

TTE Protocol Layer

The Software-Based Node for TTEthernet

The TTE Protocol Layer is a software-based implementation of the TTEthernet protocol for a broad range of Ethernet applications. It can be used for real-time control applications, data acquisition or multimedia applications. Communication systems using standard Ethernet can be updated into a real-time Ethernet network by adding the TTE Protocol Layer to the system. It provides the services to the host application through its Application Programming Interface.

KEY FEATURES/BENEFITS

- Flexible and scalable system
- Constant communication latencies
- Bounded jitter with real-time OS, like RT-Linux.
- Low communication overhead for protocol control frames
- Interoperable with standard IEEE 802.3
- Modular structure, enables easy porting to other targets

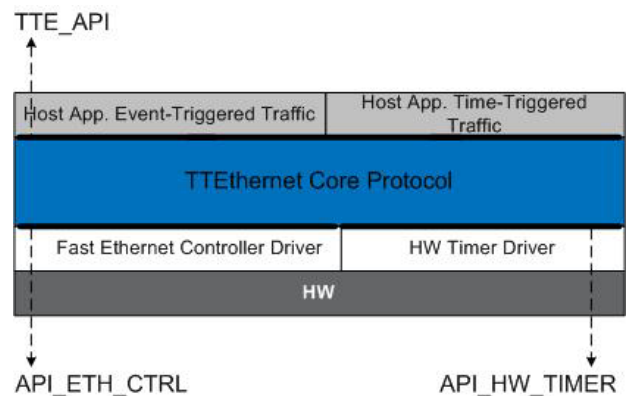
Integrating Real-Time & Non-Real-Time Traffic

The TTE Protocol Layer is compatible with the single channel configuration of the TTEthernet specification, and is being standardized as AS6802 by SAE International. The TTE Protocol Layer, when executed in a target with real-time operating system support such as RT-Linux, guarantees deterministic transmission latencies and bounded jitter for the real-time traffic class. In conjunction with the TTE Development Switch this solution enables integration of the real-time and non-real-time traffic in the same communication infrastructure.

TTE Protocol Layer Core

The TTE Protocol Layer is developed in a modular form. It consists of the TTE Protocol Layer core that has specified interfaces to the hardware resources (timer and Ethernet controller).

TTE Protocol Layer core is responsible for controlling the transmission of the time-triggered messages. Time-triggered messages are sent according to a predefined communication schedule.



Hardware and Operating System Independent

Schedule configuration files are generated by means of TTEthernet software tools. Non-real-time or standard Ethernet (best-effort) messages can be configured to be sent at any point in time when the medium is free of time-triggered messages. The TTE Protocol Layer core is hardware and operating system independent, and therefore can be easily ported to any computer that has a standard Ethernet controller and a programmable timer unit. Porting to a new target includes the development of the TTE Protocol Layer Timer and Ethernet driver for that target.

TTEthernet OS Driver for Linux

To support the usage of existing operating systems (OS) mechanism a TTEthernet OS driver is implemented and available. It allows execution of the TTEthernet based application in user space. The TTEthernet OS driver maps the best-effort message to a specific device driver and the real-time traffic class maps to another Linux device driver.

TTEthernet Services

The TTE Protocol Layer provides start-up, clock synchronization, deterministic message transport, configuration, and error handling as services to the host application.

Performance

The TTE Protocol Layer Core does not perform any copy operation over Ethernet frame buffers, resulting in a good performance with respect to memory usage and CPU utilization. CPU utilization depends on the communication schedule, as all communication activities are managed by one CPU. CPU utilization of 3 % is measured with a schedule that transmits 60 Mbit/s of real-time traffic with Intel ATOM IBX 530 PC.

Communication Speed

The TTE Protocol Layer Core supports 100 Mbit/s and 1 Gbit/s communication speed. The communication speed is a property that is implemented in the TTE Protocol Layer Ethernet driver.

Requirements

- CPU: > 80 Mhz
- Memory: > 20 KB for stack
- Memory for Ethernet buffer: Minimum 20 KB (depending on configuration)
- 1 standard Ethernet controller
- 1 programmable timer with timer interrupt
- No operating system or a real-time operating system

Features

- The TTE Protocol Layer is ported to various hardware platforms with different operating systems:
 - Freescale MPC855 (Embedded Linux) – 100 Mbit/s
 - Intel ATOM IBX 530 with Realtek Ethernet controller (Real-Time Linux) – 100 Mbit/s and 1 Gbit/s
 - Asus Eee PC with Attansic Ethernet controller (Real-Time Linux) – 100 Mbit/s
 - Standard Intel based PC with e1000 Ethernet controller (Real-Time Linux) - 100 Mbit/s
 - Freescale Coldfire 5275 (No operating system) – 100 Mbit/s
 - Powerquicc II with MPC8260 (ENE A OSE) – 100 Mbit/s
 - PICO821 Pico-ITX SBC with power Intel Atom Processors and Realtek Ethernet controller – 100 Mbit/s
- Clock synchronization precision of 20 µsec on Intel ATOM with Real-Time Linux.
- Single-channel communication
- Master/slave synchronization compatible to TTEthernet specification
- Relatively low CPU utilization

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