The PLCcore Concept Whitepaper

Abstract

This article is aimed at OEM engineers and decision makers who plan to develop or are involved in development of own control systems or controllers. Here we introduce an alternative approach using Commercial Off-the-Shelf (COTS) hardware with pre-integrated software components.

When Developing Modern Control Systems…

… engineers have to face various, sometimes even contrary challenges in terms of time, cost and customer requirements. As an embedded engineer, it is often your duty to complete projects under severe time constraints. Given this task, how can you proceed from concept to specification, prototype and final product with maximum efficiency and design integrity? In other words, how to meet best the time and cost objectives while ensuring the best quality of your embedded design? Rather consider buying Commercial Off-the-Shelf (COTS) hardware and software components than dedicating in-house resources for developing and integrating the controller hardware or communication software from scratch.

SYS TEC electronic GmbH offers a generic insert-ready controller core module – the PLCcore – that combines hardware key components, such as CPU, memory and communication interfaces with an industry-grade operating system software and IEC 61131-3 PLC runtime kernel with integrated CANopen and Ethernet communication.

Reduce Time-to-Market, Save Costs, Minimize Design Risks

Applying the principle of cost accounting, the actual costs of a development are not limited to direct material, but also include the costs and time needed for parts procurement, design, production, test, software and operating system adaptation, as well as support.

On the PLCcore, all hardware and software key components are already integrated for instant operation. From the target-optimized operating system down to the I/O driver.

Development issues and associated costs do not end with the manufacture of your microprocessor circuitry. Test, support, recurring license costs, warranty and maintenance are downstream issues that must be considered as well.

Implementation based on a SYS TEC PLCcore module removes these costs and risks from your design cycle and therefore reduces the development time and cost significantly. Even if your material costs are less than the price of a PLCcore subassembly in OEM quantities, amortizing all costs and design risk - including opportunity costs - over the quantity built yields the true cost of your development.

Considering the savings in license costs that usually apply for a conventional IEC 61131-3 PLC runtime solution, SYS TEC PLCcore modules are cost-effective even at higher quantities and represent a very attractive entry point cost and ramp-up option for new embedded designs.

No License Cost

As the PLC runtime system is already integrated on the PLCcore firmware, no extra license cost apply when selling final products that incorporate the PLCcore. You can also provide the IEC 61131-3 Integrating Development Environment for the PLCcore to your end-customers free-of-charge. Thus, using the PLCcore as a base for your controller design eliminates the need for acquiring extra development and resale licenses for the PLC runtime software.

Insert-Ready 32-bit Hardware Platform

Designing your own controller hardware is a tough job. After finding the right microcontroller platform, you might spend weeks in specification, parts procurement, complex schematic rendering and layout of your own microprocessor circuitry. Forgo the need to build and test prototypes, followed by redesign iterations needed to yield hardware ready for production.

The PLCcore modules are optimized for OEM deployment. Its hardware addresses the key challenges by quality assurance; hardware and software design requirements, as well as supply and product maintenance issues.

Its compact form factor, increased pin package and multi-layer design improves EMI (Electro Magnetic Interference) characteristics and allows the use of these modules in an even wider spectrum of user target hardware environments, including high noise environments.

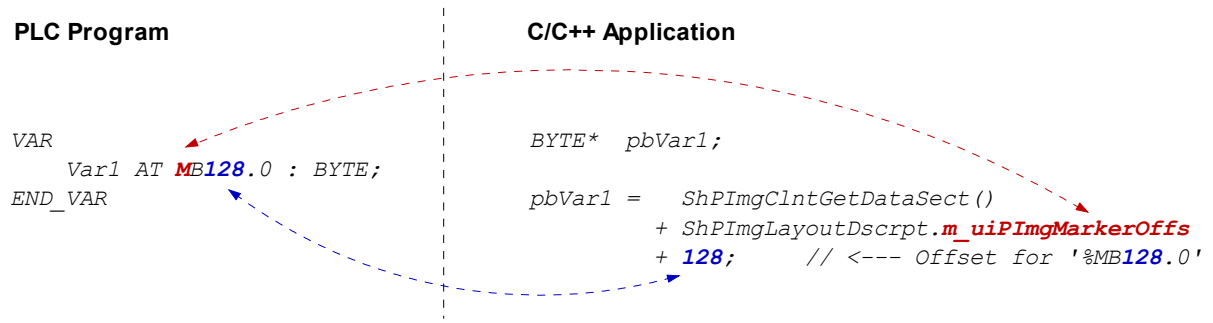
All PLCcore modules are available for use in an industrial temperature range from -40˚C to +85˚C and have gone through extensive climatic and mechanical tests.

Integrated Fieldbus Communication

The PLC runtime kernel on the PLCcore supports access to a range of on-board communication ports, such as UARTs, Ethernet and CAN through a set of IEC 61131-3 function blocks. The PLC runtime kernel incorporates a fully functional and seamlessly integrated CANopen manager. The included CANopen Configuration Manager further provides for automatic configuration of remote CANopen devices from DCF (Device Configuration Files). The CANopen Manager also provides function blocks for network management, node monitoring and error control. Alternatively, the PLCcore can operate in CANopen slave mode, where full manager functionality is not required.

Process data communication to remote devices is kept as easy and transparent as possible. Data is mapped to so-called network variables. The PLC program accesses remote data as simple as local variables. CANopen handles the assignment and translation of network variables into the corresponding PDOs completely transparently and takes care of the actual data transmission according to the configured communication parameters. This provides an extremely convenient way of I/O communication without any need to care about the communication issues itself. Network variables are dynamically created from the DCF resulting from the CANopen network configuration process. Network variables are scalable. The number of variables may grow with the amount of process data you wish to communicate via CANopen.

Your advantage: A standard compliant CANopen manager is already integrated for instant use. You do not need to consider spending extra resources on separate CANopen protocol stack software.



Operating System Support

The PLCcore is backed by an underlying Linux operating system, which was optimized in terms of performance and reliability to meet the enhanced requirements of industrial embedded systems. The pre-installed Linux also includes a Webserver, FTP server and Remote Access Console.

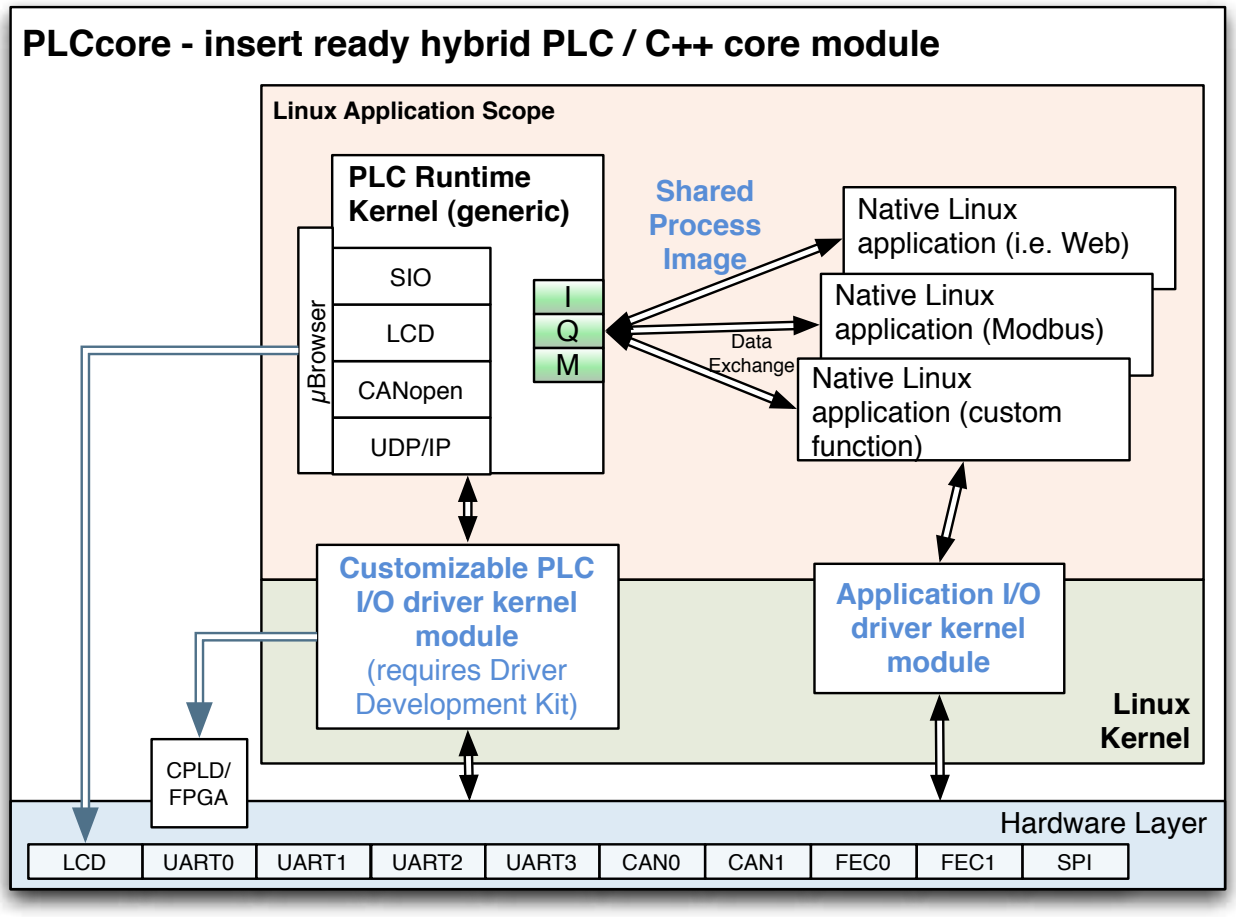
The PLCcore not only allows for execution of PLC programs, but also supports simultaneous execution of Linux native binary executable, such as the included webserver or user-written application processes. To maximize the synergy between both "worlds", the so-called Shared Process Image API is included with the PLCcore Development Kit to allow for data sharing between the PLC and native Linux applications (see Shared Process Image below).

Shared Process Image

The PLCcore provides OEM with an extremely flexible and efficient way to integrate own, vendor-specific functionality without the need of altering the PLC runtime software itself.

We have made a part of the PLC process image available for accessing from native Linux applications, thus providing an easy means of data sharing comparable to a dual-ported RAM. - The so-called Shared Process Image can be used to move extensive computations, such as complex control algorithms, encryption, or data visualization out of the PLC program scope into the operating system level. Using the Shared Process Image for implementing manufacturer-specific functions are not necessarily visible to the end user and by this means also protect your Intellectual Property.

Vendor-specific key functionalities, functions or communication protocols can now be implemented in standard C/C++ environment, provided as binary on the PLCcore. The Shared Process Image is delivered including a demo application with accompanying sources and project files.



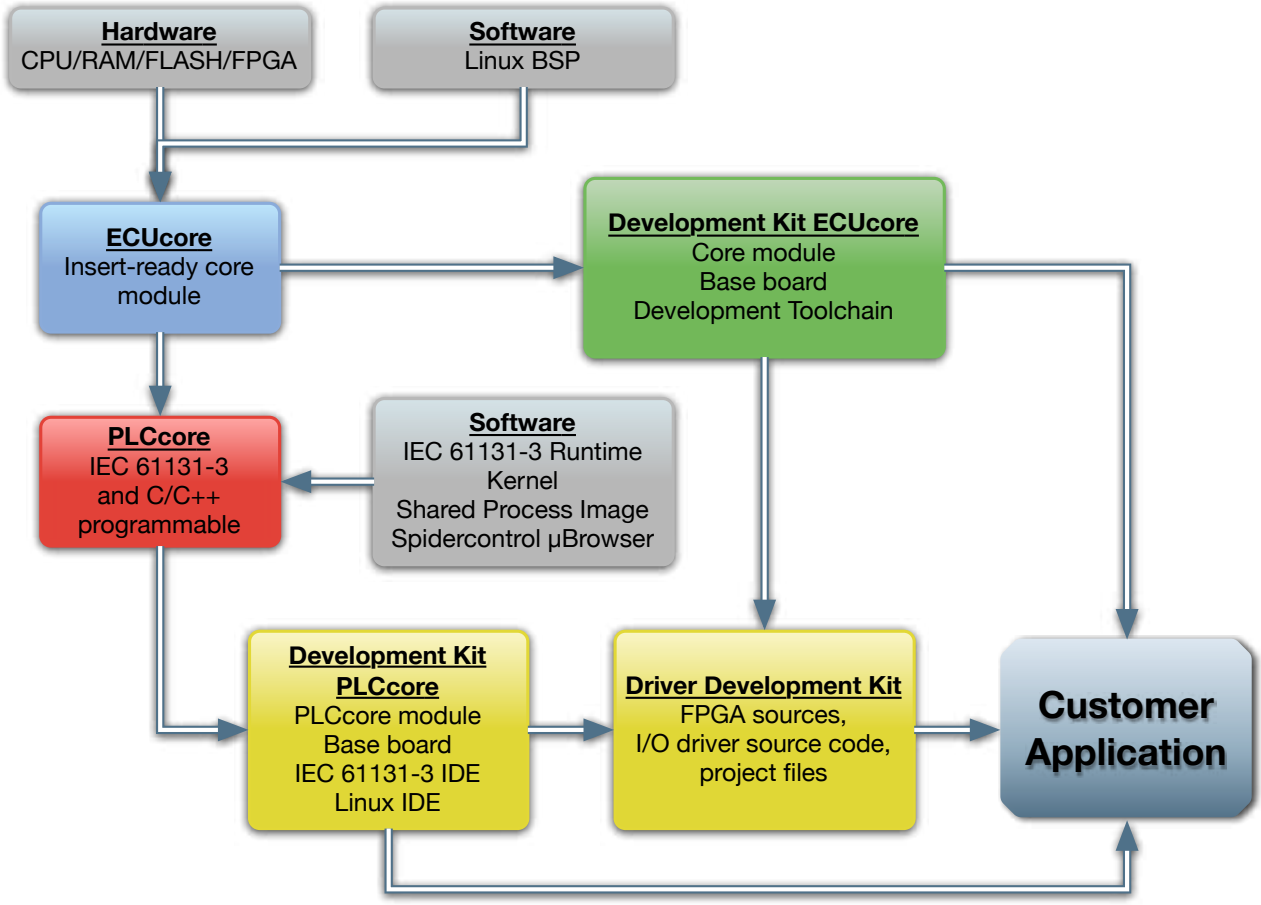
Fully Customizable I/O driver – Shared Process Image

The I/O driver is the key to the I/O functionality provided on the application carrier board. These can be digital I/O, analog I/O, or even more complex circuitry connected via SPI. On the PLCcore the I/O driver is a runtime loadable object. So when changing to a new carrier board you just need to replace the existing I/O driver on the PLCcore with a new one that matches with your new carrier board. No modification on the operating system or PLC runtime kernel itself is required.

The possibility of changing the I/O driver by the user makes the PLCcore a truly generic OEM solution and allows for developing a diversity of products based on one unique base technology.

To customize the I/O driver SYS TEC offers a special software package that includes the sources, documentation and tools required for own driver development – its called Driver Development Kit (DDK). The combination of PLCcore Development Kit and Driver Development Kit includes the hardware, software and reference projects necessary to create own I/O driver kernel modules and download CPLD/FPGA firmware to the PLCcore. The Driver Development Kit includes the VHDL source code for the on-board CPLD/FPGA . You may use this VHDL function library to realize high-speed and time-critical I/O, such as timers, counters or PWM on the CPLD/FPGA.

With the Shared Process Image, accessing PLC variables from within a native C/C++ application becomes as easy as accessing a local variable. To avoid unnecessary data copying, the user can easily register data of interest only. The implemented locking and synchronization mechanisms prevent inconsistencies when accessing data. By this means, even multiple native C/C++ application may read or write data on the Shared Process Image simultaneously.



How To Get Started – The PLCcore Development Kit

The PLCcore modules were designed to be plugged onto applicable carrier boards. Both the module and carrier board are included in the PLCcore Development Kits. The carrier board contains the connectors required for immediate start-up of the module, as well as other interface circuitry not provided on the PLCcore module itself. The PLCcore, when mounted on the carrier board, provides an excellent platform with which to evaluate controllers, develop software, as well as to specify and determine the feasibility of new embedded designs.

The PLCcore Development Kits also include the OpenPCS IEC 61131-3 Integrated Development Environment. You use OpenPCS to implement and debug applications executed by the PLC runtime kernel. OpenPCS supports all five IEC 61131-3 programming languages (IL, ST, FBD, CFC, SFC), has powerful debug features (variable watching/forcing, single step/cycle, breakpoints), allows for integration of CANopen network communications and includes an OPC server.

Besides OpenPCS, the PLCcore Development Kit comes with a ready-to-use development environment for C/C++ application development, pre-installed on a VMware virtual machine. The player required to start the virtual machine is available free of charge . The provision of virtual machines for application development provides a number of advantages to the end-user. Installation of new software on your development PC is reduced to the VMware player. Installation of the PLCcore development environment and related project files is not necessary and therefore eliminates a number of possible pitfalls for new users. You can easily keep a working copy of your virtual machine for backup. In case of data loss you can switch to your backup virtual machine and you'll be productive again in no time.

Getting The Whole Picture

To support your product development we provide you with various Development Kits that offer all you need for instant start-up. The picture below illustrates the product chain starting from basic hardware and software to the final customer product, including the available development kits.

Beyond The Module - Customer Oriented Services

At order quantities as low as 100 units, SYS TEC can customize board configurations on a component level - such as removing unnecessary components and scaling memory densities - to meet your cost objectives and technical requirements best.

The carrier boards included in our Development Kits can also serve as a reference design for the customer target hardware in which our modules are deployed. Carrier board schematics are included in the Development Kits. Further design material, such as Bills of Material are available under a Non Disclosure Agreement (NDA).

Beyond the commercial-off-the-shelf SBC modules SYS TEC offers additional design services:

- design and manufacture of a custom carrier board for your end application
- development and manufacture of a "flat" board design in which our core circuitry is integrated onto a single PCB, rather than a two PCB solution consisting of an off-shelf SYS TEC module on a carrier board
- specification, implementation and integration of additional software components; such as device or I/O drivers, operating system adaptations or communication layer software components.

For very high volumes, please feel free to discuss with us a one-time, royalty-free design license buy-out of the PLCcore circuitry in the form of schematics and Bill of Material for unrestricted use in your own embedded hardware development. Contact our experts if you need more information on possibilities of software licensing.