Flexible Interface Implementation with FPGA

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To offer an automation device with different communication protocols, specific know-how of processors and interfaces is required, and that is rarely a core competency for device manufacturers. But there is an easier and more flexible way to implement communication interfaces – encapsulated in a universal FPGA.

Industrial communication technology has today become indispensable in automation systems. There is hardly a controller that does not connect its peripherals via fieldbus or Ethernet. The bus systems used can be very disparate depending on the part of the world and the task on hand. For this reason, the vendors of controllers, drives, I/O modules and sensors often need to offer a product in different versions with different communication protocols.

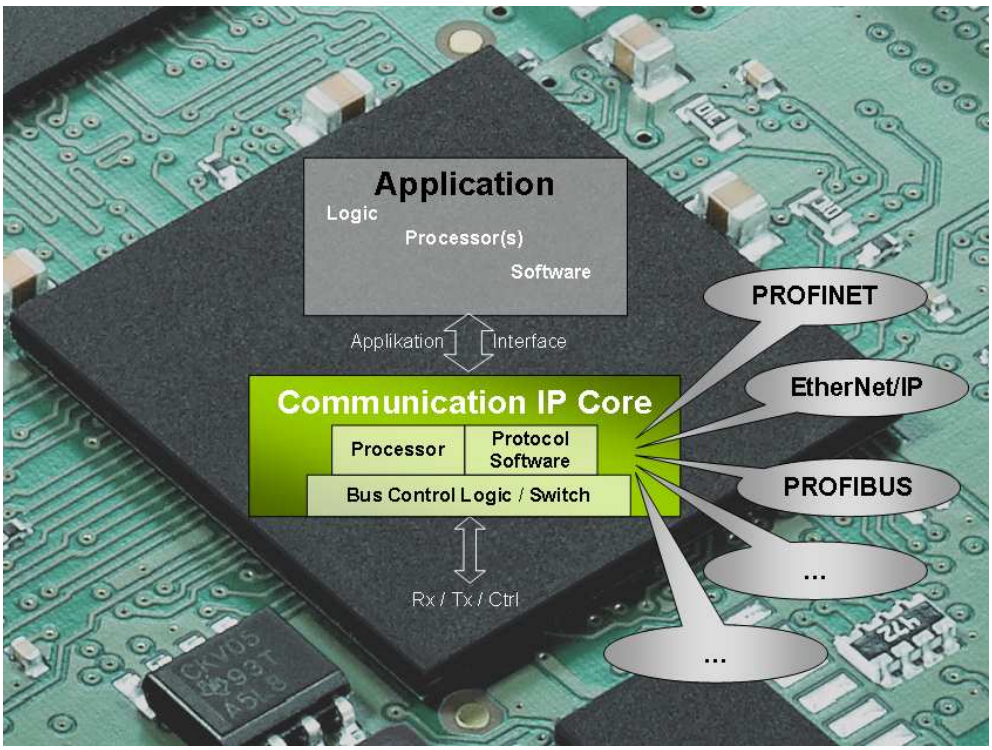

Fig. 1. *The appropriate communication protocol is simply loaded into the hardware*

This usually requires a broad know-how of the individual controller chips, and of their specific hardware and software interfaces. The issue is further complicated by the dependence on the manufacturer of these special semiconductors for which there is no second source of supply in most cases. Implementing the communication interface as an encapsulated IP component in a universal FPGA (Field Programmable Gate Array) alleviates these problems and offers many additional advantages for the entire life cycle of a product.

Protocol diversity makes life difficult for vendors

Ethernet has long been advocated as a means to supersede classical fieldbuses. But while the share of Ethernet based solutions is rapidly growing, the majority of applications continue to use fieldbuses. The Ethernet environment today is made up of many competing and mutually incompatible automation protocols. As a result, the manufacturers of automation components are forced to maintain existing products with fieldbus interfaces for a prolonged time because quantities are still attractive. At the same time, however, they need to add different industrial Ethernet protocols.

Vendors often have an excellent technical know-how of the device functionality that distinguishes them from competition.

Know-how in communication technology, however, is not part of their core competencies in most cases. As there is no unified hardware architecture and the software interfaces are not standardized, it is a major challenge for vendors to deal with the wide diversity of different protocols and the costs involved in their implementation. In addition, even a product variant that has been offered for years can lead to new costs today if essential components are discontinued.

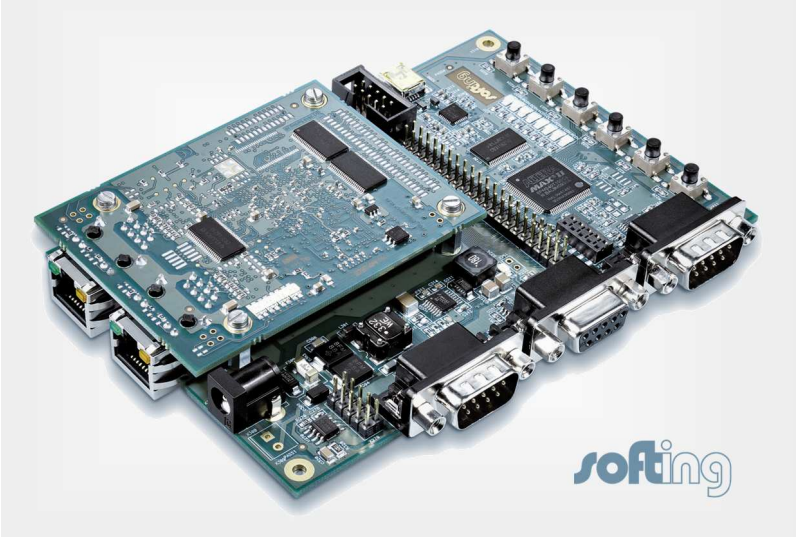

Fig. 2. *Device application and communication are quickly integrated with Softing's Evaluation Kit*

FPGA as a universal solution

To resolve this issue, various vendors provide compatible communication modules for the relevant protocols. This involves a number of tradeoffs, however. The unit costs and space requirements are significantly higher than with an integrated solution. The approach also ties users to a specific hardware format and to the architecture used by the supplier.

FPGA based solutions are much more flexible. FPGAs use loadable IP cores (Fig. 1) that contain both the communication controller – i.e. the hardware for bus access – and the software stack for the required protocol variant. The stack runs on a soft core processor that is also loaded into the FPGA and is specially customized for the communication controller. All the device manufacturers have to do is interface their application data with this communication interface. This eliminates the need to port the entire protocol stack to a separate processor platform, as is required for integrated solutions.

IP cores basically deliver all the benefits of the above standardized hardware modules – without the drawbacks.

As different IP cores can be loaded into an FPGA, this approach reduces the number of hardware variants that need to be kept available. In addition, extensions to the specifications, such as hard real-time operation of Ethernet systems, can be added even to finished designs at any time. The desired protocol is simply loaded into the hardware either before shipment or at the end user's site.

Another aspect to be considered is that classical fieldbuses like Profibus or DeviceNet need a different bus connection than Ethernet. But even in this respect, FPGA based solutions simplify the implementation because only the bus transceiver and the connection technology need to be customized. This task is significantly less complex than developing several complete fieldbus interfaces.

Rapid implementation through IP cores

The advantages of an FPGA solution become even more apparent when more than one protocol is to be implemented. From a communications expert like Softing [1], the device manufacturer can obtain all the required IP cores. As they have a standardized software interface, they make the device application independent of the selected protocol. In other words, it only has to be implemented once. Softing currently offers IP cores for PROFINET, EtherNet/IP, EtherCAT, Modbus/TCP and PROFIBUS, and others will follow. With the Evaluation Kit (**Fig. 2**), users can start developing their applications straight away – regardless of whether completely new hardware is to be developed or whether FPGA based plug-in modules from Softing are to be used. The module's circuit diagram can be used as a template for custom hardware developments without any limitations.

Long-term availability

A key criterion in design decisions is the availability of the components. Classical communication ASICs are special components for which there is often only a single source. Some of them have been on the market for many years. In these cases, supply bottlenecks for these niche products or product discontinuations directly jeopardize the availability of the devices in which they are used. FPGAs, in contrast, are universal mainstream components that are manufactured and distributed in large quantities. Continued product maintenance and improvement is thus of vital interest to FPGA vendors. The price-performance ratio is

continually improving and the advances in semiconductor technology are rapidly translated into practice. Connecting an aged communication ASIC in 5V technology to a state-of-the-art CPU today requires a level shifter and a dedicated shared RAM interface. The FPGA solution, in contrast, provides the appropriate signal levels and supports various current storage technologies. This saves space and cost. In addition, this solution offers the possibility to accommodate not only one or more communication channels, but the entire device logic plus the application processor in a single FPGA.

This makes FPGAs ideal for communication solutions aimed at long-term availability. Even if, due to a better price-performance ratio, a newer generation of these components is to be used later, there will be no significant changes to the IP core. As a communications expert, Softing sees its primary task in further expanding the already wide base of supported FPGA types and in integrating new specifications into the IP cores. Partnerships with Altera, Xilinx and Kontron demonstrate Softing's commitment in this area. For device manufacturers, this means that they can always offer a state-of-the-art product, simplify their logistics and, at the same time, minimize the complexity, risk and cost of their bus interfaces.

Bibliography

[1] Softing Industrial Automation GmbH, Haar, Germany: www.softing-ia.de

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