TTTech

TTESwitch Lab Space

User Manual

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- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/ TV technician for help.

NOTICE:
Changes or modifications made to this equipment not expressly approved by (TTTech Computertechnik AG) may void the FCC authorization to operate this equipment.

Standards Compliance

The TTE-Switch Lab Space conforms to the following standards:

- **Directive 2014/30/EU (EMC Directive)**
  - EN 55032:2015 – *Electromagnetic compatibility of multimedia equipment – Emission Requirements*
  - EN 55035:2016 – *Electromagnetic compatibility of multimedia equipment – Immunity Requirements*
- **Directive 2014/35/EU (Low Voltage Directive)**
  - EN 62368-1:2014 – *Audio/video, information and communication technology equipment – Part 1: Safety requirements*
- **Directive 2011/65/EU (ROHS)**
  - EN 50581:2012 – *Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances*
- **Directive 2012/19/EU (WEEE)**
- **FCC Title 47, Part 15B**
  - *Unintentional Radiators*

Typographic Conventions

Element	Typographic format	Example
Source code examples, parameters, file names, directory and path names	`Courier new`	`tt_start_OS;` `C:\TTTech\TTPos\`
GUI menu names and entries	**Boldface**	Click **File** and then **Open** to open the …dialog.
Keyboard keys, GUI buttons	Keystroke symbols	Click OK or press Enter to confirm the settings made.
Command-line interface commands	`Terminal`	`ls -l /dev/null`

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Important Notice

General	The TTE-Switch Lab Space is a non-repair item except for the fuse.

Handling	Only carry the TTE-Switch Lab Space by holding its carrying handles.

Modifying	The TTE-Switch Lab Space shall **not** be opened and the screws shall **not** be loosened.

Hardware Setup

Required Hardware

Several components are needed to get the TTE-Switch Lab Space installed in a rack. The following list shows which of these components are included with the switch and which are not.

- Screws and fasteners for rack mounting – *tbd*
- Ethernet cables – *not included*

Installation Instructions

Compatible Hardware

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1 Introduction

The TTE-Switch Lab Space is a 25x Ethernet port switch based on the TTE-Controller HiRel (TT6802-2-SW-B) and serves as a development platform for TTEthernet.
TTEthernet is a fault-tolerant real-time communication protocol for safety-relevant systems that makes it possible to conveniently configure the deterministic processing of **critical** Ethernet traffic (time-triggered, ARINC 664 P7 [1]) and **non-critical**, standard Ethernet traffic (IEEE 802.3 [4]) in one physical infrastructure.

Switching Function

The TTE-Switch Lab Space is a high-performance deterministic Ethernet switch and provides 25 Ethernet ports in total:

- 6x 100/1000 Mbit/s ports
- 19x 100 Mbit/s ports

These ports can also be used to monitor traffic. The TTE-Switch Lab Space has built-in mechanisms for traffic policing and fault isolation.

Virtual Links and Protocol Support

The TTE-Switch Lab Space allows configuring up to 4096 virtual links (VL). Virtual links can be configured with 8 priorities and a **bandwidth allocation gap (BAG)** of 0.5 ms to 1600 ms. The network configuration is stored in the non-volatile memory of the switch (256 Mbit). It is optionally possible to configure IEEE 802.1Q VLANs. Profiled IP/UDP, redundancy management, and traffic shaping are implemented in hardware.

Data Loading and Diagnostics

The TTE-Switch Lab Space features an integrated CPU for management. Switch management relies on SNMP. Data loading is possible through TFTP.

2 Overview of the TTE-Switch Lab Space

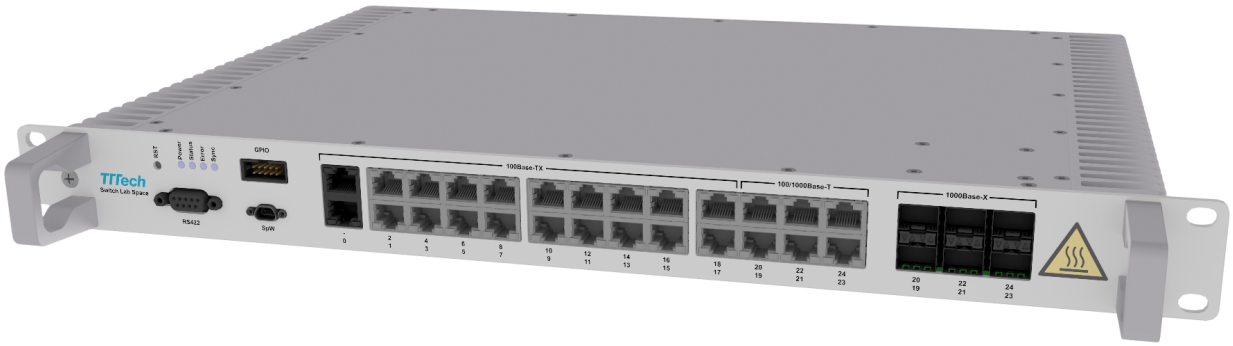

Figure 1: *The TTE-Switch Lab Space*

2.1 Identification

Each TTE-Switch Lab Space has a label at its rear that provides the following information:

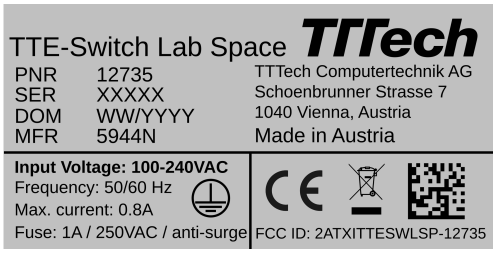

Figure 2: *Product identification label*

- Product Name: TTE-Switch Lab Space
- PNR: Part Number
- SER: Serial Number
- DOM: Date of Manufacturing
- MFR: Manufacturer
- A data matrix with the product serial number on the bottom right.

2.2 External Interfaces

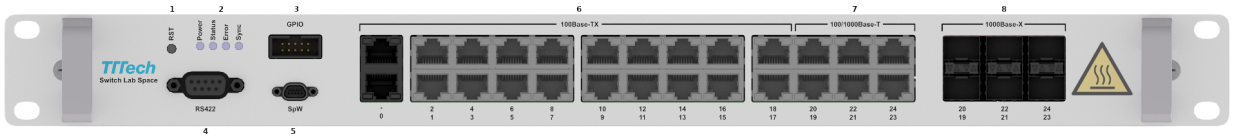

Figure 3: *Front view of the TTE-Switch Lab Space*

1. Reset
2. 4 status LEDs on the front panel (Power/Status/Error/Sync)
3. GPIO
4. RS-422 serial interface (can be used for debugging and maintenance)
5. SpaceWire (can be used for debugging and maintenance)
6. 19 x 100 Mbit/s full-duplex Ethernet ports (100Base-TX via RJ45)

7. 6 x 100/1000 Mbit/s Ethernet ports (1000Base-T via RJ45)
8. 6 x 100/1000 Mbit/s Ethernet ports (1000Base-X via SFP)

NOTE The Ethernet port labeled **–** is not functional.

Figure 4: *Rear view of the TTE-Switch Lab Space*

9. USB connector (provides access to the DSU/UART1 interface)
10. JTAG connector for factory testing and programming
11. IEC 60320-1 C14 type power connector and a power button. The switch has an electrical fuse which protects the external power rail so that a failing switch does not cause the system power supply rail to fail. Both the power connector and the power button serve as disconnect devices.

NOTE Only connect the TTE-Switch Lab Space to a socket-outlet that features a grounding wire.

2.3 Functional Features

The TTE-Switch Lab Space is intended as a development platform for TTEthernet and provides the following features:

- A high-speed deterministic network
- Rate-constrained traffic (fully compliant with ARINC 664p7 [1])
- Time-triggered traffic (SAE AS6802 [6])
- Best-effort traffic (IEEE 802.3-2005 [4])

The TTE-Switch Lab Space is mains-operated and is developed as rack-mounted electronic ground support equipment (EGSE) for TTEthernet development and as a functionally-representative demonstrator of space-grade components of TTTech Computertechnik AG's space products (i.e. Switch Controller Space and End System Controller Space).
Apart from the standard switch functions (including best-effort, rate-constrained and time-triggered Ethernet), the switch also includes support for the following utilizations:

- Access to a TTEthernet End System via SpaceWire using RMAP
- The possibility to access the UART0 interface for debugging purposes
- The ability to use physical layers other than the 1000Base-T via SFP module slots

2.3.1 TTEthernet Implementation

- 8 sub-schedules
- 8 clock synchronization masters
- 4096 virtual links
- Store-and-forward switch architecture

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2.3.2 ARINC 664p7 Implementation

- Policing, filtering, and switching engine for bandwidth control and traffic prioritization
- Integrity and error checking of frames
- 4096 virtual links with up to 8 priorities, with restrictions of their associated ports
- 4096 BAGs
- BAGs freely configurable from 0.5 ms to 1600 ms
- BAG configuration granularity of 100 µs
- Jitter and BAG resolution of 8 µs
- Support for ICMP (ping), SNMPv1 and TFTP dataloading
- Configuration data can be programmed through TFTP

NOTE Additional packaging material and additionally packed accessories, e.g. a mains power cord, may be part of the delivered product but are not considered to be part of the system in this document.

2.4 Physical Specifications

- 19-inch rack housing: 1 height unit
- Size: 346 mm x 483 mm x 44 mm

2.5 Power Supply

- AC voltage: 100-240 V, 50 to 60 Hz

2.6 Environmental Operating Ranges

- Operating temperature: 0 °C to +60 °C
- Storage temperature: -55 °Cto +85 °C

2.7 Standards Compliance

- **ARINC Specification 664P7-1**: The switch is fully compliant to ARINC 664 part 7 (deterministic Ethernet networking) [1].
- **IEEE 802.3™**-2005 (switching, flow control) [4].
- **IEEE 802.1Q™**-2011 [3].
- **IEEE 1588-2008** [5]: The switch supports the IEEE 1588 end-to-end transparent clock mode. The clock of the switch is not synchronized to the IEEE 1588 Master Clock.
- **SAE AS 6802** [6]: The switch supports the SAE AS 6802 network synchronization and start-up mechanism (fault-tolerant TTEthernet clock synchronization protocol).

3 Functional Description

This section describes the functionality of the TTE-Switch Lab Space.

3.1 Block Diagram

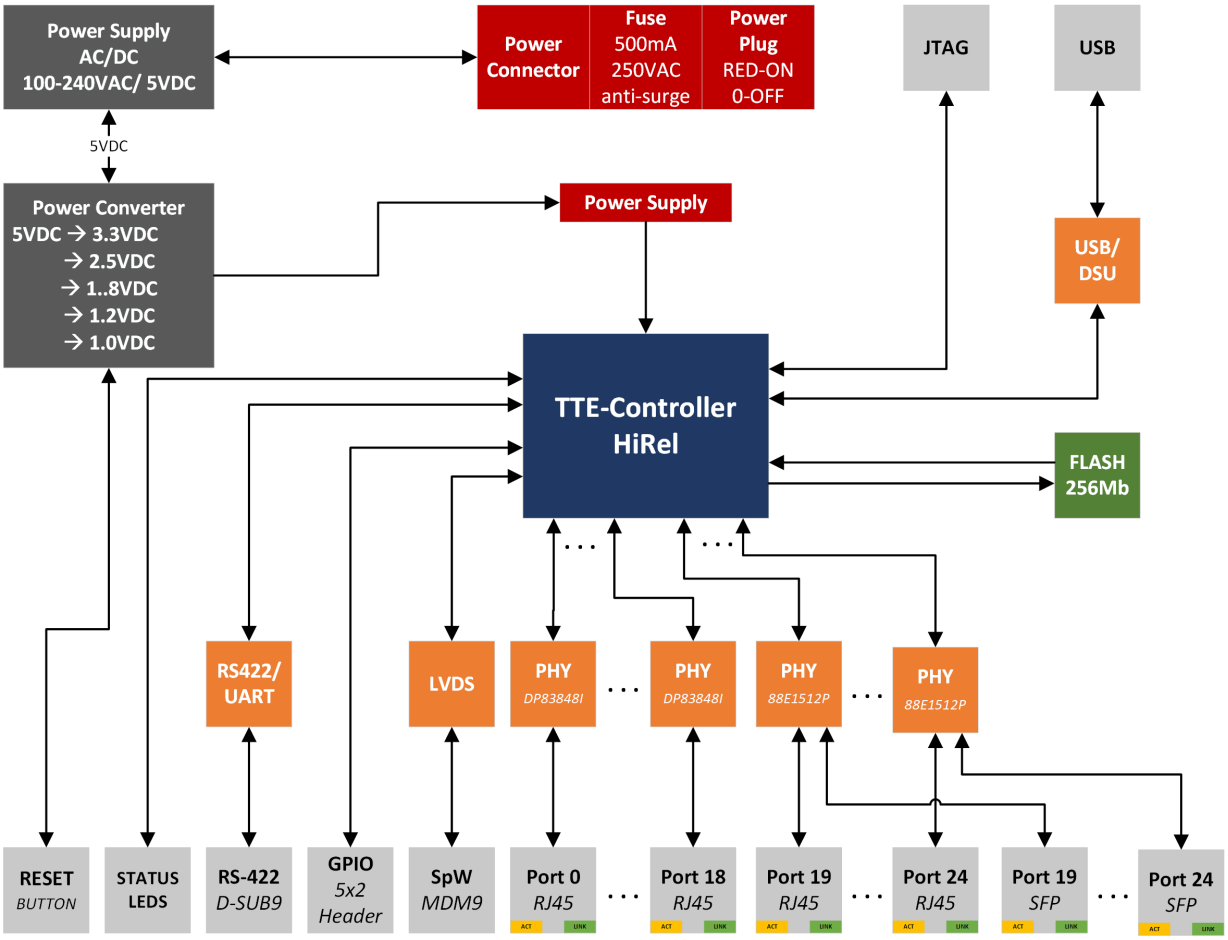

Figure 5: *Block diagram of the TTE-Switch Lab Space*

3.2 Interfaces

The TTE-Switch Lab Space features several interfaces that can be divided into networking interfaces, debug and maintenance interfaces, and human-machine interfaces. These interfaces are described in the following sections.

3.2.1 Networking Interfaces

This section describes the networking interfaces of the TTE-Switch Lab Space.

3.2.1.1 Ethernet Ports

Each Ethernet port (see Figure 3 on page 13) features two integrated LEDs: a **Link** and an **Activity** LED.

Port	Description
-	This Ethernet port is not functional.
0...18	General purpose, full-duplex RJ45 Ethernet copper ports configurable for 100Base-TX.
19...24	General purpose, full-duplex RJ45 Ethernet copper ports configurable for 100/1000Base-T.
19...24	General purpose SFP ports configurable for 1000Base-X, suitable to operate 1000Base-X-compliant SFP modules.

Table 1: *Ports of the TTE-Switch Lab Space*

NOTE

Each of the 1000Base Ethernet ports can either be used as RJ45 port or as SFP port, but not as an RJ45 and SFP port at the same time.

NOTE

Hot-plugging SFP modules (i.e., inserting a module during runtime) is only supported if the switch is configured to use the 1000Base-X ports. Otherwise, a reset is required to configure SFP modules.

Port LED	Description
	The Link LED illuminates steadily when a link is established with the connected internal end system.
	The Activity LED flashes when communication activity is detected (frame transmission or reception).
	No link and no activity detected.

Table 2: *RJ45 copper port LED status*

3.2.2 Debug and Maintenance Interfaces

The TTE-Switch Lab Space interfaces described in this section are not meant for static cable installations and serve for debug and maintenance purposes only.

3.2.2.1 GPIO Interface

The GPIO interface is used to access the GPIO interface of the TTE-Controller HiRel. This interface is used for general purposes as can be seen in Table 3 on the next page.
The GPIO pins (see Figure 6 on this page) are used to select which configuration will be loaded at boot.
When using a jumper between the pins 9 and 10, the default configuration is loaded. If no jumper is used, the user configuration is loaded.

Figure 6: *GPIO*

Pin No.	Feature	Description	Default
1	IRQ0	Internal end system external trigger 0.	Output high
3	IRQ1	Internal end system external trigger 1.	Output high
5	IRQ2	Integration cycle start interrupt.	Output high
7	NA	NA	Input

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Pin No.	Feature	Description	Default
9	Default/user configuration	When connected to GND, the default configuration is loaded. Otherwise, the user configuration is loaded.	Input
2,4,6	+3.3VDC	Pins connected to +3.3VDC.	–
8,10	GND	Pins connected to ground.	–

Table 3: *Pin assignment of the GPIO interface*

3.2.2.2 RS-422 Interface

The RS-422 interface (see Figure 3 on page 13) is used to access the UART0 interface of the TTE-Controller ASIC. This interface is used for debugging.
Connector type: 9-pin D-sub female connector. The control interface conforms with the RS-422 standards and enables connection to one of the COM ports of a PC using a serial 1:1 adapter cable (DB-9 connector to DB-9 socket). The settings are 115200 baud, 8 data bits, one stop bit, no handshake, no parity.

RS-422 Constraints

The cable length must not exceed 3 m.

Pin No.	Signal Name	Signal Type
1	RXD−	Receive data output
2	RXD+	Receive data output
3	TXD+	Transmit data output
4	TXD−	Transmit data output
5	GND	Ground
6	CTS−	Clear to send
7	CTS+	Clear to send
8	RTS+	Request to send
9	RTS−	Request to send

Table 4: *Pin assignment of the RS-422 interface*

3.2.2.3 SpaceWire Interface

The SpaceWire interface (see Figure 3 on page 13) is a host interface that is used to read and/or write all registers of the ASIC. The internal end system can be access by using the correct SpaceWire driver.

3.2.2.4 USB Interface

The TTE-Switch Lab Space provides access to the DSU/UART1 interface of the TTE-Controller HiRel through the USB interface (see Figure 4 on page 14). The USB interface is used for factory firmware programming.

3.2.2.5 JTAG Interface

The TTE-Switch Lab Space features a standard JTAG interface (see Figure 4 on page 14) on the back panel. The JTAG connector is used for factory testing.

3.2.3 Human-Machine Interfaces

This section describes the human-machine interfaces of the TTE-Switch Lab Space.

3.2.3.1 Power Button

The power button is located right next to the power connector on the rear panel of the switch (see Figure 4 on page 14). To turn on the power, press the power button into the I position.

NOTE

The power button also serves as a disconnect device.

3.2.3.2 Reset Button

The reset button (see Figure 3 on page 13) is recessed and can only be pushed with a thin tool, such as a pencil. This prevents that the reset button is pushed by accident. A long press of the reset button of approximately 10 seconds (the Status LED will light up green) will load the default configuration.

3.2.3.3 Status LEDs

In operation, the front panel LEDs (see Figure 3 on page 13) of the TTE-Switch Lab Space indicate the following status information:

Power	Status	Sync	Error	Description
●	○	○	○	The *Power* LED lights up green when the power supply of the switch is turned on.
●	●	○	○	The firmware is running without active TTEthernet synchronization. If the Default mode was selected, then the default configuration is loaded and the Status LED lights up green. If the User mode was selected, then the user configuration is loaded (see Table 3 on the facing page) and the Status LED lights up green only if the user configuration file is valid.
●	●	○	●	The firmware is running with active TTEthernet synchronization. If the Default mode was selected, then the default configuration is loaded. If the User mode was selected, then the user configuration is loaded. The Sync and Status LEDs light up green.
●	○	●	○	The firmware is running without active TTEthernet synchronization. No user configuration is loaded or the uploaded user configuration file has an error. The Error LED lights up red.
●	●	○	○	The debug support unit is active (e.g., during a firmware upload)”
●	○	○	○	The *Power* LED lights up red if the PCB registers excess voltage.

Table 5: *Front panel status LEDs of the switch*

3.3 Technical Data

3.3.1 Cooling

The switch is constructed for passive cooling only and can withstand an operational ambient temperature ranging from 0 °C to +60 °C.

NOTE

When the switch is used in environmental conditions with temperatures exceeding +45 °C, it is mandatory to mount the switch in a suitable rack to avoid the risk of burns or other personal injury.

3.3.2 Size

The TTE-Switch Lab Space complies with the IEC 60297 [2] standard and comes with a housing that takes up one rack unit (1U). Size: 346 mm x 483 mm x 44 mm.

3.3.3 Weight

The TTE-Switch Lab Space weighs a maximum of 5 kg.

3.3.4 Electrical Characteristics

Power Supply The TTE-Switch Lab Space supports the following input voltages:

- Voltage: 100 VAC - 240 VAC
- Frequency: 60 Hz - 50 Hz

Power Consumption The TTE-Switch Lab Space consumes a maximum of 45 W.

Grounding

- For ESD protection, Signal Ground (GND) is connected with a 5 x 1 nF and 2 x 10 MΩ to CHASSIS-GND.
- Signal Ground (GND) is AC/DC-coupled with CHASSISGND, which is connected to the housing and the metal-plated connectors (Ethernet RJ45, SFP Cages, D-SUB DE-9), which can be accessed from the outside.

4 Getting Started

NOTE

The Python scripts mentioned in this and subsequent sections require Python 2.7. Depending on the Python installation on the host system, the Python command will be either `python` or `python2`. The examples in this document use `python2` for consistency. The Python scripts delivered to the customer were tested on Ubuntu version 14.04.

This section describes how to get started with the TTE-Switch Lab Space in 4 steps.

1. Make sure that the switch is connected to a power outlet and switched off.
2. Use a jumper and connect the pins according to Table 3 on page 18 in order to select the default configuration of the switch.
3. Power on the switch.

   The Power LED will turn on (see Table 5 on page 19). When the switch has successfully finished its start-up, the Power LED and the Status LED will remain green. This means the switch is running the default configuration (see Table 5 on page 19).
4. Connect a host PC directly to one of the 25 front panel Ethernet ports using a standard Cat5 or Cat5e patch cable.
   - Set the IP address of the host PC to the same subnet as the switch, for example to `10.10.10.20`.
   - Set the subnet mask of the host PC to `255.255.0.0`.
   - Set the transmission speed to `100 Mbps` for port 0–18 and to 1000 Mbps for ports 19–24.
   - Open a **Command Prompt** to verify that the switch is operational.
   - Type `arp -s 10.10.10.10 A6-A7-A8-00-01-20 10.10.10.20`
     `10.10.10.10` is the default IP address, `A6-A7-A8-00-01-20` is the default MAC address. The host PC has to be on the same subnet as the TTE-Switch Lab Space. See Section 8.3 on page 37 if the `arp` command does not work.
   - Type `ping 10.10.10.10` and press **Enter** (see Section A on page 39).
     If no data packet is lost, the ping was successful (see Listing Listing 1 on page 29).

```
Pinging 10.10.10.10 with 32 bytes of data:
Reply from 10.10.10.10: bytes=32 time=12ms TTL=128
Reply from 10.10.10.10: bytes=32 time=9ms TTL=128
Reply from 10.10.10.10: bytes=32 time=7ms TTL=128
Reply from 10.10.10.10: bytes=32 time=7ms TTL=128

Ping statistics for 10.10.10.10:
Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milliseconds:
Minimum = 7ms, Maximum = 12ms, Average = 8ms
```

NOTE

See Section A on page 39 for the functionality of the Default Configuration.

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5 State Machine

5.1 State Machine Overview

The embedded software of the TTE-Switch Lab Space consists of two main parts:

- Bootloader
- Firmware

The bootloader is stored permanently in the internal ROM of the TTE-Controller HiRel. It cannot be modified or updated. The bootloader initializes the CPU and loads the firmware image. The bootloader then verifies the integrity of this firmware image through a CRC check. If the CRC is successful, the bootloader executes the firmware image.
The firmware then starts in INIT mode. In this mode, it initializes the rest of the system, executes the Built-In Self-Tests (BISTs), and verifies the integrity of all configuration images in the attached flash device.
The runtime system of the firmware provides several operational modes. Each operational mode consists of specific runtime system tasks that can only be executed in this mode. Several other tasks are shared by several modes. See Figure 7 on this page for a visual representation of the embedded software and its process sequence.

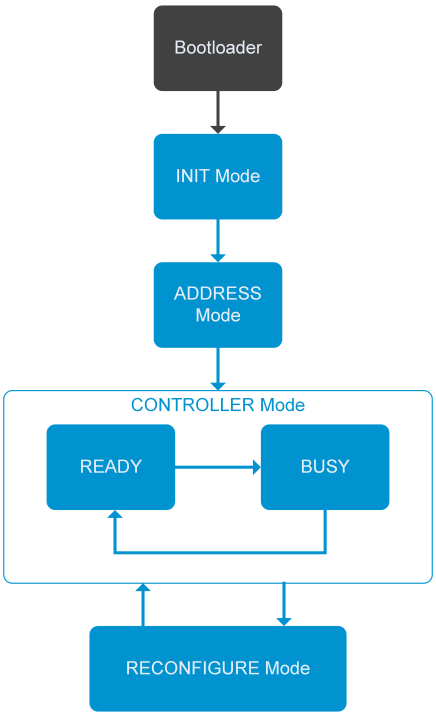

Figure 7: *The state machine*

5.2 Operational Modes of the Firmware

The firmware has the following operational modes: INIT, ADDRESS, CONTROLLER, RECONFIGURE, and ERROR.

5.2.1 INIT Mode

In this mode, the firmware starts and initializes the rest of the system before it executes the BISTs and verifies the configuration images.

Identification

- Shared memory.Operation mode = 0x0000 14E5
- No response on the network
- Shared memory.Lifesign value is undefined

Operation

- The firmware initializes all peripherals of the TTE-Switch Lab Space and the PHYs.
- The firmware loads the configuration of the internal end system that was selected through the GPIO interface (see Section 3.2.2.1 on page 17) or a long-press of the reset button (see Section 3.2.3.2 on page 19).
- The firmware configuration files are loaded.
- The Power-up Built-In Tests (PBITs) are performed.

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User Operations

None.

Transitions

- If successful, the firmware transitions to ADDRESS mode.
- In the case of an error, the firmware transitions to ERROR mode.

Remarks

There is no interaction with the user on the network.

5.2.2 ADDRESS Mode

In this mode, the firmware sets the internal software network stack to the data provided by the network configuration.

Identification

- Shared memory.Operation mode = 0x0000 14FB
- No firmware communication on the network
- Shared memory.Lifesign value increments every 5 ms

Operation

- Set up the network stack.
- Set the network address (MAC and IP) to a fixed value.
- Continuous internal end system diagnostics.
- Continuous switch diagnostics.
- Continuous Built-In Tests (CBITs) are performed.

User Operations

None.

Transitions

- If successful, the firmware transitions to CONTROLLER mode.
- In the case of an error, the firmware transitions to ERROR mode.

Remarks

There is no interaction with the user on the network.

5.2.3 CONTROLLER Mode

In this mode, the user can interact with the TTE-Switch Lab Space. This includes the upload (Section 6.2 on page 32) and download (Section 6.3 on page 34) of files, status information requests (ICMP echo requests, SNMP get requests), and the acceptance of user commands (SNMP set requests). With a user-specific command, the user can switch the operational mode of the firmware to the RECONFIGURE mode.

Identification

- Shared memory.Operation mode = 0x0000 14FC
- The firmware responds on the network to ICMP, SNMP, and TFTP requests.
- The firmware communicates with best-effort traffic only.
- Shared memory.Lifesign value increments every 5 ms

Operation

- SNMP
- ICMP ping
- TFTP
- Continuous internal end system diagnostics
- Continuous switch diagnostics
- Continuous Built-In Tests (CBITs) are performed

User Operations

- Telemetry (SNMP)
- Network management (ICMP ping)
- Commands (SNMP set requests)
- File upload (TFTP)
- File download (TFTP)

Transitions

- At the user's request the firmware transitions to RECONFIGURE mode.
- In the case of an error, the firmware transitions to ERROR mode.

Remarks

None.

5.2.4 RECONFIGURE Mode

In this mode, the firmware configures the internal end system and the switch engine with the configuration selected through the GPIO interface (see Section 3.2.2.1 on page 17) or a long-press of the reset button (see Section 3.2.3.2 on page 19). Once the reconfiguration is complete, the firmware will switch back to CONTROLLER mode.

Identification

- Shared memory.Operation mode = 0x0000 1502
- There is no firmware communication on the network.
- Shared memory.Lifesign value increments every 5 ms

Operation

- Reconfigure the internal end system and switch engine with the user's configuration file.
- The firmware configures the host interrupts according to the firmware configuration file.
- The flash memory is disabled.

User Operations

None.

Transitions

- If the reconfiguration is successful, the firmware transitions to CONTROLLER mode.
- In the case of an error, the firmware transitions to ERROR mode.

Remarks

None.

5.2.5 ERROR Mode

This operational mode is triggered when a non-recoverable error occurs. The firmware disables the CPU and remains fail-silent (i.e., the CPU does not operate on an external interface any more). Also, the Error LED will light up.

Identification

- Shared memory.Operation mode = 0x0000 151B
- There is no firmware communication on the network.
- The shared memory.Lifesign does not advance over time.

Operation

- The firmware is turned off.
- The firmware is fail-silent on the network.

User Operations

The user needs to reset the TTE-Switch Lab Space.

Transitions

None.

Remarks

None.

6 Configuring the TTE-Switch Lab Space

The device and network configuration files for the TTE-Switch Lab Space are created (see Section 6.1 on the next page) and stored in the flash memory. The firmware maintains a file system on the flash device to this end.

The device configuration files can be updated through TFTP only. A Python script lets the user prepare the configuration files for the TFTP transfer. The Python script will add the header, CRC checksum, and hash values that the firmware needs to check that the configuration files were transferred correctly before they are stored.

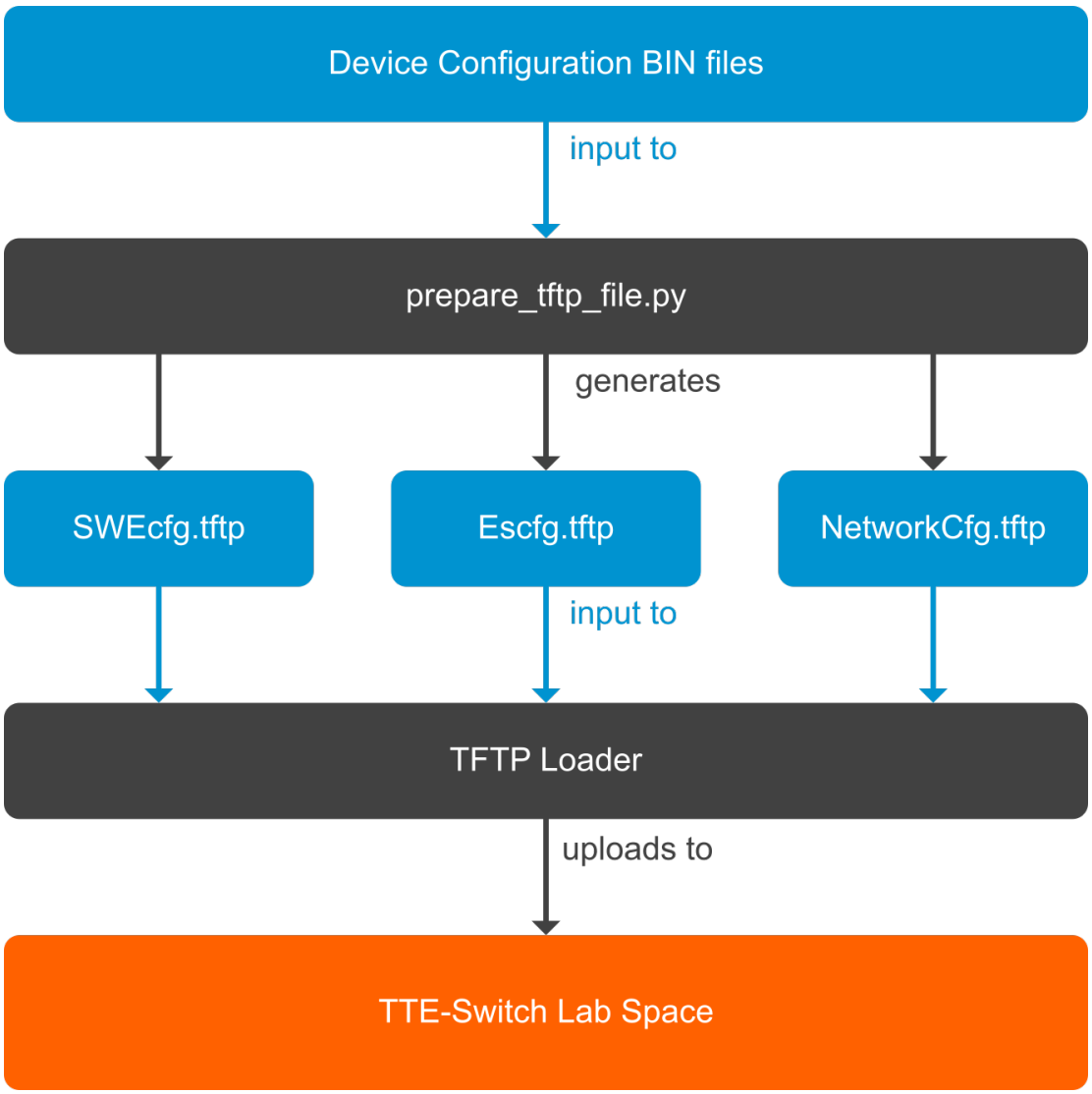

Figure 8: *Schematic overview of dataloading*

NOTE Any dataloading software that supports TFTP can be used on the host system to transfer configuration files to the TTE-Switch Lab Space.

NOTE Both the `SWEcfg.tfpt` and the `Escfg.tftp` configurations must be uploaded to obtain a working setup.

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6.1 Creating a Switch Configuration

In order to upload files to the TTE-Switch Lab Space, it is recommended to use the default configuration. It is also possible to upload files with the user configuration on the condition that the internal end system is reachable with best-effort traffic. The target files (also see Table 6 on page 32) are as follows:

- Internal End System Configuration File
- Switch Engine Configuration File
- Network Configuration File

The internal end system configuration is required in order to communicate with the firmware. In addition, it is also necessary to configure the switch engine to route packets meant for the internal end system. If the switch engine does not forward any frames to the internal end system and/or the internal end system is not configured correctly, the switch cannot be reconfigured until a hard reset to its default configuration is done.
The device configuration includes the internal end system and switch engine configuration files that are created with the TTE-Tools. The network configuration file is created with a hex editor by modifying the network parameters.
These files should be replaced and will run in user configuration mode.

6.1.1 Using the TTE-Tools for Device Configuration

The configuration for the switch is created by the TTE-Tools (minimum recommended version: 5.3.1037) – TTE-Plan, TTE-Build Network Configuration, and TTE-Build Device Configuration (see Figure 9 on the next page).

- **TTE-Plan** is the TTEthernet network design tool. Based on input provided in a network description XML file, TTE-Plan creates the network configuration in a user-convenient way and calculates the TTEthernet schedule for the network. The network description XML file describes the high-level communication requirements for the system, e.g., physical and logical topology, virtual links (VLs), including their IDs, timing requirements and possible frame sizes, as well as synchronization parameters and requirements, e.g., the SAE AS 6802 clock.
- **TTE-Build Network Configuration** knows the specifics of all supported TTEthernet devices. The tool extracts the data from the network configuration, calculates the parameters for the individual devices, and generates the device configuration files.
- **TTE-Build Device Configuration** converts the device configurations from the XML representation into binary configuration images required by the TTEthernet switches and TTEthernet end systems. The XML schemas used to describe these specifications will be publicly available and allow for the highest level of flexibility when TTE-Build Device Configuration is integrated with third-party tools or customer-specific tool chains.

NOTE

A detailed description of how to create a configuration with the TTE-Tools can be found in the TTE- Plan User Manual [9] and the TTE-Build User Manual [8]. The TTE-Tools model the entire network, not just a single device. Therefore, it is necessary to specify an end system for each port of the switch that a virtual link has as source or destination. The virtual links must be configured from end system to end system.

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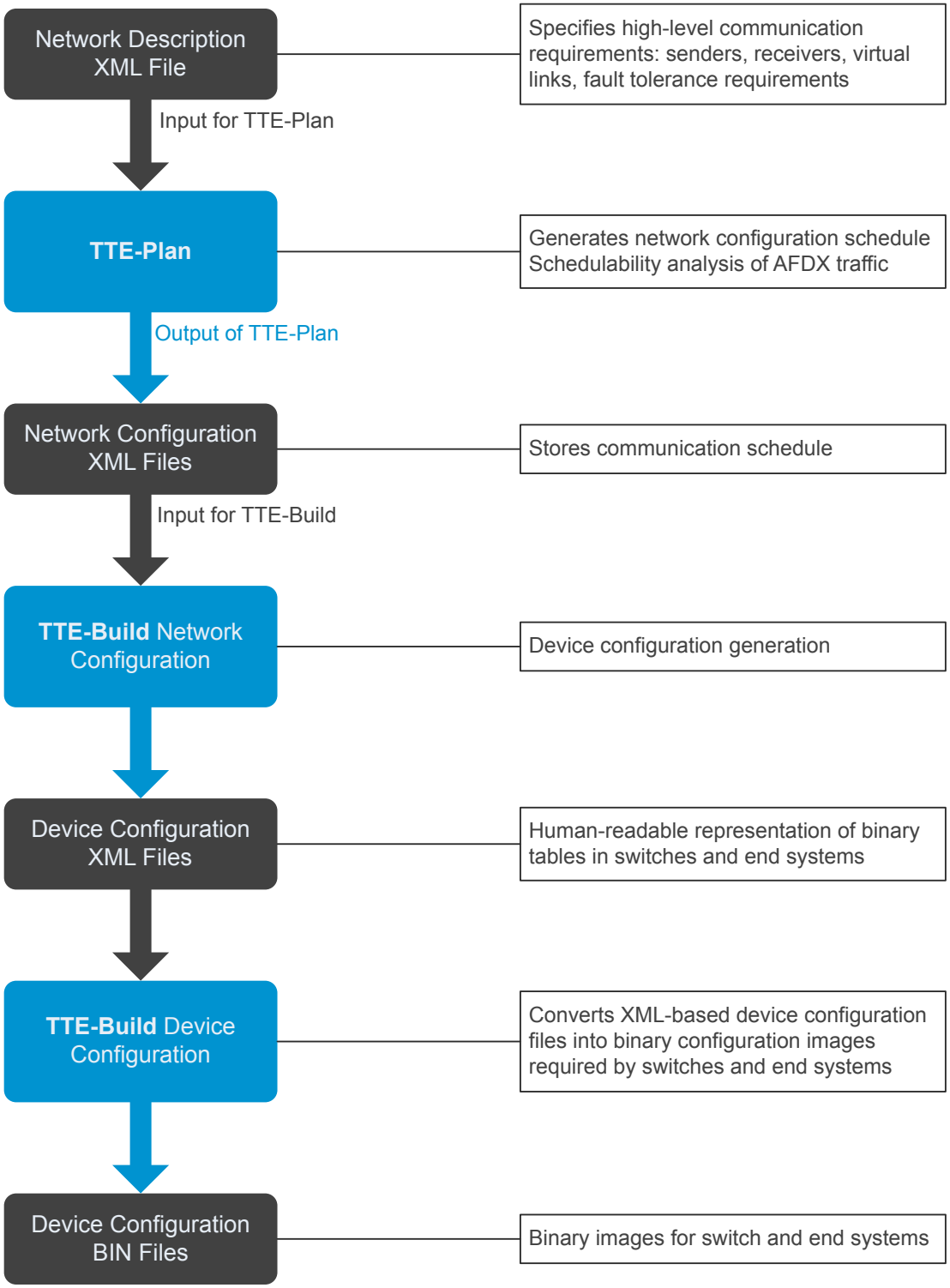

Figure 9: *TTE-Tools data flow overview*

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6.1.1.1 Configuring the Switch

In the network description XML file, a switch device must be created.

For **TTE-Tools version 5.3 or below**, the device target is `TTE-Switch_Controller_Space_ASIC`:

```
 <device xsi:type="topo:Switch" name="swlsp_sw0_0">
<port name="swlsp_sw0_P0" targetId="PHY.25"/>
    <port name="swlsp_sw0_P1" targetId="PHY.22"/>
    <port name="swlsp_sw0_P2" targetId="PHY.21"/>
    <port name="swlsp_sw0_P3" targetId="PHY.7"/>
    <port name="swlsp_sw0_P4" targetId="PHY.8"/>
    <port name="swlsp_sw0_P5" targetId="PHY.9"/>
    <port name="swlsp_sw0_P6" targetId="PHY.10"/>
    <port name="swlsp_sw0_P7" targetId="PHY.11"/>
    <port name="swlsp_sw0_P8" targetId="PHY.12"/>
    <port name="swlsp_sw0_P9" targetId="PHY.13"/>
    <port name="swlsp_sw0_P10" targetId="PHY.23"/>
    <port name="swlsp_sw0_P11" targetId="PHY.24"/>
    <port name="swlsp_sw0_P12" targetId="PHY.14"/>
    <port name="swlsp_sw0_P13" targetId="PHY.15"/>
    <port name="swlsp_sw0_P14" targetId="PHY.16"/>
    <port name="swlsp_sw0_P15" targetId="PHY.17"/>
    <port name="swlsp_sw0_P16" targetId="PHY.18"/>
    <port name="swlsp_sw0_P17" targetId="PHY.19"/>
    <port name="swlsp_sw0_P18" targetId="PHY.20"/>
    <port name="swlsp_sw0_P19" targetId="PHY.6"/>
    <port name="swlsp_sw0_P20" targetId="PHY.5"/>
    <port name="swlsp_sw0_P21" targetId="PHY.4"/>
    <port name="swlsp_sw0_P22" targetId="PHY.3"/>
    <port name="swlsp_sw0_P23" targetId="PHY.2"/>
    <port name="swlsp_sw0_P24" targetId="PHY.1"/>
    <port name="swlsp_sw0_0_P0" targetId="PHY.0"/>
      <syncConfig xsi:type="sync:AS6802SyncConfig" name="swlsp_sw0_PSYNC"
   targetId="AS6802.0" syncRole="syncCompressionMaster"
   syncPriority="//@syncDomain[name='SYNC_DOMAIN_1']
   /@syncPriority[name='PRIORITY_1']"/>
      <bestEffortRoute destinationMacAddress="FF:FF:FF:FF:FF:FF"
   addrMask="FF:FF:FF:FF:FF:FF" srcPorts="//@device[name='swlsp_sw0_0']
   /@port[name='swlsp_sw0_0_P0']"
   dstPorts="//@device[name='swlsp_sw0_0']/@port[name='swlsp_sw0_P1']
   //@device[name='swlsp_sw0_0']/@port[name='swlsp_sw0_P2']
   //@device[name='swlsp_sw0_0']/@port[name='swlsp_sw0_P3']"/>
      <deviceTarget
   href="platform:/plugin/com.tttech.ttetools.models.targetdevice/data
   /TTE_Switch_Controller_Space_ASIC.targetdevice#/"/>
 </device>
```

Listing 1: *Mapping the ports*

For **TTE-Tools above version 5.3**, the device target is `TTE_Switch_Lab_ Space`:

```
    This feature will be available upon release of the corresponding
   TTE-Tools release.
```

Synchronization only needs to be configured if time-triggered traffic is to be transmitted in the network. According to the SAE AS6802 [6] standard, a TTEthernet network can have 1..n synchronization domains

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and 1..n synchronization priorities.

- `port`
  The attribute `port` is used to define all the necessary ports of the switch. The user must define 25 physical ports, from `P0` to `P24`.
- `syncConfig`
  Set the attribute `syncRole` to `syncCompressionMaster` when configuring the switch as the TTEthernet compression master and reference a `syncPriority`, or set the attribute `syncRole` to `syncNone` if no TTEthernet clock synchronization is required. The synchronization port `AS6802.0` must be defined if TTEthernet clock synchronization is required.
- `deviceTarget`
  This attribue specifies the name of the device target. For **TTE-Tools 5.3 and below**, use `TTE_Switch_Controller_Space_ASIC`. For **TTE-Tools x.x**, use `TTE_Switch_Lab_Space`.

6.1.1.2 Configuring the Internal End System

The management CPU of the switch uses an internal end system to send and receive frames for ICMP (ping) and diagnostics via SNMP. ICMP and SNMP via best-effort traffic are always possible by selecting the default configuration.

Best-Effort Management Configuration

If a certain configuration apart from the default configuration also requires management services via best-effort traffic, the corresponding routes must be defined between the switch and the internal end system. In this case, the following settings must be made in the network description to configure the internal end system for the switch:

- Create a switch-internal management end system.
- Specify the name of the device target.
- Define a physical port and a host port.
- Specify the MAC interface.

For **TTE-Tools version 5.3 or below**, the device target is `TTE-ES_Controller_Space_ASIC`:

```
<device xsi:type="topo:EndSystem" name="ESx">
     <port name="swlsp_sw0_ES_P1" targetId="PHY.1"/>
     <deviceTarget
  href="platform:/plugin/com.tttech.ttetools.models.targetdevice/
  data/TTE_ES_Controller_Space_ASIC.targetdevice#/"/>
     <hostInterface name="swlsp_sw0_ES_PHOST" targetId="HOST.0">
     <macInterface name="swlsp_sw0_ES_MAC" address="22:22:22:22:22:22"/>
     </hostInterface>
</device>
```

Listing 2: *BE management configuration*

For **TTE-Tools version 5.3.1027 and above**, the device target is `TTE_Switch_Lab_Space_Internal_ES`:

```
 This feature will be available upon release of the corresponding
TTE-Tools release.
```

- `port`
  The attribute port is used to specify all the necessary ports of the internal end system. `PHY.1`, `PHY.2` and `PHY.3` specify the physical ports.

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- `deviceTargets`
  This attribute specifies the name of the device target. For **TTE-Tools 5.3 and below**, use `TTE_ES_Controller_Space_ASIC`. For **TTE-Tools x.x**, use `TTE_Switch_Lab_Space_Internal_ES`.
- `hostInterface`
  The attribute `HOST.0` specifies the host port and the attribute address of element `<macInterface>` specifies the MAC address of the internal end system.

6.1.1.3 Configuring Best-Effort Routes

If a management service such as ARP support (ICMP ping) and diagnostics via SNMP shall be available, this has to be correctly defined and configured. For this purpose, broadcast best-effort routes from each switch port to the management port have to be defined in the network description XML. These broadcast best-effort routes are necessary to have the switch accept the messages and handle them accordingly. The following section describes how these broadcasting routes are defined.
These best-effort route configurations consist of two parts:
In the first part, a BE broadcast route from the internal end system port (`swlp_sw0_0_P0`) to all switch ports (`P1`, `P1`, ...,`P1`) needs to be created as follows:

```
1  <bestEffortRoute destinationMacAddress="FF:FF:FF:FF:FF:FF"
     addrMask="FF:FF:FF:FF:FF:FF" srcPorts="//@device[name='swlsp_sw0_0']/
     @port[name='swlsp_sw0_0_P0']"
     dstPorts="//@device[name='swlsp_sw0_0']/@port[name='swlsp_sw0_P1']
     //@device[name='swlsp_sw0_0']/@port[name='swlsp_sw0_P2']
     //@device[name='swlsp_sw0_0']/@port[name='swlsp_sw0_P3']"/>
2
3  <bestEffortRoute destinationMacAddress="FF:FF:FF:FF:FF:FF"
     addrMask="FF:FF:FF:FF:FF:FF" srcPorts="//@device[name='swlsp_sw0_0']/
     @port[name='swlsp_sw0_0_P0']"
     dstPorts="//@device[name='swlsp_sw0_0']/@port[name='swlsp_sw0_P4']
     //@device[name='swlsp_sw0_0']/@port[name='swlsp_sw0_P5']
     //@device[name='swlsp_sw0_0']/@port[name='swlsp_sw0_P6']"/>
```

Listing 3: *First part of the BE route configuration*

- `destinationMacAddress`
  Set the attribute `destinationMacAddress` to `FF:FF:FF:FF:FF:FF` to define a broadcast route.
- `addrMask`
  Set the attribute `addrMask FF:FF:FF:FF:FF:FF` to define a broadcast route.
- `srcPorts`
  This concerns the source physical port of the route, `swlsp_sw0_0_P0`.
- `dstPorts`
  This concerns the destination physical port of the route, all physical ports.

In the second part of the best-effort route configuration, it is necessary to define routes from every physical port of the switch that is a source to the `swlsp_sw0_0_P0` destination as follows:

```
1  <bestEffortRoute destinationMacAddress="FF:FF:FF:FF:FF:FF"
     addrMask="FF:FF:FF:FF:FF:FF"
     srcPorts="//@device[name='swlsp_sw0_0']/@port[name='swlsp_sw0_P1']"
     dstPorts="//@device[name='swlsp_sw0_0']/@port[name='swlsp_sw0_0_P0']"/>
2
3  <bestEffortRoute destinationMacAddress="FF:FF:FF:FF:FF:FF"
     addrMask="FF:FF:FF:FF:FF:FF"
     srcPorts="//@device[name='swlsp_sw0_0']/@port[name='swlsp_sw0_P2']"
     dstPorts="//@device[name='swlsp_sw0_0']/@port[name='swlsp_sw0_0_P0']"/>
```


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```
4
5   <bestEffortRoute destinationMacAddress="FF:FF:FF:FF:FF:FF"
      addrMask="FF:FF:FF:FF:FF:FF"
      srcPorts="//@device[name='swlsp_sw0_0']/@port[name='swlsp_sw0_P3']"
      dstPorts="//@device[name='swlsp_sw0_0']/@port[name='swlsp_sw0_0_P0']"/>
6
7   <bestEffortRoute destinationMacAddress="FF:FF:FF:FF:FF:FF"
      addrMask="FF:FF:FF:FF:FF:FF"
      srcPorts="//@device[name='swlsp_sw0_0']/@port[name='swlsp_sw0_P4']"
      dstPorts="//@device[name='swlsp_sw0_0']/@port[name='swlsp_sw0_0_P0']"/>
8
9   <bestEffortRoute destinationMacAddress="FF:FF:FF:FF:FF:FF"
      addrMask="FF:FF:FF:FF:FF:FF"
      srcPorts="//@device[name='swlsp_sw0_0']/@port[name='swlsp_sw0_P5']"
      dstPorts="//@device[name='swlsp_sw0_0']/@port[name='swlsp_sw0_0_P0']"/>
10
11  <bestEffortRoute destinationMacAddress="FF:FF:FF:FF:FF:FF"
      addrMask="FF:FF:FF:FF:FF:FF"
      srcPorts="//@device[name='swlsp_sw0_0']/@port[name='swlsp_sw0_P6']"
      dstPorts="//@device[name='swlsp_sw0_0']/@port[name='swlsp_sw0_0_P0']"/>
```

Listing 4: *Second part of the BE route configuration*

6.1.2 Using a Python Script to Configure the Network

The `create_network_config.py` Python script makes it possible to create a network configuration without the TTE-Tools.

Example

```
python2 create_network_config.py --mac A6:A7:A8:0:1:20 --ip 10.10.10.81
   --gateway 10.10.10.1 --subnet 255.255.0.0 NW_cfg.bin
```

`NW_cfg.bin` The name of the configuration binary that will be created.

6.2 Uploading the Switch Configuration

The memory of the flash storage device is organized as a set of files as listed in Table 6 on this page. These files are typically accessed via TFTP.

File Name	Maximum File Size	Protection	Purpose
`TTC_EScfg.bin`	1 MB	None	The user internal end system (ES) configuration.
`TTC_SWEcfg.bin`	1 MB	None	The user switch engine (SWE) configuration.
`TTC_NetworkCfg.bin`	128 kB	None	The network configuration for the internal end system.

Table 6: *List of files in the flash memory*

NOTE The firmware does not check the data of the files, only the integrity of the files as a whole. Therefore, it is the user's responsibility to upload the correct data files to the file system in the flash memory.

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NOTE

It is possible to use any TFTP client to upload the files. If the files are not uploaded correctly, the Error LED will light up red when trying to enter the user configuration mode (see Table 5 on page 19). It is recommended to use the default configuration when uploading configuration files.

6.2.1 Preparing Files for an Upload

To upload a file with TFTP, it must be converted to a specific binary format. The script `prepare_tftp_file.py` is called as follows:

```
python2 prepare_tftp_file.py [-e] [-h] [-l] [--verbose] [-v] [-f file]
   -s source <filename.bin> <filename.tftp>
```

`-e`	Force encoding with 64/72-bit ECC protection, must be used only for converting a firmware binary. Not needed when source type FIP is used.
`-h`	Print this usage help and exit.
`-l`	List available file names in the file system and exit.
`--verbose`	Verbose output, print additional information during processing.
`-v`	Print the version of the script and exit.
`-f file`	Name of the file in the file system in the flash memory.
`-s source`	Type of the source file, either `Image` or `FIP`.
`<filename.bin>`	Binary input file, e.g., a switch engine or network configuration file.
`<filename.tftp>`	Output file, i.e., the converted input file, ready for an upload via TFTP.

Example The following command converts a stand-alone end system configuration for an upload via TFTP:

```
python2 prepare_tftp_file.py -s Image ES_Config.bin ES_user_cfg.tftp
```

6.2.2 Uploading TFTP Files

Once a TFTP file has been generated, it can be uploaded to the respective target binary files.
Example 1

```
tftp -i <ipaddress> PUT NW_cfg.bin TTC_NetworkCfg.bin
```

Example 2

```
tftp -i <ipaddress> PUT ES.tftp TTC_EScfg.bin
```

Example 3

```
tftp -i <ipaddress> PUT SWE.tftp TTC_SWEcfg.bin
```

`<ipaddress>`	The actual IP address of the switch (default: 10.10.10.10).

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6.3 Downloading the Switch Configuration

Files can be downloaded from the TTE-Switch Lab Space through any TFTP client. The user therefore has to know the preconfigured IP address.
In comparison with the upload process (where the file must be converted), a file downloaded from the TTE-Switch Lab Space is a plain binary file without any header, hash, ECC protection, or other modification. To upload such a file again, the `prepare_tftp_file.py` script needs to be run.

```
tftp -i <ip address> GET <target.bin> <filename.bin>
```

`<ip address>`	The actual IP address of the switch (default: 10.10.10.10).
`<target.bin>`	The target configuration file that will be downloaded, e.g., `TTC_NetworkCfg.bin`, `TTC_EScfg.bin`, or `TTC_SWEcfg.bin`.
`<filename.bin>`	The output binary file, i.e., the file converted by `prepare_tftp_file.py`.

Example
The following command downloads a binary from the flash memory:

```
tftp -i 10.10.10.10 GET TTC_EScfg.bin ES_user_cfg.bin
```

6.4 Recovering from Errors

The following error conditions may apply during operation. These descriptions are for general guidance only.

Error	Possible Cause	Mitigation
Firmware does not respond on the network	• Network cable not connected • Wrong network speed • Wrong MAC address • Firmware in ERROR mode • Wrong port configured for PHY	• Check UART for critical error • Check network cable • Set network speed to 100 Mbit • Check for UART error messages
SNMP error response on GET request	OID not supported.	No mitigation.
SNMP error response on SET request	OID not supported.	No mitigation.
TFTP error response	• File corrupted • Wrong file name provided	• See Section 6.2 on page 32 and Section 6.3 on the current page. • See Table 6 on page 32.
SNMP trap is not transmitted	User configuration is not correct.	• Check the current firmware mode via SNMP.
No response to SNMP GET requests	The firmware is in ERROR mode.	Check the UART for an error message.
SNMP timeout	• Firmware in wrong mode • Firmware in ERROR mode • Wrong network address (default configuration) • Wrong network address (user configuration)	• Check the last message on the UART. • Check the addresses used in the user configuration.

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Error	Possible Cause	Mitigation
TFTP timeout	• Firmware in wrong mode • Firmware in ERROR mode • Wrong network address (default configuration)	• Check the last message on the UART. • Check the addresses that was sent by the SNMP SET request.

Table 7: *Recovery from errors*

7 Diagnosis

Management Information Database

The Management Information Database (MIB) describes the managed objects that can be retrieved via SNMP Version 1 (SNMPv1) on UDP port 161. Make sure to use the correct IP address according to your loaded configuration. The default configuration has the IP address `10.10.10.10` (see Section B on page 39).
In your preferred SNMP client, make sure to choose SNMPv1 and disable all other versions of the SNMP protocol. The MIB files listed below can be loaded into any SNMPv1-compliant SNMP client. The MIB files contain the following diagnostic information about the switch status:

- `TT_MIB-TTE-SWE` (see Section B.2 on page 39)
  Contains all relevant status information and error counters of the switch engine.
- `TT-MIB-TTE-ES` (see Section B.3 on page 47)
  Contains all relevant status information and error counters of the switch-internal end system. For more detailed information about the switch-internal end system (see the Pegasus End System Interface Control Document [7]).

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8 Troubleshooting

8.1 Basic Checks

If you encounter a malfunction of the TTE-Switch Lab Space, there are some basic checks you can perform:

- Does the power fuse work? If the power fuse works, but the LEDs of the switch still do not light up, have the AC wall socket checked to see if the wall socket is working as intended.
- Is the pin programming of the GPIO interface correct for the desired configuration?
- What do the status LEDs display? See Section 3.2.3.3 on page 19 for details.
- Are all temperatures within the allowed ranges? See Section 3.3 on page 19 for details and check the SNMP client output for the temperature values of the different sensors.

8.2 SpaceWire Hot-Plugging Issues

If you run into hot-plugging issues with SpaceWire, the following procedure has been proven to work during tests:

1. Plug in the SpaceWire cable
2. Power on the SpaceWire component
3. Power up the TTE-Switch Lab Space

Alternatively, hit the reset button upon connecting the SpaceWire cable to the TTE-Switch Lab Space.

8.3 The `arp` Command Fails

The `arp` command needs to be run as administrator.
If you get an error message that states that `The ARP entry addition failed: Access is denied.`, find out the interface name (i.e., the name of the network card) and add it to the list:

1. `netsh interface show interface`
2. `netsh interface ip add neighbors "<interface name>" <gateway IP> <gateway MAC>`

Example

```
netsh interface ip add neighbors "Ethernet 4" 10.10.10.10 A6-A7-A8-00-01-20
```

8.4 The `tftp` Command Does Not Work

To use the TFTP client through the `tftp` command, TFTP has to be enabled in the operating system. On Microsoft Windows this can be achieved as follows:

1. Open the  menu.
2. Type `Turn Windows features on or off` and press Enter ↵.
3. Select the checkbox next to **TFTP Client** and press **OK**.

8.5 No Link Is Established

If no link is established, autonegation may be the culprit. A crossover cable is needed to create a link in this case.

A crossover cable is also needed if the two devices that are to be linked both have autonegation set to **disabled**.

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8.6 Customer Support Information

Company address:
TTTech Computertechnik AG
Schoenbrunner Strasse 7
A-1040 Vienna, Austria

For technical assistance and support regarding TTTech products, please contact our customer support:

- E-Mail: support@tttech.com

- If there are problems with your TTE-Switch Lab Space, please have the serial number ready to speed up the processing of your support request.

A Default Configuration

The default configuration is part of the firmware image of the switch. Therefore, the default configuration is not part of the user configuration and cannot be changed via TFTP.
For default/user configuration selection, see Section 3.2.2.1 on page 17.

The settings of the default configuration are:

```
    IP: 10.10.10.10
    MSK: 255.255.0.0
    GW: 10.10.10.1
    MAC: A6:A7:A8:00:01:20
```

Listing 5: *Default configuration settings*

B MIBs

B.1 TT-MIB

```
TT-MIB DEFINITIONS ::= BEGIN

    IMPORTS enterprises
            FROM RFC1155-SMI;

    tttech      OBJECT IDENTIFIER ::= { enterprises 38355 }
    technology  OBJECT IDENTIFIER ::= { tttech 100 }
    platformSW  OBJECT IDENTIFIER ::= { technology 1 }
    ttEthernet  OBJECT IDENTIFIER ::= { technology 2 }
    ttp         OBJECT IDENTIFIER ::= { technology 3 }

    products    OBJECT IDENTIFIER ::= { tttech 200 }
    common      OBJECT IDENTIFIER ::= { products 1 }
    smc         OBJECT IDENTIFIER ::= { common 1 }

    aerospace   OBJECT IDENTIFIER ::= { products 3 }
    spaceAsic   OBJECT IDENTIFIER ::= { aerospace 1 }
    aeroSwitch  OBJECT IDENTIFIER ::= { aerospace 3 }

END
```

Listing 6: *TT-MIB definitions*

B.2 TT-SWE-VNV-MIB

```
TT-SWE-VNV-MIB DEFINITIONS ::= BEGIN


IMPORTS
ttEthernet FROM TT-MIB
Counter, OBJECT-TYPE FROM RFC1155-SMI;

```

```
    tteSwitchingEngineVnV        OBJECT IDENTIFIER ::= { ttEthernet 4 }

    tteSweDevId OBJECT-TYPE
        SYNTAX      OCTET STRING (SIZE(0..50))
        ACCESS      read-only
        STATUS      mandatory
        DESCRIPTION
            "TTE-SWE Device ID."
        ::= { tteSwitchingEngineVnV 1 }

    tteSweDevRev OBJECT-TYPE
        SYNTAX      OCTET STRING (SIZE(0..50))
        ACCESS      read-only
        STATUS      mandatory
        DESCRIPTION
            "TTE-SWE Device revision."
        ::= { tteSwitchingEngineVnV 2 }

    tteSweDevItfRev OBJECT-TYPE
        SYNTAX      OCTET STRING (SIZE(0..50))
        ACCESS      read-only
        STATUS      mandatory
        DESCRIPTION
            "TTE-SWE Device Interface Revision."
        ::= { tteSwitchingEngineVnV 3 }

    tteSweUsrCfgTable OBJECT-TYPE
        SYNTAX      OCTET STRING (SIZE(0..50))
        ACCESS      read-only
        STATUS      mandatory
        DESCRIPTION
            "User configuration table. This is part of the TTEthernet
             configuration.
             NOTE: Only the first 252 characters can be read here."
        ::= { tteSwitchingEngineVnV 4 }

    tteSweComMonMode OBJECT-TYPE
        SYNTAX      INTEGER (0..2)
        ACCESS      read-only
        STATUS      mandatory
        DESCRIPTION
            "COM/MON mode detected by the TTE-SwE.
             Possible values are:
              0: TTE_SWE_CM_MODE_MON
                   COM/MON setup is active, core works as MON.
              1: TTE_SWE_CM_MODE_COM
                 COM/MON setup is active, core works as COM.
              2: TTE_SWE_CM_MODE_STANDALONE
                  COM/MON setup is deactivated, core works standalone."
        ::= { tteSwitchingEngineVnV 5 }

    tteSweComMonError OBJECT-TYPE
        SYNTAX      INTEGER (0..67108863)
        ACCESS      read-only
        STATUS      mandatory
        DESCRIPTION
```

```
64              "COM/MON error detected by the TTE-SwE on the respective port.
65               Each port is represented by a bit, port 0 at bit 0, port 1 at
66               bit 1 and so on.
67                0: No error occurred.
68                1: A COM/MON mismatch was detected at the respecitve port."
69          ::= { tteSwitchingEngineVnV 6 }
70
71      tteSweOutOfMemCond OBJECT-TYPE
72          SYNTAX      INTEGER (0..67108863)
73          ACCESS      read-only
74          STATUS      mandatory
75          DESCRIPTION
76              "Out-of-memory conditions detected by the TTE-SwE.
77                0: No error occurred.
78                1: An out-of-memory condition occurred in one of the
79                   TTE-SwE's memory partition."
80          ::= { tteSwitchingEngineVnV 7 }
81
82      tteSweAccessMode OBJECT-TYPE
83          SYNTAX      INTEGER (0..2)
84          ACCESS      read-write
85          STATUS      mandatory
86          DESCRIPTION
87              "Access mode for the TTE-SwE IP. Possible values are:
88               0: TTE_SWE_CM_ACC_MODE_COM_MON
89                   Request is sent to COM and MON module.
90               1: TTE_SWE_CM_ACC_MODE_COM
91                   Request is sent to COM only.
92               2: TTE_SWE_CM_ACC_MODE_MON
93                   Request is sent to MON only. NOTE: If not MON is given in
94                   the system an status query might fail or provide invalid
95                   data."
96          ::= { tteSwitchingEngineVnV 8 }
97
98      tteSweSyncState OBJECT-TYPE
99          SYNTAX      INTEGER (0..8)
100         ACCESS      read-only
101         STATUS      mandatory
102         DESCRIPTION
103             "Current state of the synchronization engine.
104              Possible values are:
105               0: INIT
106               1: INTEGRATE
107               2: UNSYNC
108               3: WAIT 4 CYCLE START
109               4: CA ENABLED
110               5: WAIT FOR IN
111               6: TENTATIVE SYNC
112               7: SYNC
113               8: STABLE"
114         ::= { tteSwitchingEngineVnV 9 }
115
116     tteSweClockCorrSmallest OBJECT-TYPE
117         SYNTAX      INTEGER
118         ACCESS      read-only
119         STATUS      mandatory
```

```
120         DESCRIPTION
121             "Smallest correction value ever applied by the clock
122              synchronization algorithm."
123         ::= { tteSwitchingEngineVnV 10 }
124
125     tteSweClockCorrLargest OBJECT-TYPE
126         SYNTAX      INTEGER
127         ACCESS      read-only
128         STATUS      mandatory
129         DESCRIPTION
130             "Largest correction value ever applied by the clock
131              synchronization algorithm."
132         ::= { tteSwitchingEngineVnV 11 }
133
134     tteSweNumberOfSyncLoss OBJECT-TYPE
135         SYNTAX      INTEGER(0..65535)
136         ACCESS      read-only
137         STATUS      mandatory
138         DESCRIPTION
139             "Number of transitions of the clock synchronization state
140              machine from SYNC state or STABLE state to anything else than
141              SYNC state or STABLE."
142         ::= { tteSwitchingEngineVnV 12 }
143
144     tteSweMembershipVectorCurrent OBJECT-TYPE
145         SYNTAX      INTEGER(0..255)
146         ACCESS      read-only
147         STATUS      mandatory
148         DESCRIPTION
149             "Membership value of the in-schedule integration protocol
150              control frame received within the most recent acceptance
151              window that has the largest weight.
152              NOTE: The field contains valid data only if the IP is
153                    synchronized."
154         ::= { tteSwitchingEngineVnV 13 }
155
156     tteSweMembershipVectorSmallest OBJECT-TYPE
157         SYNTAX      INTEGER(0..255)
158         ACCESS      read-only
159         STATUS      mandatory
160         DESCRIPTION
161             "Membership vector with the smallest number of flags set of
    all
162              in-schedule integration frames ever processed by the
163              synchronization state machine. The field will maintain its
164              value also when synchronization is lost."
165         ::= { tteSwitchingEngineVnV 14 }
166
167     tteSweMembershipVectorLargest OBJECT-TYPE
168         SYNTAX      INTEGER(0..255)
169         ACCESS      read-only
170         STATUS      mandatory
171         DESCRIPTION
172             "Membership vector with the largest number of flags set of all
173              in-schedule integration frames ever processed by the
174              synchronization state machine. The field will maintain its
```

```
175                value also when synchronization is lost."
176            ::= { tteSwitchingEngineVnV 15 }
177
178        ----------------------------------------
179        -- TTE-SWE Ethernet Port Status Table --
180        ----------------------------------------
181        tteSweEthPortStatusTable OBJECT-TYPE
182          SYNTAX  SEQUENCE OF TteSweEthPortStatusTableEntries
183          ACCESS  not-accessible
184          STATUS  mandatory
185          DESCRIPTION
186                  "TTE-SWE Ethernet Port status table."
187          ::= { tteSwitchingEngineVnV 16 }
188
189        tteSweEthPortStatusTableEntry OBJECT-TYPE
190          SYNTAX  TteSweEthPortStatusTableEntries
191          ACCESS  not-accessible
192          STATUS  mandatory
193          DESCRIPTION
194                  "TTE-SWE Ethernet Port status table entry."
195          INDEX   { tteSweEthPortName }
196          ::= { tteSweEthPortStatusTable 1 }
197
198        TteSweEthPortStatusTableEntries ::=
199          SEQUENCE {
200              tteSweEthPortName
201                  OCTET STRING (SIZE(0..50)),
202              tteSweEthPortTxBytes
203                  OCTET STRING (SIZE(0..50)),
204              tteSweEthPortTxFrames
205                    Counter,
206              tteSweEthPortRxBytes
207                  OCTET STRING (SIZE(0..50)),
208              tteSweEthPortRxFrames
209                    Counter,
210              tteSweEthPortNoLossBePolicing
211                  Counter,
212              tteSweEthPortNoLossCtPolicing
213                  Counter,
214              tteSweEthPortNoLossUnknownVl
215                  Counter,
216              tteSweEthPortNoLossCrcError
217                  Counter,
218              tteSweEthPortNoLossLengthError
219                  Counter,
220              tteSweEthPortNoLossSofError
221                  INTEGER(0..255),
222              tteSweEthPortNoLossAlignmentError
223                  INTEGER(0..255),
224              tteSweEthPortNoLossMiiError
225                  INTEGER(0..255),
226              tteSweEthPortNoLossRunt
227                  INTEGER(0..255)
228          }
229
230        tteSweEthPortName OBJECT-TYPE
```

```
231         SYNTAX  OCTET STRING (SIZE(0..50))
232         ACCESS  read-only
233         STATUS  mandatory
234         DESCRIPTION
235                 "Name of the Ethernet port."
236         ::= { tteSweEthPortStatusTableEntry 1 }
237
238       tteSweEthPortTxBytes OBJECT-TYPE
239         SYNTAX  OCTET STRING (SIZE(0..50))
240         ACCESS  read-only
241         STATUS  mandatory
242         DESCRIPTION
243                 "Number of bytes sent on the respective Ethernet port."
244         ::= { tteSweEthPortStatusTableEntry 2 }
245
246       tteSweEthPortTxFrames OBJECT-TYPE
247         SYNTAX  Counter
248         ACCESS  read-only
249         STATUS  mandatory
250         DESCRIPTION
251                 "Number of frames sent on the respective Ethernet port."
252         ::= { tteSweEthPortStatusTableEntry 3 }
253
254       tteSweEthPortRxBytes OBJECT-TYPE
255         SYNTAX  OCTET STRING (SIZE(0..50))
256         ACCESS  read-only
257         STATUS  mandatory
258         DESCRIPTION
259                 "Number of bytes received on the respective Ethernet port."
260         ::= { tteSweEthPortStatusTableEntry 4 }
261
262       tteSweEthPortRxFrames OBJECT-TYPE
263         SYNTAX  Counter
264         ACCESS  read-only
265         STATUS  mandatory
266         DESCRIPTION
267                 "Number of frames received on the respective Ethernet port."
268         ::= { tteSweEthPortStatusTableEntry 5 }
269
270       tteSweEthPortNoLossBePolicing OBJECT-TYPE
271         SYNTAX  Counter
272         ACCESS  read-only
273         STATUS  mandatory
274         DESCRIPTION
275                 "Number of frames which were dropped based on the best
      effort
276                  policing operation."
277         ::= { tteSweEthPortStatusTableEntry 6 }
278
279       tteSweEthPortNoLossCtPolicing OBJECT-TYPE
280         SYNTAX  Counter
281         ACCESS  read-only
282         STATUS  mandatory
283         DESCRIPTION
284                 "Number of frames which were dropped based on the
285                  critical-traffic policing operation."
```

```
286         ::= { tteSweEthPortStatusTableEntry 7 }
287
288       tteSweEthPortNoLossUnknownVl OBJECT-TYPE
289         SYNTAX  Counter
290         ACCESS  read-only
291         STATUS  mandatory
292         DESCRIPTION
293                 "Number of frames which were dropped because the Virtual
      Link
294                  ID has not been configured for this port."
295         ::= { tteSweEthPortStatusTableEntry 8 }
296
297       tteSweEthPortNoLossCrcError OBJECT-TYPE
298         SYNTAX  Counter
299         ACCESS  read-only
300         STATUS  mandatory
301         DESCRIPTION
302                 "Number of frames received on the port carrying a wrong CRC
303                  checksum."
304         ::= { tteSweEthPortStatusTableEntry 9 }
305
306       tteSweEthPortNoLossLengthError OBJECT-TYPE
307         SYNTAX  Counter
308         ACCESS  read-only
309         STATUS  mandatory
310         DESCRIPTION
311                 "Number of frames that are longer than 2047 bytes."
312         ::= { tteSweEthPortStatusTableEntry 10 }
313
314       tteSweEthPortNoLossSofError OBJECT-TYPE
315         SYNTAX  INTEGER(0..255)
316         ACCESS  read-only
317         STATUS  mandatory
318         DESCRIPTION
319                 "Number of frames that start with a byte other than 0x55 or
320                  0xD5, have a byte other than 0xD5 being the first byte that
321                  is different than 0x55 or 0xD5, or that terminated before
322                  the SOF delimiter byte."
323         ::= { tteSweEthPortStatusTableEntry 11 }
324
325       tteSweEthPortNoLossAlignmentError OBJECT-TYPE
326         SYNTAX  INTEGER(0..255)
327         ACCESS  read-only
328         STATUS  mandatory
329         DESCRIPTION
330                 "Number of frames having a length that is not a multiple of
331                  eight bits (at the given line speed)."
332         ::= { tteSweEthPortStatusTableEntry 12 }
333
334       tteSweEthPortNoLossMiiError OBJECT-TYPE
335         SYNTAX  INTEGER(0..255)
336         ACCESS  read-only
337         STATUS  mandatory
338         DESCRIPTION
339                 "Number of frames that terminated with the MII error input
340                  being asserted."
```

```
341         ::= { tteSweEthPortStatusTableEntry 13 }
342
343       tteSweEthPortNoLossRunt OBJECT-TYPE
344         SYNTAX  INTEGER(0..255)
345         ACCESS  read-only
346         STATUS  mandatory
347         DESCRIPTION
348                 "Number of frames that do not have a SOF error, alignment
349                  error, nor MII error, but are shorter than 64 bytes."
350         ::= { tteSweEthPortStatusTableEntry 14 }
351
352       ---------------------------------------------
353       -- TTE-SWE Memory Partition BE Status Table --
354       ---------------------------------------------
355       tteSweMemPartBeStatusTable OBJECT-TYPE
356         SYNTAX  SEQUENCE OF TteSweMemPartBeStatusTableEntry
357         ACCESS  not-accessible
358         STATUS  mandatory
359         DESCRIPTION
360                 "TTE-SWE memory partition status table for best effort
361                  traffic."
362         ::= { tteSwitchingEngineVnV 17 }
363
364       tteSweMemPartBeStatusTableEntry OBJECT-TYPE
365         SYNTAX  TteSweMemPartBeStatusTableEntry
366         ACCESS  not-accessible
367         STATUS  mandatory
368         DESCRIPTION
369                 "TTE-SWE memory partition status table entry for best effort
370                  traffic."
371         INDEX   { tteSweMemPartBeDropCounter }
372         ::= { tteSweMemPartBeStatusTable 1 }
373
374       TteSweMemPartBeStatusTableEntry ::=
375         SEQUENCE {
376             tteSweMemPartBeDropCounter
377                 Counter
378             }
379
380       tteSweMemPartBeDropCounter OBJECT-TYPE
381         SYNTAX  Counter
382         ACCESS  read-only
383         STATUS  mandatory
384         DESCRIPTION
385                 "Number of frames dropped due to lack of best effort memory
386                  partition space."
387         ::= { tteSweMemPartBeStatusTableEntry 1 }
388
389       ---------------------------------------------
390       -- TTE-SWE Memory Partition CT Status Table --
391       ---------------------------------------------
392       tteSweMemPartCtStatusTable OBJECT-TYPE
393         SYNTAX  SEQUENCE OF TteSweMemPartCtStatusEntry
394         ACCESS  not-accessible
395         STATUS  mandatory
396         DESCRIPTION
```

```
397                "TTE-SWE memory partition status table for critical
       traffic."
398          ::= { tteSwitchingEngineVnV 18 }
399
400        tteSweMemPartCtStatusEntry OBJECT-TYPE
401          SYNTAX  TteSweMemPartCtStatusEntry
402          ACCESS  not-accessible
403          STATUS  mandatory
404          DESCRIPTION
405                  "TTE-SWE memory partition status table entry for critical
406                   traffic."
407          INDEX   { tteSweMemPartCtDropCounter }
408          ::= { tteSweMemPartCtStatusTable 1 }
409
410        TteSweMemPartCtStatusEntry ::=
411          SEQUENCE {
412              tteSweMemPartCtDropCounter
413                  Counter
414              }
415
416        tteSweMemPartCtDropCounter OBJECT-TYPE
417          SYNTAX  Counter
418          ACCESS  read-only
419          STATUS  mandatory
420          DESCRIPTION
421                  "Number of frames dropped due to lack of virtual link memory
422                   partition space."
423          ::= { tteSweMemPartCtStatusEntry 1 }
424    END
```

Listing 7: *TT-SWE-VNV-MIB definitions*

B.3 TTE-ES-1-7-MIB

```
1   TTE-ES-1-7-MIB DEFINITIONS ::= BEGIN
2
3
4   IMPORTS ttEthernet FROM TT-MIB
5       Counter, OBJECT-TYPE FROM RFC1155-SMI;
6
7
8       tteEndSystem1-7  OBJECT IDENTIFIER ::= { ttEthernet 3 }
9
10          tteItfRev OBJECT-TYPE
11                  SYNTAX      Counter
12                  ACCESS          read-only
13                  STATUS      mandatory
14                  DESCRIPTION
15                          "TTEthernet End System Interface Revision."
16                  ::= { tteEndSystem1-7 1 }
17
18          tteDevId OBJECT-TYPE
19                  SYNTAX      Counter
20                  ACCESS          read-only
```

```
                STATUS      mandatory
                DESCRIPTION
                        "TTEthernet End System Device ID."
                ::= { tteEndSystem1-7 2 }

        tteDevRev OBJECT-TYPE
                SYNTAX      Counter
                ACCESS          read-only
                STATUS      mandatory
                DESCRIPTION
                        "TTEthernet End System Device Revision Number."
                ::= { tteEndSystem1-7 3 }

        tteSyncState OBJECT-TYPE
                SYNTAX      Counter
                ACCESS          read-only
                STATUS      mandatory
                DESCRIPTION
                        "TTEthernet Clock Synchronization State."
                ::= { tteEndSystem1-7 4 }

        tteSyncLoss OBJECT-TYPE
                SYNTAX      Counter (0..65535)
                ACCESS          read-only
                STATUS      mandatory
                DESCRIPTION
                        "The number of transitions of the clock
    synchronization state
                         machine from SYNC state or STABLE state to any
    other state
                         than SYNC or STABLE."
                ::= { tteEndSystem1-7 5 }

     tteDropIpFrag OBJECT-TYPE
         SYNTAX      Counter
         ACCESS      read-only
         STATUS      mandatory
         DESCRIPTION
             "Number of frames dropped because of IPv4 fragmentation
    errors."
         ::= { tteEndSystem1-7 6 }

     tteDropNoMem OBJECT-TYPE
         SYNTAX      Counter
         ACCESS      read-only
         STATUS      mandatory
         DESCRIPTION
             "Number of frames dropped that could not be stored in the
    frame
              memory because the complete frame memory was full."
         ::= { tteEndSystem1-7 7 }

     tteUserData OBJECT-TYPE
         SYNTAX      OCTET STRING (SIZE(0..127))
         ACCESS      read-only
         STATUS      mandatory
```

```
73          DESCRIPTION
74              "User Configuration Data. This is part of the TTEthernet
75               configuration.
76               NOTE: Only the first 128 characters can be read here."
77          ::= { tteEndSystem1-7 8 }
78
79      tteMinClkCorr OBJECT-TYPE
80          SYNTAX      INTEGER
81          ACCESS      read-only
82          STATUS      mandatory
83          DESCRIPTION
84              "The smallest correction value ever applied by the clock
85               synchronization algorithm."
86          ::= { tteEndSystem1-7 9 }
87
88      tteMaxClkCorr OBJECT-TYPE
89          SYNTAX      INTEGER
90          ACCESS      read-only
91          STATUS      mandatory
92          DESCRIPTION
93              "The largest correction value ever applied by the clock
94               synchronization algorithm."
95          ::= { tteEndSystem1-7 10 }
96
97      -- Channel statistics table
98
99      chStatTable OBJECT-TYPE
100       SYNTAX  SEQUENCE OF ChStatEntry
101       ACCESS  not-accessible
102       STATUS  mandatory
103       DESCRIPTION
104               "A table containing channel statistics columns."
105       ::= { tteEndSystem1-7 11 }
106
107     chStatEntry OBJECT-TYPE
108       SYNTAX  ChStatEntry
109       ACCESS  not-accessible
110       STATUS  mandatory
111       DESCRIPTION
112               "Information about a particular table row."
113       INDEX   { tteRxBytes }
114       ::= { chStatTable 1 }
115
116     ChStatEntry ::=
117       SEQUENCE {
118           tteRxBytes
119               Counter,
120           tteTxBytes
121               Counter,
122           tteSizeErr
123               Counter,
124           tteCrcErr
125               Counter,
126           tteSofErr
127               Counter,
128           tteAlignErr
```

```
129                 Counter,
130             tteMiiErr
131                 Counter,
132             tteRxFrames
133                 Counter,
134             tteTxFrames
135                 Counter,
136             tteVlNotFound
137                 Counter
138       }
139
140       tteRxBytes OBJECT-TYPE
141           SYNTAX      Counter
142           ACCESS      read-only
143           STATUS      mandatory
144           DESCRIPTION
145               "Number of received bytes on the channel."
146           ::= { chStatEntry 1 }
147
148       tteTxBytes OBJECT-TYPE
149           SYNTAX      Counter
150           ACCESS      read-only
151           STATUS      mandatory
152           DESCRIPTION
153               "Number of sent bytes on the channel."
154           ::= { chStatEntry 2 }
155
156       tteSizeErr OBJECT-TYPE
157           SYNTAX      Counter
158           ACCESS      read-only
159           STATUS      mandatory
160           DESCRIPTION
161               "The number of frames that are either shorter than 64 bytes,
162                longer than 1518 bytes, or whose length does not match
163                the value of the EtherType/Length field of the Ethernet
      frame."
164           ::= { chStatEntry 3 }
165
166       tteCrcErr OBJECT-TYPE
167           SYNTAX      Counter
168           ACCESS      read-only
169           STATUS      mandatory
170           DESCRIPTION
171               "The number of frames that terminated with a checksum error."
172           ::= { chStatEntry 4 }
173
174       tteSofErr OBJECT-TYPE
175           SYNTAX      Counter
176           ACCESS      read-only
177           STATUS      mandatory
178           DESCRIPTION
179               "The number of frames that start with a byte other than 0x55,
180                have a byte other than 0xD5 being the first byte that is
181                different from 0x55, or that terminated before the SOF
182                delimiter byte."
183           ::= { chStatEntry 5 }
```

```
184
185       tteAlignErr OBJECT-TYPE
186           SYNTAX      Counter
187           ACCESS      read-only
188           STATUS      mandatory
189           DESCRIPTION
190               "The number of frames having a length that is not a multiple
      of
191                8 bits (at the given line speed)."
192           ::= { chStatEntry 6 }
193
194       tteMiiErr OBJECT-TYPE
195           SYNTAX      Counter
196           ACCESS      read-only
197           STATUS      mandatory
198           DESCRIPTION
199               "The number of frames that terminated with the MII error input
200                being asserted."
201           ::= { chStatEntry 7 }
202
203       tteRxFrames OBJECT-TYPE
204           SYNTAX      Counter
205           ACCESS      read-only
206           STATUS      mandatory
207           DESCRIPTION
208               "The number correctly received frames on the channel."
209           ::= { chStatEntry 8 }
210
211       tteTxFrames OBJECT-TYPE
212           SYNTAX      Counter
213           ACCESS      read-only
214           STATUS      mandatory
215           DESCRIPTION
216               "The number transmitted frames on the channel."
217           ::= { chStatEntry 9 }
218
219       tteVlNotFound OBJECT-TYPE
220           SYNTAX      Counter
221           ACCESS      read-only
222           STATUS      mandatory
223           DESCRIPTION
224               "The number of critical traffic frames dropped at the
      respective
225                channel (since power-on or reset or the most recent read
      access
226                of the host layer to this field) because their VL ID did not
227                produce a hit in the Input VL Lookup Table."
228           ::= { chStatEntry 10 }
229
230       -- Partition Statistics table
231
232       parStatTable OBJECT-TYPE
233         SYNTAX  SEQUENCE OF ParStatEntry
234         ACCESS  not-accessible
235         STATUS  mandatory
236         DESCRIPTION
```

```
237               "A table containing partition statistics."
238       ::= { tteEndSystem1-7 12 }
239
240     parStatEntry OBJECT-TYPE
241       SYNTAX  ParStatEntry
242       ACCESS  not-accessible
243       STATUS  mandatory
244       DESCRIPTION
245               "Information about a particular table row."
246       INDEX   { tteDropFull }
247       ::= { parStatTable 1 }
248
249     ParStatEntry ::=
250       SEQUENCE {
251           tteDropFull
252               Counter,
253           tteMemThreshold
254               Counter
255       }
256
257     tteDropFull OBJECT-TYPE
258           SYNTAX      Counter
259           ACCESS      read-only
260           STATUS      mandatory
261           DESCRIPTION
262               "This counter is incremented when a message that could be
    stored
263               in an input port of partition i was dropped because
264               the corresponding input port was already full (only in case of
265               a queue). The counter is 24 bits wide and does not wrap."
266           ::= { parStatEntry 1 }
267
268     tteMemThreshold OBJECT-TYPE
269           SYNTAX      Counter
270           ACCESS      read-only
271           STATUS      mandatory
272           DESCRIPTION
273               "Indicator that the amount of free memory buffers exceeds
274                the configured threshold on the partition. 0 means threshold
275                was not reached. 1 means the threshold was reached."
276           ::= { parStatEntry 2 }
277
278     tteRmDropSpecial OBJECT-TYPE
279           SYNTAX      INTEGER
280           ACCESS      read-only
281           STATUS      mandatory
282           DESCRIPTION
283               "This flag will be set whenever the MAC drops a frame because
    of
284                ARINC 664 redundancy management if the sequence number of
285                the frame received did not match the sequence number of
286                the frame of the same VL that most recently passed RM."
287           ::= { tteEndSystem1-7 13 }
288
289     tteRmIdxSpecial OBJECT-TYPE
290           SYNTAX      INTEGER
```

```
291         ACCESS      read-only
292         STATUS      mandatory
293         DESCRIPTION
294             "Index of the entry within the IC/RMTable of the configuration
295              file that was processed when most recently triggering setting
296              the tteRmDropSpecial flag.
297              This value is only valid after reading tteRmDropSpecial first
298              and if tteRmDropSpecial indicates an error. Otherwise its
299              content is undefined."
300         ::= { tteEndSystem1-7 14 }
301
302     tteRmDrop OBJECT-TYPE
303         SYNTAX      INTEGER
304         ACCESS      read-only
305         STATUS      mandatory
306         DESCRIPTION
307             "This flag will be set whenever the MAC drops a frame because
308              (a) it carried the same sequence number as the most recent
309              frame of the same VL that passed the check in case of ARINC
    664
310              redundancy management or (b) it was received too close to
311              the most recent frame of the same VL that passed the check in
312              case of time-triggered redundancy management ."
313         ::= { tteEndSystem1-7 15 }
314
315     tteRmIdx OBJECT-TYPE
316         SYNTAX      INTEGER
317         ACCESS      read-only
318         STATUS      mandatory
319         DESCRIPTION
320             "Index of the entry within the IC/RM Table of the
    configuration
321             file that was processed when most recently triggering setting
322             the tteRmDrop flag.
323             This value is only valid after reading tteRmDrop first
324             and if tteRmDrop indicates an error. Otherwise its
325             content is undefined."
326         ::= { tteEndSystem1-7 16 }
327
328     tteDropIpSize OBJECT-TYPE
329         SYNTAX      Counter
330         ACCESS      read-only
331         STATUS      mandatory
332         DESCRIPTION
333             "Number of frames dropped because of incorrect size of IP
334             packet."
335         ::= { tteEndSystem1-7 17 }
336
337     tteMinMembVec OBJECT-TYPE
338         SYNTAX      INTEGER
339         ACCESS      read-only
340         STATUS      mandatory
341         DESCRIPTION
342             "The membership vector with the smallest number of
343              flags set of all in-schedule integration frames
344              ever processed by the synchronization state
```

```
345                 machine."
346             ::= { tteEndSystem1-7 18 }
347
348         tteMaxMembVec OBJECT-TYPE
349             SYNTAX      INTEGER
350             ACCESS      read-only
351             STATUS      mandatory
352             DESCRIPTION
353                 "The membership vector with the largest number of
354                  flags set of all in-schedule integration frames
355                  ever processed by the synchronization state
356                  machine."
357             ::= { tteEndSystem1-7 19 }
358
359         tteAggrMembVec OBJECT-TYPE
360             SYNTAX      INTEGER
361             ACCESS      read-only
362             STATUS      mandatory
363             DESCRIPTION
364                 "The aggregated membership value of in-schedule
365                  integration protocol control frames received
366                  within the most recent acceptance window."
367             ::= { tteEndSystem1-7 20 }
368     END
```

Listing 8: *TTE-ES-1-7-MIB definitions*

Terms and Abbreviations

Entry	Description
ASIC	Application-Specific Integrated Circuit
BAG	Bandwidth Allocation Gap
BE	Best Effort
BIST	Built-In Self-Test
Best-Effort (BE) Traffic	Ethernet traffic that is not critical traffic (IEEE 802.3 standard traffic [4]). BE traffic will be serviced with lowest priority.
CBIT	Continuous Built-In Test
COM	Communication port, a serial port that acts as a serial communication interface.
CRC	Cyclic Redundancy Check
DSU	Debug Support Unit
EAN	European Article Number
Fail-silent	A fail-silent system either provides a service as intended or no service at all, i.e., it fails silently.
GPIO	General-Purpose Input/Output
ICMP	Internet Control Message Protocol
JTAG	Joint Test Action Group
LVDS	Low-Voltage Differential Signaling
MIB	Management Information Database
PBIT	Power-up Built-In Test
PCB	Printed Circuit Board
PHY	Physical Layer
QR Code	Quick Response Code
RC	Rate Constrained
RMAP	Remote Memory Access Protocol
Rate-Constrained (RC) Traffic	TTEthernet traffic that is used for applications with less stringent determinism and real-time requirements than strictly time-triggered applications (ARINC 664 avionics traffic). RC traffic is ued for safety-critical aerospace applications that depend on highly reliable communication and have moderate temporal quality requirements, e.g., multimedia systems.
S/N	Serial Number

Entry	Description
SFP	Small Form-factor Pluggable, a compact, optical module transceiver.
SNMP	Simple Network Management Protocol
SpW	SpaceWire
TFTP	Trivial File Transfer Protocol
TTE	Time-Triggered Ethernet (*this abbreviations is used as a prefix only*).
TT	Time-Triggered
Time-Triggered (TT) Traffic	TTEthernet traffic that is used for applications with stringent determinism and real-time requirements (IEEE 1588-compatible clock synchronization service, real-time control [5]). TT traffic guarantees that bandwidth and latency are predefined for each application. TT traffic is used for safety-critical aerospace applications that depend on highly reliable communication and have high temporal quality requirements, e.g., closed loop control systems.
UART	Universal Asynchronous Receiver-Transmitter
UDP	User Datagram Protocol
VLAN	Virtual Local Area Network
VL	Virtual Link
TTEthernet	Time-Triggered Ethernet, also *TTE* when used as a prefix.

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