



Deterministic Ethernet

for High-Availability, Safety-, and
Mission-Critical Systems

- Ethernet/IEEE 802.3
- ARINC 664 p7
- SAE AS6802 / Time-Triggered Ethernet

Key Offering

From lab to rugged to certified flight hardware

Switches

TTTech offers various switch solutions (LRM, LRU, 3U VPX, up to 24 ports) based on standard Ethernet, ARINC 664 p7 and Time-Triggered Ethernet. With up to 1 Gbit/s these switches enable the integration of standard, rate-constrained and time-triggered Ethernet traffic for mixed-criticality architectures like standard LAN, audio, video and critical controls in one network.



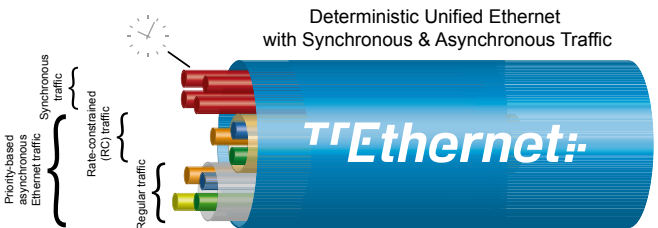
End Systems

TTTech offers ARINC 664 p7 and TTEthernet IP, PMC/XMC boards and middleware that can be used with commercial off-the-shelf solutions. VxWorks, QNX and Linux operating systems are supported. Chip IP is available for dedicated FPGA families.



Software Tools

The TTEthernet tool suite allows design, configuration, verification and validation of complex deterministic ARINC 664 p7 and TTEthernet networks. It supports full integration of customer-specific design process and tooling.





Key Capabilities

- Standard LAN and low-latency/ μ s-jitter applications in shared Ethernet networks
- Strictly Deterministic Ethernet, lossless operation, low-latency/ μ s-jitter
- Hard real-time and standard Ethernet communication for critical and highly available applications
- For automotive, energy, aerospace, process automation, robotics, medical, telecom, governmental applications, railway and other transportation applications

Features

- Synchronous (μ s-jitter/fixed latency) and asynchronous traffic
- Robust emulation of TDM communication in asynchronous IEEE 802.3 networks
- Robust separation of critical and non-critical data streams
- Distributed, fault-tolerant system clock; guaranteed Quality of Service (QoS) under multiple faults
- Dynamic release ($< 10 \mu$ s) of unused synchronous bandwidth
- Certification according to SIL 61508 and RTCA DO-254 (DAL A)

Ethernet LAN Compatibility

- Full compatibility with standard IEEE 802.3 Ethernet
- SAE AS6802 service added at OSI Layer 2 (network switch)
- No impact on existing UDP/TCP/IP and higher OSI layers and applications
- TTEthernet switch operates as IEEE 802.3 switch if SAE AS6802 service is not used
- Compatible with industry-specific Ethernet QoS enhancements (e.g. ARINC 664 p7)

What Makes TTTech Switches Unique?

1. TTTech switches support standard Ethernet, ARINC 664 p7 and inherently deterministic communication (time-triggered) and have been designed for safe and highly available real-time applications from the ground up.
2. TTTech switches provide support for system...
 - availability
 - safety and certification
 - scalable fault-tolerance
 - security and partitioning
 - soft to hard real-time operation
 - asynchronous and synchronous operation
3. TTTech switches are 100 % compatible with IEEE 802.3 Ethernet and COTS hardware. They integrate transparently with Ethernet networks.
4. TTTech switches enable convergence of hard real-time communication and standard Ethernet traffic in parallel on the same network.

Networks with TTTech's TTEthernet products simplify the design of fault-tolerant and high-availability solutions and support seamless concurrent engineering in critical applications.

Technical Specification

- 100 Mbit/s / 1 Gbit/s – optical or copper physical layer (any IEEE 802.3 compliant physical layer supported)
- Tight system synchronization
- Fault-tolerant distributed clock synchronization
- Cycle time: min. < 100 μ s (1 Gbit/s, 8 nodes), configurable cycle times
- Concurrent routing multiplies system data throughput (with 12 ports at 1 Gbit/s up to 24 Gbit/s), full concurrent line rate support on all lines
- Configurable speed conversion among 100 Mbit/s / 1 Gbit/s sub networks (buffered switch)
- Support for star incl. multi-hop and redundant stars; line and arbitrary tree

Key Benefits

TTEthernet products allow parallel use of standard LAN (Ethernet) applications in shared networks up to deterministic and robust hard real-time, high-integrity, highly available, fail-operational applications. Non-critical applications cannot influence operation of critical subsystems.

Modularity & Integration

- Modular and deterministic use of all computing/networking resources for non-critical and critical distributed functions
- Guaranteed integration due to 100 % determinism of the network
- Co-existence and integration of Ethernet, ARINC 664 p7 and Time-Triggered Ethernet

Scalability

- Scalable bandwidth: 100 Mbit/s, 1 Gbit/s
- Scalable network topology: star, line, tree, ring
- Scalable QoS and fault tolerance: single-, dual-, or triple-redundancy

Safety & Availability

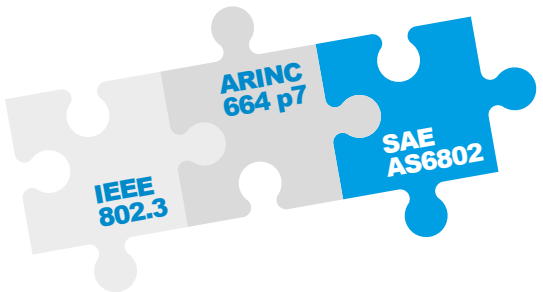
- Supports safety and redundancy at the network level without application involvement
- Replicated synchronous communication guarantees transmission of messages without switch-over or communication recovery delays
- Fully supports DO-297 certification standard

Security

- Supports secure operation in critical networks; less critical functions cannot impact highly critical functions
- Synchronization, partitioning and deterministic performance support secure operation
- Supports integration of MILS layers

TTEthernet Products

TTTech's TTEthernet product line uniquely integrates standard Ethernet (IEEE 802.3), ARINC 664 p7 and Time-Triggered Ethernet (SAE AS6802) into one networking solution for critical systems.



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