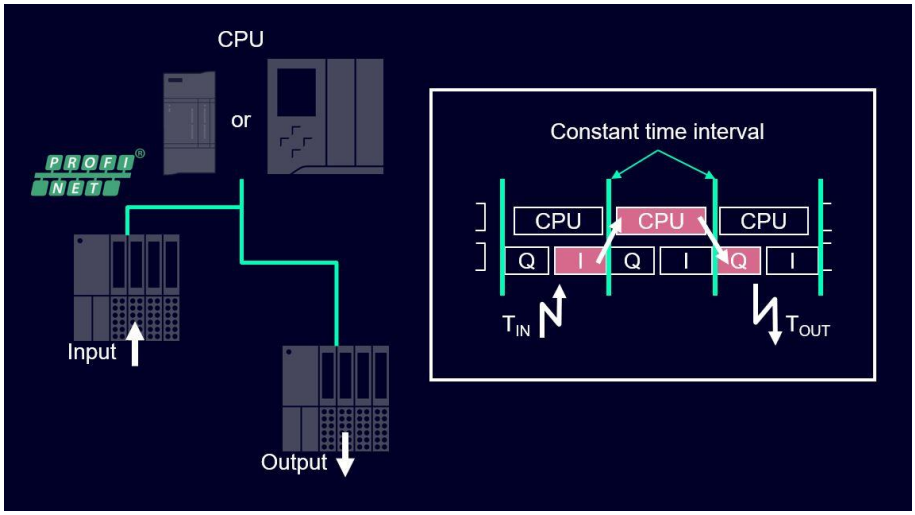


Increasing performance through **high-level language programming**

Applications such as image processing or AI often require high computing power and are therefore implemented on PC systems. Software controllers enable efficient and high-performance integration of high-level language applications into automation.

Challenge

In order to further increase the level of automation and the performance of a machine, data-intensive applications such as image recognition or data analysis with AI should be integrated into the automation. These applications should be able to be used for machine control without having to implement additional hardware.

Solution

With a software controller, it is possible to combine high-level language applications on Windows or Linux systems with real-time applications. These applications are then executed in the software controller in parallel to the control program in real time so that, for example, complex mathematical operations can be used for machine control.

Benefits

By integrating high-level language applications into automation, users benefit from many new possibilities for increased performance, such as access to databases, AI, or autonomous processing units. An integrated software controller also enables:

- Combining the execution of the PLC program with high-level language applications without additional hardware
- Efficient engineering by using the same tools as for hardware controllers and tools for application development
- Flexible execution of the high-level language application directly in real-time or Windows/Linux environment

SIMATIC S7-1500 software controller

SIMATIC S7-1500 software controllers combine the advantages of SIMATIC S7-1500 controllers and industrial PCs and can be connected directly to PC applications programmed in high-level languages. The controller is independent of the operating system and continues to work reliably even during a restart.
siemens.com/software-controller

Increasing machine performance with **decentralized intelligence**

High-speed modules achieve cycle times of less than one microsecond and reduce the load on the central CPU by executing tasks that do not require high computing power but need very short processing times.

Challenge

In many machines, in addition to general control tasks, there are often processes that do not require particularly high computing power but must run in very short processing times. However, using a more powerful PLC is not always the best solution, especially if the required cycle times are significantly shorter than the cycle time of the PLC. Instead, it makes sense to outsource these processes to dedicated modules.

Solution

Many tasks can be outsourced to modules optimized for fast response times. These modules are controlled by the CPU but carry out the outsourced tasks independently. For this purpose, the technology modules have their own application logic that enables very short response times. For some time now, there have also been programmable high-speed technology modules such as the TM FAST module for SIMATIC S7-1500, whose application logic can be tailored to each specific task. The module has a special programmable chip, the Field Programmable Gate Array (FPGA), which is used with its internal interface to the CPU after programming in the hardware description language VHDL.

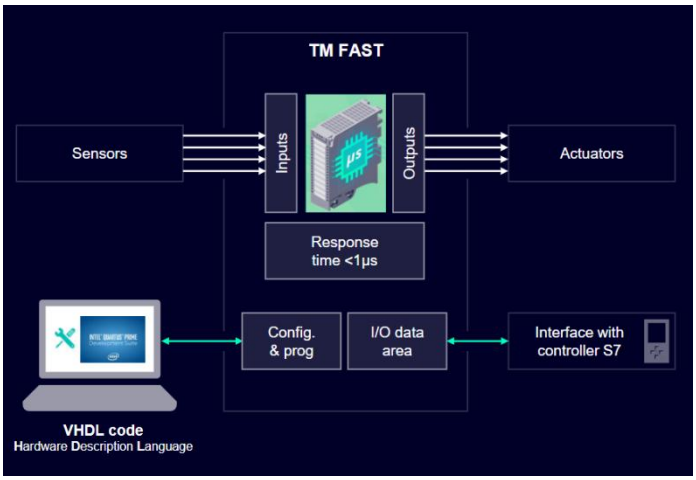
Benefits

Thanks to this special chip, such high-speed modules achieve an internal cycle time of just 20 ns and total response time well under 1 µs. Tasks with high response time requirements can therefore be executed in parallel to the central CPU in these special modules. This enables the optimal use of the resources in the automation components:

- Very fast response times thanks to the outsourced intelligence and special inputs and outputs
- Easy integration into the overall solution just like any other automation component, either centralized in a SIMATIC S7-1500 or decentralized in a SIMATIC ET 200MP system combined with a SIMATIC S7-1200, S7-1500, or any other control system
- Flexible application options thanks to user-programmable logic (FPGA)

TM FAST high-speed technology module

The TM FAST high-speed technology module for SIMATIC S7-1500 (centralized) or ET 200MP (decentralized) can be used to control particularly fast processes with response times in the micro- and nanosecond range. The function can be programmed for specific applications and executed independently of the PLC's CPU.
More about TM FAST (product support)



OUR LOCATIONS

National footprint with strategic local stockholdings.

APS Industrial is headquartered in Melbourne and in addition has a national network of offices in Adelaide, Perth, Sydney, Brisbane and Tasmania supported by strategic local stockholdings and expert technical and application knowledge.

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