Ready-to-go hardware/software subsystem for Ethernet Powerlink

by Peter Duchemin, Smart Network Devices

SMART NETWORK DEVICES IS EXPEDITING THE SUCCESS OF ETHERNET POWERLINK (EPL) WITH A READY-TO-GO EMBEDDED EPL COMMUNICATION MODULE BASED ON THE NEW HYPERSTONE HYNET32XS CPU AND SND'S REAL TIME OPERATING SYSTEM HYNETOS.

Ethernet Powerlink (EPL) is an open and licence-free industry standard in industrial automation. This technology requires no special Ethernet controllers or special Ethernet hubs for node interconnection, but it uses a sophisticated time-slice protocol based on a master/slave software architecture instead. Most industrial automation component manufacturers considering adapting their products to the new EPL technology will be interested in reaching a fast time-to-market in order to secure or even expand their market shares. What could consequently be better than to find all interface hardware components, all the complexity of the related protocols and all real-time requirements realised in a tiny hardware module that can easily be integrated in any kind of industrial automation device? This is exactly what Smart Network Devices (SND) can offer with the "EPL Unit", a complete and self-contained hardware/software subsystem realising the Ethernet Powerlink interface according to V 2.0 of the standard.

The heart of SND's EPL unit is the new hyNet32XS CPU from Hyperstone. This embedded technology combines almost all necessary hardware parts on one single chip. Based on the 32-bit RISC/DSP CPU core in 18 micron technology, Hyperstone integrated two 100 Mbit/s Ethernet MACs and one 100 Mbit/s Ethernet PHY on one single semiconductor die. The hyNet32XS furthermore integrates a large number of additional interfaces such as 2 configurable and buffered SIO engines (SSI, SPI, I2C, UART) with up to 40 Mbit/s data throughput, a USB interface, a CAN bus interface as well as the possibility to drive ATM buses and PCMCIA cards (see figure1).

Probably the most important feature of the hyNet32XS CPU is the integrated memory. A 16 KB ROM area will host a bootstrap loader software able to boot the actual operating code from a remote file server over Ethernet and TCP/IP. This makes even a local flash memory obsolete, while this option still remains available. The ROM code, which per definition cannot be overwritten, furthermore ensures that any circuit built on this CPU is fail-safe from erroneous flash or EPROM memory overwrite. Even a blank flash or EPROM memory can be programmed in-circuit. Next an internal 64 KB shared memory area is used as buffer for fast block transfers from any of the Ethernet MACs to the CPU and vice versa or for inter-MAC bridging. Finally an internal 128 KB SRAM can serve as main memory.

For small operating systems such as SND's HyNetOS this amount of memory is sufficient to even make external SRAM or DRAM obsolete. Even better, there is a considerable speed advantage, since the internal memory can be accessed with a 32-bit-wide data bus without additional cost. And it can be attached with much smaller signal delays and load capacities than any external memory ever could. This allows single-cycle access up to 200 MHz CPU clock, which results in an access time of 5 ns and a data throughput of 6.4 Gbit/s. If the operating software is small enough to fit in 128 KB of SRAM, it is like running at cache-speed all the time.

One crucial feature of an EPL node is the ability to operate as an Ethernet repeater for other EPL nodes in order to be able to realise a line topology. In elongated assembly lines, as typically found in manufacturing plants, a star topology is not convenient since Ethernet cabling would be by far too expensive. To realise a line topology every EPL node needs two external Ethernet ports and one internal Ethernet port, thus a 3-port repeater is required. SND's EPL unit realises the repeater function on MII bus level right on the hardware module. The concept of SND's EPL unit is shown in figure 2. Both DRAM and flash memory are optional and needed whenever extended functionality is required. The existing controller system, which will most probably be the interface towards the EPL unit, can be connected over serial (SSI, SPI, I2C, UART, CAN) or parallel (FIFO, dual-port RAM) links. The EPL unit can be configured to work as EPL controlled node (CN) as well as

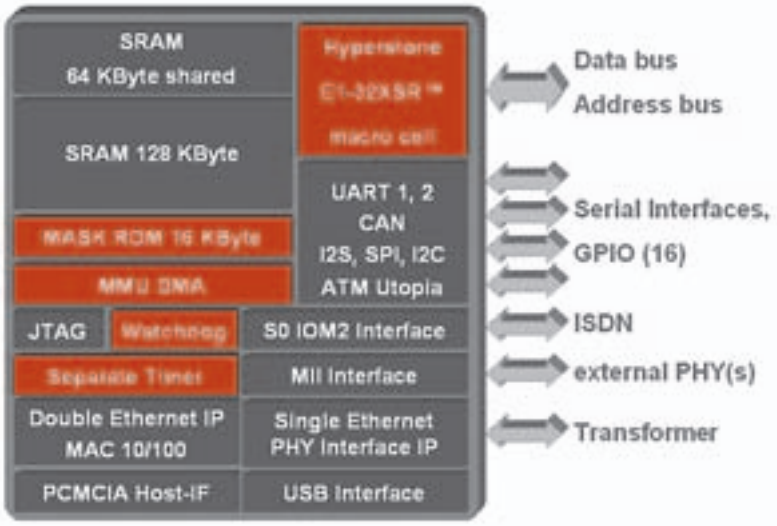

Figure 1. The architecture of the hyNet32XS communication processor from Hyperstone

EPL managing node (MN).

One of the main reasons to consider Ethernet as replacement for different field bus systems is of course to connect office computers and servers with the factory floor. The former have been operated with Ethernet and TCP/IP ever since and it comes without saying that the same standards apply for the communication of automation components. In this way configuration over web-browser, firmware updates via FTP file transfer and many more TCP/IP-based services become available. At application level EPL relies on CANopen structures (DS 301 or EN 50325-4). This simplifies the migration from CAN bus devices to EPL a lot. Application programmers can use the same device profiles known from CANopen also for EPL. Currently profiles are defined for I/O modules, drives and motion controllers, measuring devices and closed-loop controllers, encoders and hydraulic valves.

With SND's HyNetOS chosen as operating software for the EPL unit, not only a full-featured TCP/IP stack but also all necessary CANopen structures are available as a base for an Ethernet Powerlink protocol stack. Also the fact that HyNetOS is a purely asynchronous operating system is an advantage in terms of fast response time and high efficiency for EPL specific protocol processing. All the user needs are a few high-level API calls to control the EPL unit. The latter takes care of all complex TCP/IP and CANopen mechanisms, and necessary real-time requirements and parameters. The user can rely on compliance to the EPL V 2.0 specification and does not need to care about details from the same.

Also in respect of converting or bridging from CAN bus architectures to EPL architectures the combination of the new hyNet32XS processor and HyNetOS is the right choice. The interface versatility of the CPU combined with the flexibility and the small size of HyNetOS will result in very small and inexpensive conversion and bridging devices, which will facilitate the attachment of CANopen devices and legacy Ethernet devices (such as PCs) to EPL networks.

SND's HyNetOS is sold on a royalty base and the EPL units are available in any volume for serial production. However, should a specific hardware adaptation be necessary, hardware schematics can also be requested or modifications can be done as per the customer's requirements. Evaluation kits will soon be available and the official specification approval of both the EPL managing node and EPL controlled node are scheduled for Q2/2004. ■

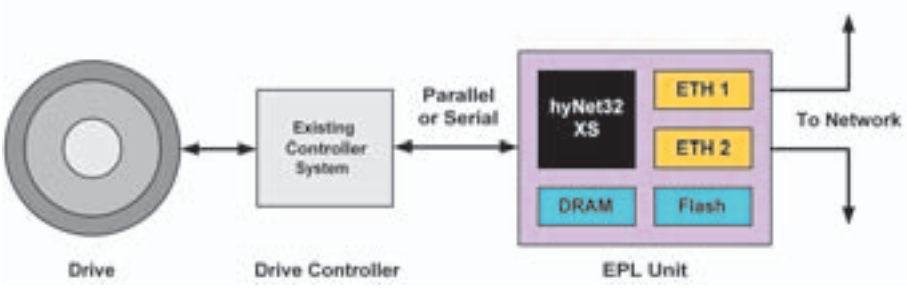

Figure 2. The concept of SND's EPL unit