Right On Target

Meeting individual manufacturer requirements for the implementation of Industrial Ethernet field devices through scalable solutions

The key to individual device implementations is a complete, scalable solution (Source: Shutterstock)

The requirements that device manufacturers specify for the implementation of Industrial Ethernet field devices may vary significantly, e.g. with regard to the supported performance, the availability of general Ethernet services, the device architecture or the offered communication capabilities. Meeting this wide variety of demands requires a high level of flexibility. A powerful solution to achieve this is to take advantage of the FPGA technology which Softing Industrial Automation successfully uses for field device implementations.

Among the many Industrial Ethernet standards, the protocols EtherCAT, Ethernet POWERLINK, EtherNet/IP, Modbus TCP and PROFINET are well established in the market today for use on a wide-scale basis. Each of these protocols consists of a mandatory basic functionality and various expansion options, which gives manufacturers a high degree of freedom in respect to the supported functionality: Manufacturers can specify their own individual requirements catalog to reflect their unique selling points while ensuring optimal positioning of their field devices in the market.

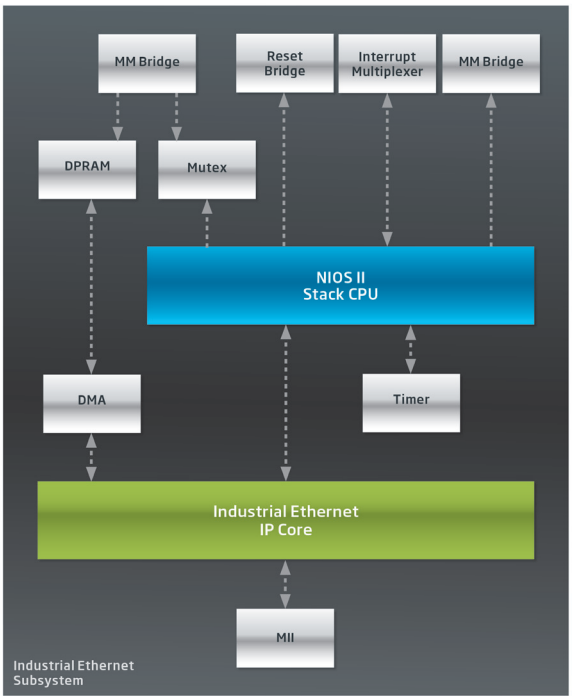
FPGA technology to suit all applications

The key to individual device implementations is a complete, scalable solution that, on the one hand, comprises different Industrial Ethernet protocol stacks with the necessary selection options and, on the other hand, allows the manufacturers to implement their unique selling points with no compromises. Softing‘s solution accommodates this diversity by making use of the flexible application possibilities of an FPGA. The current projects described in this article illustrate how versatile this solution is.

Optimized data processing

A device manufacturer was looking to improve the performance of their Industrial Ethernet implementation over their previous PROFIBUS solution in order to achieve a transfer rate of several thousand measurement values per second. In another project, performance requirements specifying a cycle time of less than 100 µs played a key role for the transfer of a large amount of measurement data. In both cases, the output values of the controller were to be transferred cyclically to the field devices, and the measured values were to be returned to the controller as input values. It had to be ensured that any existing new values were transferred and further processed in each cycle. The achievable cycle time largely depends on the time it takes to process the data in the protocol stack (stack throughput) and in the application.

The execution of the Industrial Ethernet protocol above layer 2 of the OSI model (Data Link Layer) can be implemented either purely in software or by using a combination of hardware and software. For the existing software solution, stack throughput times of up to 100 µs were measured. It thus failed to meet the specified requirements. To increase performance, an additional hardware solution was integrated in which the data is copied directly from/to the Industrial Ethernet IP Core. This



Softing Protocol IP: The components of an Industrial Ethernet subsystem for implementation in an FPGA (Source: Softing)

approach allows copying 100 bytes in ten microseconds from the Industrial Ethernet IP Core to the dual port memory, thereby increasing the performance approximately by a factor of ten.
Another way to improve the performance is to implement at least part of the device application in hardware. For this purpose, the sensor data is directly captured and preprocessed by an application IP Core. As opposed to ASIC-based implementations, which are mostly limited to a few digital inputs and outputs, this solution supports the connection of any directly connectable peripherals. For data exchange, the measured data is transferred from the application IP Core directly to the Industrial Ethernet IP Core.
With its proven lean application interface, Softing's solution also supports the described implementations for integrating the different Industrial Ethernet protocols.

Parallel TCP/IP channel
A key advantage of using Industrial Ethernet protocols is that they allow parallel transmission of standard IT data over the same cable and the same Ethernet interface in the device. Softing's solution therefore supports a transparent IT channel that can be used, for example, to access device data over the Internet or to download data.
For instance, a customer uses the TCP/IP channel on a System-on-Chip (SoC) module that integrates an ARM processor in addition to the FPGA components. In this implementation, the Switch IP Core was extended by an additional internal port connected directly to the integrated Ethernet MAC of the ARM processor. The result is a compact device that provides the full functionality in a single module and thus cuts hardware costs.
Other scalability options offered by Softing's solution include the distribution of the overall functionality to multiple processors and the use of different external hardware interfaces.
Frank Iwanitz, product manager for Industrial Ethernet, sees clear benefits to customers through the use of a scalable solution: "The use of FPGA technology offers all degrees of freedom for the implementation of an Industrial Ethernet field device. Thanks to the supported flexibility of our solution, the implemented functionality can be tailored to the customer's individual needs and requirements. This saves resources and reduces costs."

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