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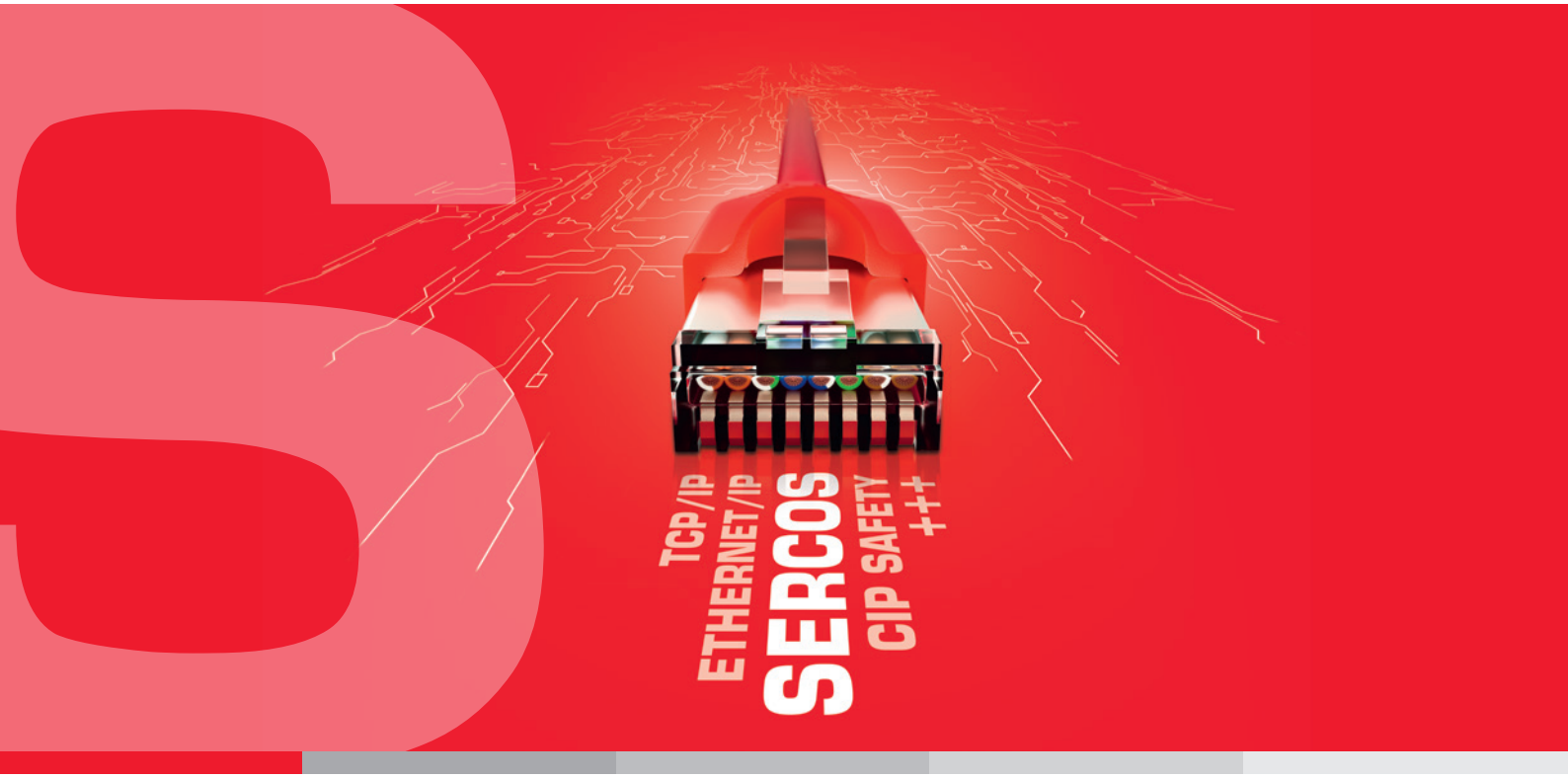

Sercos SoftMaster

Platform-independent Sercos III master implementation based on Open Source Software

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Sercos SoftMaster: Platform-independent Sercos III master implementation based on Open Source Software

	a) SoftMaster with Std. Ethernet Controller	b) SoftMaster with NIC-timed Controller	c) HardMaster with Sercos Hardware
Architecture	Application / Master Stack / CoSeMa / SoftMaster Core / RTOS Abstraction / Std. Ethernet C. (Std. HW)	Application / Master Stack / CoSeMa / SoftMaster Core / RTOS Abstraction / NIC-timed Eth.C. (Std. HW)	Application / Master Stack / CoSeMa / Sercos HW / Ethernet PHY (Spec. HW)
Compatibility	Sercos v1.3.x		
Min. cycle time *1)	Typ. 250 µs .. 1 ms	Typ. 125 µs	Typ. 31.25 µs
Network topology*2)	Line	Line, double line, ring	Line, double line, ring
UCC possible? *1) *2)	Slaves only	Yes	Yes
Network cascading	No	Yes	Yes
Packet jitter / slave synchronization*1)	Typ. 10 .. 60 µs / ~1 µs	< 100 ns / << 1 µs	< 100 ns / << 1 µs

*1) Depending on HW and RTOS platform
*2) Redundancy and UCC support are currently in prototype status
NIC: Network-interface controller, Std: Standard, HW: Hardware, CoSeMa: Common Sercos Master
RTOS: Real-time Operating System, UCC: Unified Communication Channel (e.g. IP transmission)

Figure 1: Sercos master implementation options

Sercos has been using time-triggered and time-slot based communication since the introduction of the technology in the late 1990s. Traditionally a specific Sercos® hardware was required to meet the strict timing requirements. Now, by using a Sercos III SoftMaster, a Sercos III master device can be implemented without a specific FPGA or ASIC. Instead, a standard Ethernet controller is used with the Sercos III hardware functions emulated in a host-based driver software. With this implementation approach, a sufficient real-time performance can be ensured for a large number of applications. If an Ethernet controller that supports Time-Triggered Send (TTS) is used (e.g. the INTEL i210™), a synchronization similar to that of a hardware-based master can be achieved (see Figure 1). The Sercos SoftMaster approach facilitates the use of an industrial PC without special fieldbus hardware and PCI slots to control the machine.

Implementation options

An individual standard Ethernet controller combined with a suitable real-time operating system is sufficient for all entry-level solutions requiring bus cycle times of >= 250µs and line topology and synchronization between the system components in the microsecond range (see Figure 1a). It is estimated that this applies to at least 50% of all applications. For medium to high synchronization requirements in the range of <100ns and bus cycle times >=125µs, the use of a NIC-timed Ethernet controller together with the suitable real-time system offers an excellent solution (see Figure 1b). If two of these Ethernet controllers are synchronized, the support of ring architecture with seamless redundancy is also possible, meaning over 90% of applications are covered. For all applications that have higher requirements in terms of bus cycle time, or for which the hardware and operating system platform requirements cannot be met, the conventional Sercos HardMaster solutions based on FPGA or netX controllers are still available (see Figure 1c).

Generic Ethernet mode vs. NIC-TIMED/TTS mode

In the generic Ethernet mode, the cyclic telegram transmission is triggered by an operating system timer. In conjunction with a data packet supply via raw sockets, operation with every Ethernet controller is hereby facilitated. However, the synchronization accuracy is reduced by the telegram jitter caused by this (see Figure 2a).

For higher performance in terms of synchronization and cycle time, the NIC/TTS mode is available. Here, the application provides the data packet to be sent well in advance in a prioritized queue and the Ethernet controller carries out the transmission at precisely the right time (see Figure 2b).

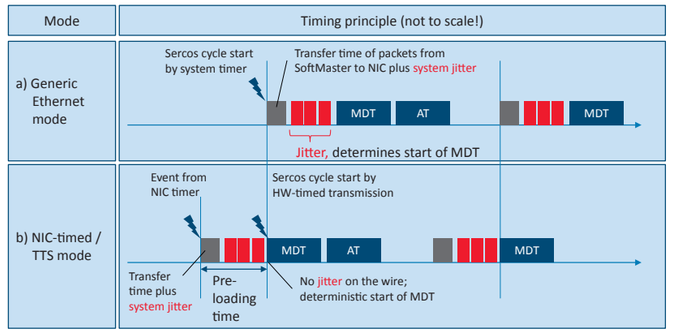

Figure 2: Generic Ethernet mode vs. NIC-timed / TTS mode

Advantages

The integration of Sercos SoftMaster technology enables machine builders, system integrators and control suppliers to reduce hardware components and costs, which is of great importance especially in the entry-level segment of production machines and automation applications.

With the availability of the Sercos SoftMaster implementation as open source, it becomes much easier for manufacturers to develop a Sercos III master and to benefit from future improvements and extensions of the software.

The implementation of a NIC-timed SoftMaster using Ethernet TSN hardware facilitates the migration from a conventional Sercos III master to a TSN-based Sercos III master supporting "Sercos over TSN".

Open Source availability

Over the past three years, numerous prototype systems at over 15 evaluating companies and organizations worldwide were equipped with the precursors to the SoftMaster software package. This enabled an extremely high quality level to be ensured by the release date. Despite the easy access to software technologies, many industrial users are nevertheless concerned that when using open source software in embedded systems, such as automation solutions, the applicable license conditions could force them to disclose their expertise. This aspect was taken into account with a conversion of the license model from LGPL (https://opensource.org/licenses/lgpl-license) to an MIT license (https://opensource.org/licenses/MIT). Thanks to the license model, potential uses offering approaches for a wide range of business models are open to all interested companies and organizations.

The operating system abstraction and a test application are available free of charge. The following operating systems are supported and systematically incorporated into the release tests:

- Linux PREEMPT_RT ("OSADL Linux")
- QNX Neutrino
- Windows CE/Embedded Compact
- TenAsys INtime
- IntervalZero RTX/RTX64
- Windriver VxWorks
- Linux (Standard Ubuntu 14 LTS)
- Windows/Windows Embedded Standard (with WinPCAP)

The ANSI-C implementation is kept completely platform-independent and can thus be adapted to every operating system and every platform, meaning the user is free to choose the operating system.

The open source software for master implementations (CoSeMa and SoftMaster core) can be downloaded from SourceForge:

https://sourceforge.net/projects/cosema
https://sourceforge.net/projects/sercos-softmaster-core

Operating system	Versions tested	SoftMaster Std. Ethernet	SoftMaster NIC-timed
Linux PREEMPT_RT "OSADL Linux"	2.x; 3.x; 4.x	+	+
QNX Neutrino	6.5	+	< in progress >
Windows CE / Embedded Compact	6;7	+	
tenAsys INtime	5.x;6.x	+	+
IntervalZero RTX /RTX64	2014	+	< in progress >
VxWorks	6.9; 7.0	+	< in progress >
(Std.) Linux	2.x; 3.x; 4.x	(+)*	- *
(Std.) Windows(with WinPCAP)	XP; 7	(+)*	-*

* Non-real-time only, i.e. typically only Sercos phase 2 reachable.
NIC-timed transmission support does not make sense.

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About Sercos International

Sercos International is an association of users and manufacturers that is in charge of technical development, standardization, certification and marketing for the Sercos automation bus. Conformance tests guarantee that Sercos implementations are standard-compliant, ensuring that devices from different manufacturers can be combined. Based in Germany, the organization presently has more than 90 member companies located around the world and has national liaison offices in North America and Asia.

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