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2018-10-31	4.4.0	AUTOSAR Release Management	• Modifications to enhance the precision of Global Time Synchronization • Additional minor corrections / clarifications / editorial changes; For details please refer to the ChangeDocumentation
2017-12-08	4.3.1	AUTOSAR Release Management	• Corrections and clarification on how to apply rate correction • Clarifications on Time Base Status and Time Leap behavior • Additional minor corrections / clarifications / editorial changes; For details please refer to the ChangeDocumentation
2016-11-30	4.3.0	AUTOSAR Release Management	• Rate Correction added • Time precision measurement support added • Time/status notification mechanism added • Various enhancements and corrections
2015-07-31	4.2.2	AUTOSAR Release Management	• Config parameter argument added to StbM_Init • StbM_TimeStampRawType changed uint32 • StbM_BusSetGlobalTime allow NULL as userDataPtr • 'const' added to input arguments passed by pointer • Debugging support marked as obsolete

Document Change History

Date	Release	Changed by	Change Description
2014-10-31	4.2.1	AUTOSAR Release Management	• Concept "Global Time Synchronization" incorporated to replace (and by that improve) original functionality and to support new functionality, e.g.: • support of CAN and Ethernet • support for gateways to enable time domains spanning several busses • Due to deficiencies R4.0/1 content has been removed (e.g. customer API + polling of time-base providers). Exception: API to synchronize OS schedule tables.
2014-03-31	4.1.3	AUTOSAR Release Management	• Clarification on Autonomous Time Maintenance
2013-10-31	4.1.2	AUTOSAR Release Management	• Parameter StbMMainFunctionPeriod added • Requirements StbM_0030 and 00035 removed • Restructuring of and clarification w.r.t. Service Interface related chapters • Parameters StbMFlexRayClusterRef / StbMTtcanClusterRef set to obsolete • Editorial changes • Removed chapter(s) on change documentation
2013-03-15	4.1.1	AUTOSAR Administration	• Added “Known Limitations” • Contradictions in error handling removed • Added chapter service interfaces • Added Subchapter 3.x due to SWS General Rollout • Reworked according to the new SWS_BSWGeneral
2011-12-22	4.0.3	AUTOSAR Administration	• Added functionality for absolute time provision

Document Change History			
Date	**Release**	**Changed by**	**Change Description**
2010-09-30	3.1.5	AUTOSAR Administration	• SRS_General: SRS_BSW_00004 • Binding character of the Standardized AUTOSAR Interfaces mentioned in the SWS Documents. • Missing Port Driver DET Error Codes
2010-02-02	3.1.4	AUTOSAR Administration	• Initial Release

Disclaimer

Table of Contents

1 Introduction and Functional Overview

This document specifies the functionality, API and the configuration of the Synchronized Time-Base Manager (StbM) module.

The purpose of the Synchronized Time-Base Manager is to provide Synchronized Time Bases to its customers, i.e., time bases, which are synchronized with time bases on other nodes of a distributed system.

1.1 Use Cases

Two main use cases are supported by the Synchronized Time-Base Manager:

- **Synchronization of RunnableEntities**

  An arbitrary number of RunnableEntities must be executed synchronously. Synchronous means that they shall start with a well-defined and guaranteed relative offset (e.g. relative offset “0”, means the execution shall occur at the same point in time).

  Such a requirement can be specified by the AUTOSAR Timing Extensions [10] and must be fulfilled independently of the actual deployment of the software components.

  Typcial examples of this use case are the sensor data read out or synchronous actuator triggering by different RunnableEntities.

- **Provision of absolute time value**

  The application (and other BSW modules) shall provide a central module that is responsible for the provision of information about the absolute time and passage of time.

  Typical examples of this use case are:
  - Sensor data fusion: Data from various sensor systems like radar or stereo multi-purpose cameras can be temporally correlated.
  - Event data recording: In some cases, e.g. crash, it is desirable to store data about the events and the internal state of different ECUs. For a temporal correlation of these events and states a common time base is required.
  - Access to synchronized calendar time for diagnostic events storage.

1.2 Functional Overview

Figure 1 illustrates how the Synchronized Time-Base Manager interacts with other modules.

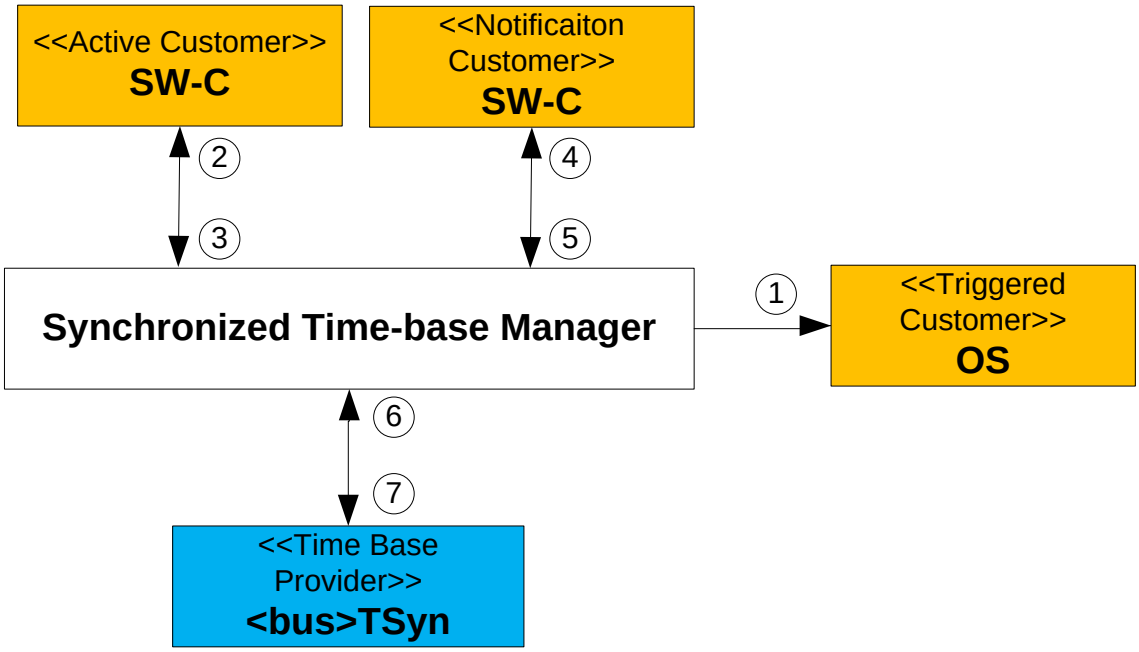


Figure 1: Synchronized Time-Base Manager as broker

The Synchronized Time-Base Manager itself does not provide means like network time protocols or time agreement protocols to synchronize its (local) Time Bases to Time Bases on other nodes. It interacts with the <Bus>TSyn modules of the BSW to achieve such synchronization. Those modules take as shown in Figure 1 the role of a Time Base Provider and support above mentioned time protocols.

With the information retrieved from the provider modules, the Synchronized Time-Base Manager is able to synchronize its Time Bases to Time Bases on other nodes.

BSW modules and SW-C, which take the role of a customer, consume the time information provided and managed by the Synchronized Time-Base Manager. Three types of customers may be distingushed:

a) Triggered customer
b) Active customer
c) Notification customer

For a detailed description of those three types refer to chapter 2.2.8.

Thus, the Synchronized Time-Base Manager acts as Time Base broker by offering the customers access to Synchronized Time Bases. Doing so, the Synchronized Time-Base Manager abstracts from the “real” Time Base provider.

Providing access to Synchronized Time Bases between the updates of the Time Base Providers is usually realized by using a Hardware Reference Clock; often in combination with a Software Counter which keeps track of the Hardware Reference Clock’s overflows. Together Software Counter and Hardware Reference clock form the Virtual Local Time (despite the name the Virtual Local Time is an actually realized implementation).

This time is subsequently used to drive the time of the Time Bases, taking account their Rate Deviations and Offsets to the Virtual Local Time.

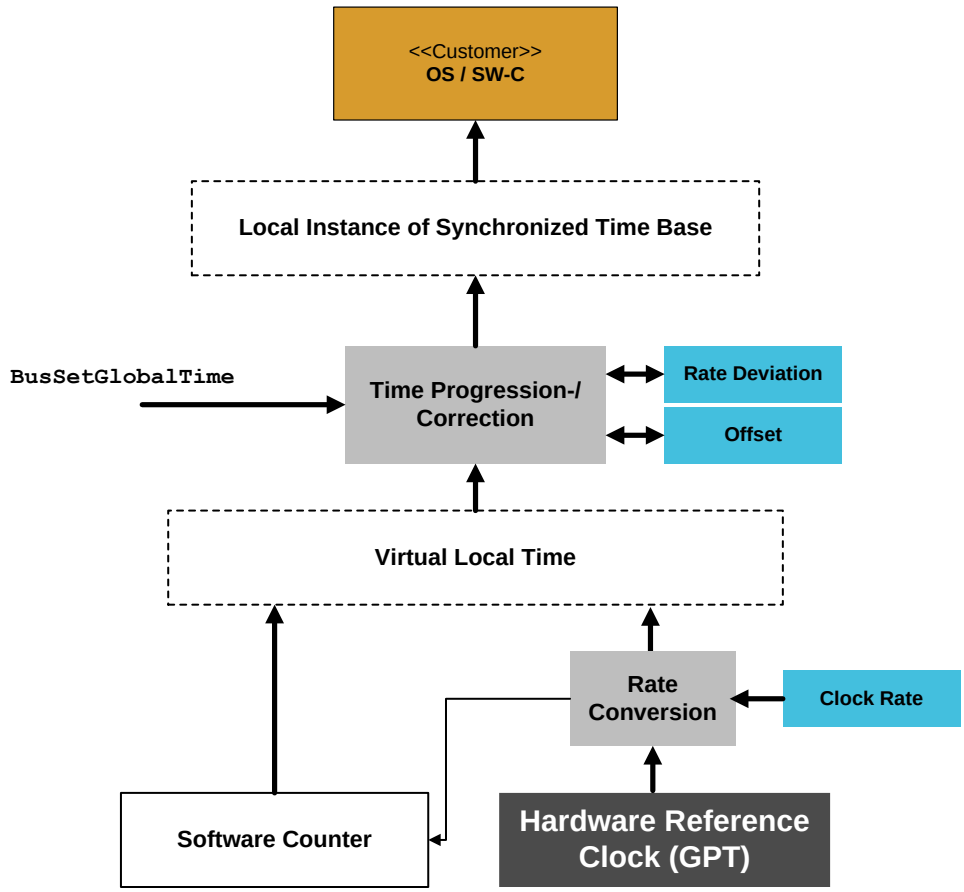


Figure 2: Abstract Working Principle of the Synchronized Time-Base Manager

The API for accessing the Synchronized Time Bases is provided to application software components as well as to other BSW modules:

- For the interaction with application software components, standardized AUTOSAR interfaces are specified in chapter 8.2.
- For the interaction with other BSW modules, respective interfaces are specified in chapter 8.1.3.

2 Acronyms, Abbreviations, and Definitions

Acronyms, abbreviations, and definitions, which have a StbM local scope and therefore are not contained in the AUTOSAR glossary, appear in this local glossary.

2.1 Acronyms and Abbreviations

Abbreviation / Acronym:	Description
(G)TD	(Global) Time Domain
(G)TM	(Global)Time Master
<Bus>TSyn	A bus specific Time Synchronization Provider module
AVB	Audio Video Bridging
BMCA	Best Master Clock Algorithm
CAN	Controller Area Network
CanTSyn	Time Synchronization Provider module for CAN
DET	Default Error Tracer
ECU	Electronic Control Unit
ETH	Ethernet
EthTSyn	Time Synchronization Provider module for Ethernet
FR	FlexRay
FRC	Free running counter
FrTSyn	Time Synchronization Provider module for FlexRay
FUP message	Follow-Up message for a Synchronized Time Base
GM(C)	Grand Master (Clock)
GTS	Global Time Synchronization
OFNS message	Time Synchronization message for an Offset Time Base (containing the nanosecond part of the time)
OFS message	Time Synchronization message for an Offset Time Base
PTP	Precision Time Protocol
StbM	Synchronized Time-Base Manager
SYNC message	Time Synchronization message for a Synchronized Time Base
TG	Time Gateway
Timesync	Time Synchronization
TS	Time Slave
TSD	Time Sub-domain

2.2 Definitions

2.2.1 Clock

Definition: A Clock references to a time capable hardware part of a microcontroller.

2.2.2 Global Time Master

Definition: A Global Time Master is the global owner and origin for a certain Time Base and on the top of the Time Base hierarchy for that Time Base.

2.2.3 Synchronized Time Base

Definition: A Synchronized Time Base is a Time Base existing at a processing entity (actor / processor / node of a distributed system) that is synchronized with Time Bases at different processing entities. A Synchronized Time Base can be achieved by time protocols or time agreement protocols that derive the Synchronized Time Base in a defined way from one or more physical Time Bases. Examples are the network time protocol (NTP) and FlexRay time agreement protocol.

The synchronization will apply to the clock rate and optionally apply also to the clock absolute value.

A Synchronized Time Base allows synchronized action of the processing units. Synchronized Time Bases are often called “Global Time”.

More than one Synchronized Time Base can exist at one processing unit, e.g. a FlexRay node will have the Synchronized Time Base retrieved from the FlexRay time agreement protocol in the network cluster but might also have a Synchronized Time Base derived from the time provided by a UTC time server (which is based on a set of atomic clocks). Both Synchronized Time Bases will probably have slightly different rate, and there is no relationship defined between their absolute values.

2.2.4 Time Base

Definition: A Time Base is a unique time entity characterized by:

- Progression of time, which denotes how time progresses, i.e. the rate (i.e. the rate is derived from a local quartz oscillator) and absolute changes of the time value at certain point in times (e.g. effects of offset correction in FlexRay).
- Ownership, which denotes who is the owner of the time base. A distributed FlexRay Time Base e.g. has multiple owners and the progression of time with respect to rate and offset corrections is a result of involving a subset of FlexRay nodes.
- Reference to the physical world, i.e. whether the Time Base is a relative Time Base counting local operation time of an ECU or representing an absolute time like UTC.
  A Time Base can have more than one reference, e.g. it can be a relative time which in combination with an offset value also represents an absolute time.

Examples of Time Bases in vehicles are:

- Absolute, which is based on a GPS based time

- Relative, which represents the accumulated overall operating time of a vehicle, i.e. this Time Base does not start with a value of zero whenever the vehicle starts operating
- Relative, starting at zero when the ECU begins its operation

A Time Base implies the availability of a Clock.

Special case "Pure Local Time Base":
A Pure Local Time Base is a Time Base with a local scope as it is neither propagated to other nodes nor received from other nodes. A Pure Local Time Base will only locally be set and read. It is therefore possible to have multiple Pure Local Time Bases with the same Time Domain number in various nodes in parallel. A Pure Local Time Base behaves like a Synchronized Time Base since it progresses in time, however it is not synchronized via Timesync Modules. Pure Local Time Bases behaving like Offset Time Bases are not supported.

2.2.5 Time Base Provider

Definition: A Time Base Provider is the role that a <Bus>TSyn module takes for a given Time Base. Therefore a <Bus>TSyn module can contain only one Time Base provider or more than one Time Base provider. Time Base providers are either of type importer or exporter, whereas an importer acts as Time Slave and an exporter acts as Time Master. A Time Gateway consists of one Time Base importer and one or more Time Base exporters for a given Time Base. In order to limit the terminology importers are denoted as slaves and exporters are denoted as masters.

2.2.6 Time Communication Port

Definition: A Time Communication Port is a physical communication interface (in AUTOSAR coverable by the item: Physical Connector) at an ECU which is used to transport time information.

2.2.7 Time Communication Service

Definition: A Time Communication Service is an interaction between Time Bases which is performed by Time Base providers. Time communication services are message based between a Time Master and one or more Time Slaves or between one Time Slave and his Time Master.

Figure 3 shows a network topology example and the related terminology.

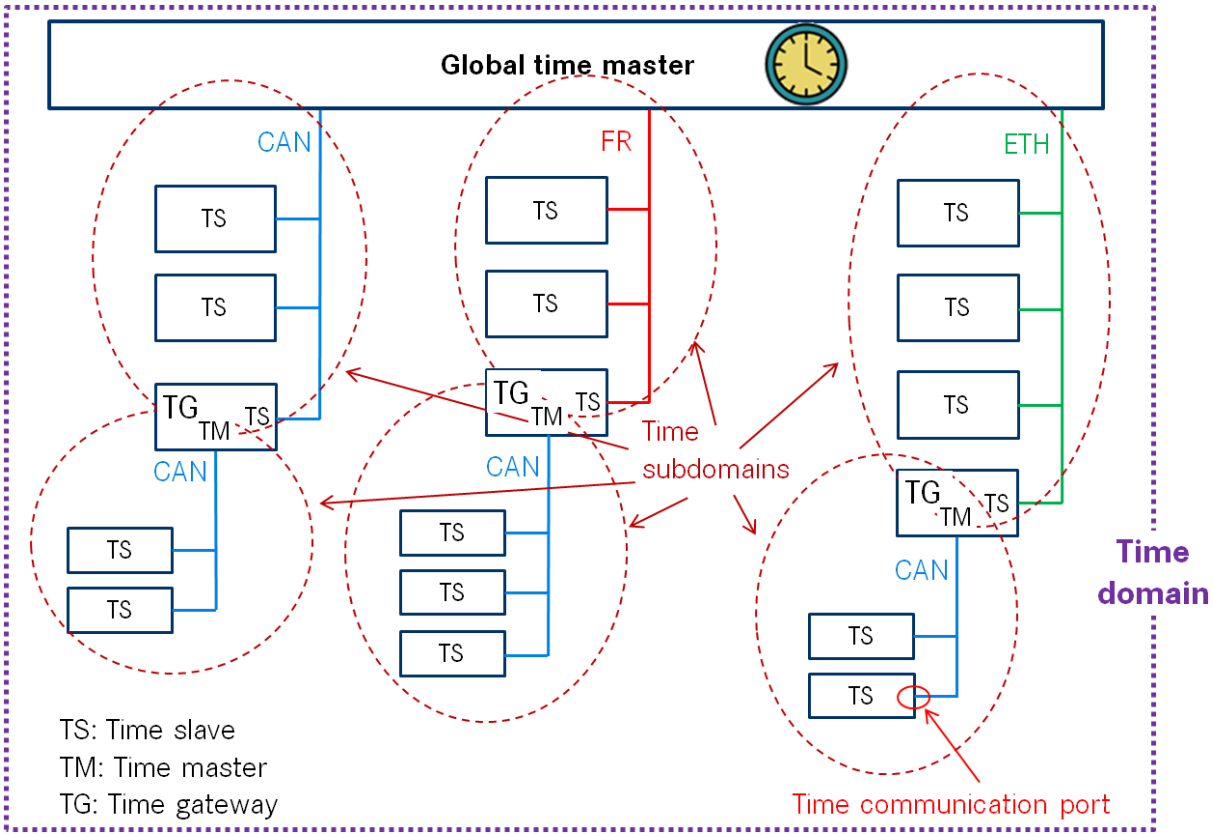


Figure 3: Terminology Example

2.2.8 Time Base Customer

a) Active Customer

This kind of customer autonomously calls the Synchronized Time-Base Manager either

- To read time information (arrow “2” in Figure 1) from the Synchronized Time-Base Manager or
- To update (arrow “3” in Figure 1) the Time Base maintained by the Synchronized Time-Base Manager according to application information.

b) Triggered Customer

This kind of customer is triggered by the Synchronized Time-Base Manager (arrow “1” in Figure 1). Thus, the Synchronized Time-Base Manager itself is aware of the required functionality of the customer, and uses the defined interface of the customer to access it.

This functionality is currently limited to synchronization of OS ScheduleTables.

c) Notification Customer

This kind of customer is notified by the Synchronized Time-Base Manager (arrow “4” in Figure 1), if the following Time Base related events occur:

- Time Base status has changed (e.g. a timeout has occurred for a Time Base)
- Time Base value has reached a given value, which has been previously set by the customer (arrow “5” in Figure 1).

2.2.9 Time Domain

Definition: A Time Domain denotes which components (e.g. nodes, communication systems) are linked to a certain Time Base. A Time Domain can contain no or more than one Time Sub-domains. If the timing hierarchy of a Time Domain contains no Time Gateways, i.e. all nodes are connected to the same bus system, then there is no dedicated Time Sub-domain which otherwise would be equal to the Time Domain itself.

2.2.10 Time Gateway

Definition: A Time Gateway is a set of entities where one entity is acting as Time Slave for a certain Time Base. The other (one or more) entities are acting as Time Masters which are distributing this Time Base to sets of Time Slaves. A Timesync ECU can contain multiple Time Gateways. A Time Gateway can be connected to different types of bus systems (e.g. the slave side could be connected to a FlexRay bus whereas the master side could be connected to a CAN bus system).

2.2.11 Time Hierarchy

Definition: The Time Hierarchy describes how a certain Time Base is distributed, starting at the Global Time Master and being distributed across various Time Gateways (if present) to various Time Slaves.

2.2.12 Time Master

Definition: A Time Master is an entity which is the master for a certain Time Base and which propagates this Time Base to a set of Time Slaves within a certain segment of a communication network, being a source for this Time Base.
If a Time Master is also the owner of the Time Base then he is the Global Time Master. A Time Gateway typically consists of one Time Slave and one or more Time Masters. When mapping time entities to real ECUs it has to be noted, that an ECU could be Time Master (or even Global Time Master) for one Time Base and Time Slave for another Time Base.

Special Case “Pure Local Time Master“:
A Pure Local Time Master is an entity which is the master of a Pure Local Time Base and which does therefore not propagate this time base to any Time Slave.

2.2.13 Time Slave

Definition: A Time Slave is an entity which is the recipient for a certain Time Base within a certain segment of a communication network, being a consumer for this Time Base.

2.2.14 Time Sub-domain

Definition: A Time Sub-domain denotes which components (e.g. nodes) are linked to a certain Time Base whereas the scope is limited to one communication bus.

2.2.15 Timesync ECU

Definition: A Timesync ECU is an ECU which is part of a Time Domain by containing one or more Time Slaves or Time Masters.

2.2.16 Timesync Module

Definition: Timesync Modules (<Bus>TSyn modules) are bus specific modules to receive or transmit time information on bus systems by applying bus specific mechanisms. A Timesync module can serve multiple communication buses of the same type.

2.2.17 Virtual Local Time

Definition: The Virtual Local Time is a time which is driven by the OS counter or a hardware clock and which in turn drives a Synchronized Time Base. The associated Synchronized Time Base has an offset to the Virtual Local Time. For Time Slaves there is usually also a deviation in rate caused by different clock drifts of the HW reference clocks used by Time Master and Time Slave.

The term Virtual Local Time describes a Time Base whose time progresses monotonously without jumps.

Virtual Local Time Bases are necessary for interpolating

- local instances of Synchronized Time Bases (in either Master or Slave)
- Pure Local Time Bases
- and Offset Time Bases (in case of rate correction)

In addition, Virtual Local Time Bases can be used to measure timespans, i.e., for rate correction measurement intervals or timeouts.

Virtual Local Time Bases are based on a hardware clock and can be derived from various sources:

- OS counter
- GPT counter
- Ethernet freerunning counter (used for ingress and egress timestamping)

It is possible to use different Virtual Local Time Bases in parallel.

Although the different counter sources vary regarding tick duration and counter width, each derived Virtual Local Time Base has the same width (64 bit) and tick duration (1 ns).

To achieve this, it is necessary to count overflows of the counters and to convert counter specific tick durations if required.

2.2.18 Time Correction

Definition: Time Correction in Time Slaves is the process of adjusting the value of the local instance of the Time Base to the value of the Global Time Base.
In Time Masters, Time Correction is the process of eliminating the deviation of an Offset Clock compared to its corresponding Synchronized Time Base.
Time Correction can be divided into Rate Correction, which corrects rate deviations and Offset Correction, which corrects absolute time deviations. Offset Correction can be furthermore divided into (Offset Correction By) Jump Correction or (Offset Correction By) Rate Adaption.

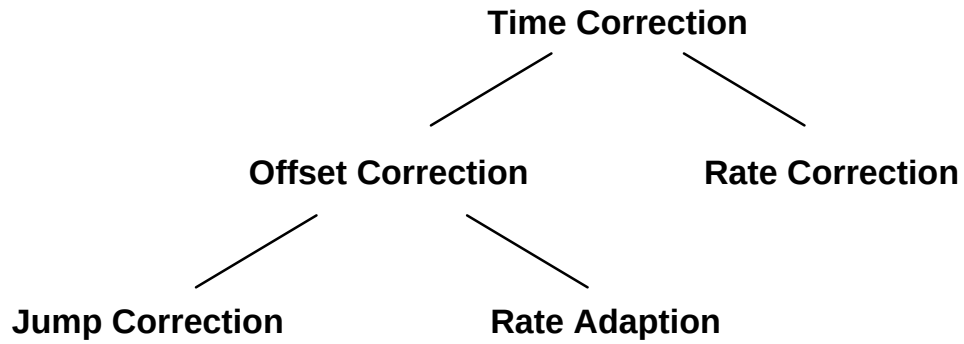


Figure 4 Time Correction Hierarchy

Note:

- Rate Deviation: This means that the time progresses at different rates in the local instance of the Time Base and the Global Time Base. Such deviations can occur if, for example, the local hardware reference clock is driven by a crystal whose frequency is off due to manufacturing tolerances and/or thermal effects.
- Time Offset: This means that the local instance of the Time Base and the Global Time Base are not synchronized precisely. Such deviations occur when the rate of the local hardware reference clock is not accurate and because the synchronization with the global Time Base is influenced by jitter effects, software delays and counter granularities.

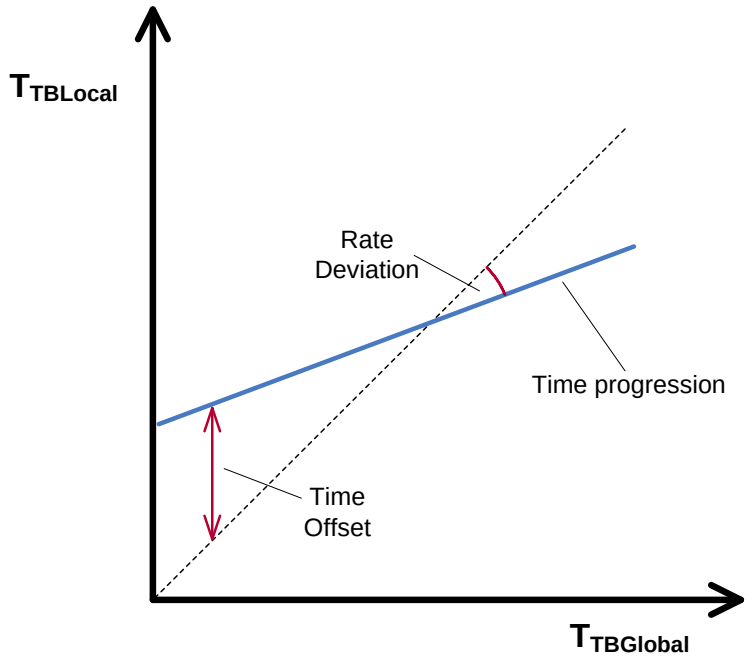


Figure 5: Time Deviations Rate Correction

Definition: Rate Correction corrects the rate-deviation of a local hardware reference clock. This correction is done by a multiplicative correction factor which is used in addition to the clock's preconfigured rate. Rate Correction determines the correction factor in the scope of a measurement. This correction factor is however not fixed but updated after each successful measurement.

The working principle of Rate Correction is not to adjust the local hardware reference clock in order to let it progress with the correct rate. Instead Rate Correction only corrects the values of the local instance of the Time Base on-the-fly when they are read.

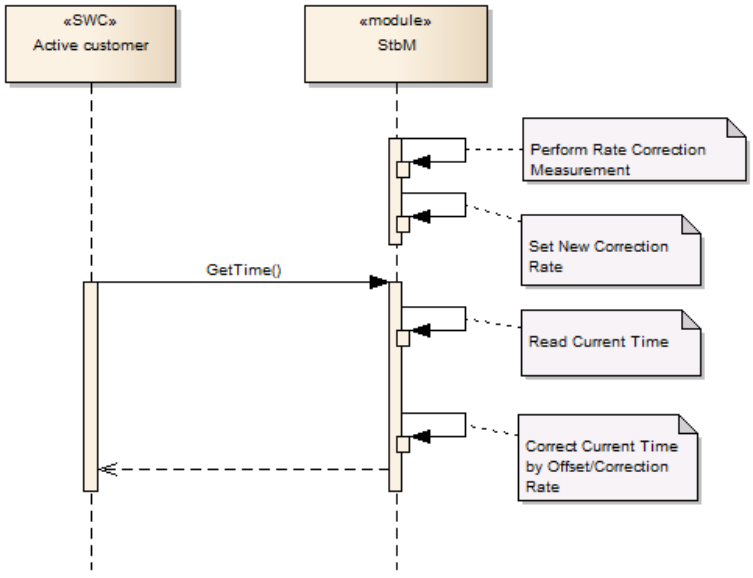


Figure 6: Rate Correction

2.2.19 Offset Correction

Definition: Offset Correction corrects absolute time deviations (offsets). Depending on the magnitude of the offset and the configuration of StbM, this correction is either performed by Jump Correction or Rate Adaption.
Offset Correction is independent from Rate Correction. It is performed each time the local instance of the Time Base is synchronized to its Global Time Base.

2.2.20 Jump Correction

Definition: Jump Correction corrects absolute time offsets in a single step by adding the offset to the local instance of the Time Base (which is equivalent to taking over the value of the Global Time Base).

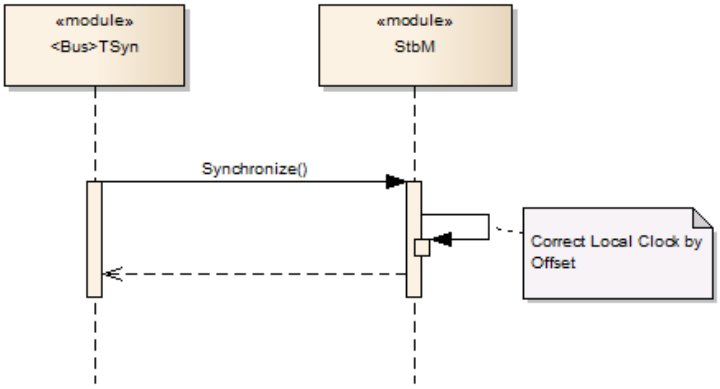


Figure 7: Offset Jump Correction

2.2.21 Rate Adaption

Definition: Rate Adaption corrects time offsets gradually within a predefined timespan. Hereto, Rate Adaption switches the rate of the local instance of the Time Base temporarily to a different value. This rate is chosen to completely eliminate the offset within the preconfigured timespan.

Like Rate Correction, Rate Adaption does not adjust the local instance of the Time Base (including hardware reference clock). It merely corrects the clock values on-the-fly when they are read.

Note: Rate Adaption and Rate Correction use a similar mechanism. They are however completely independent from each other.

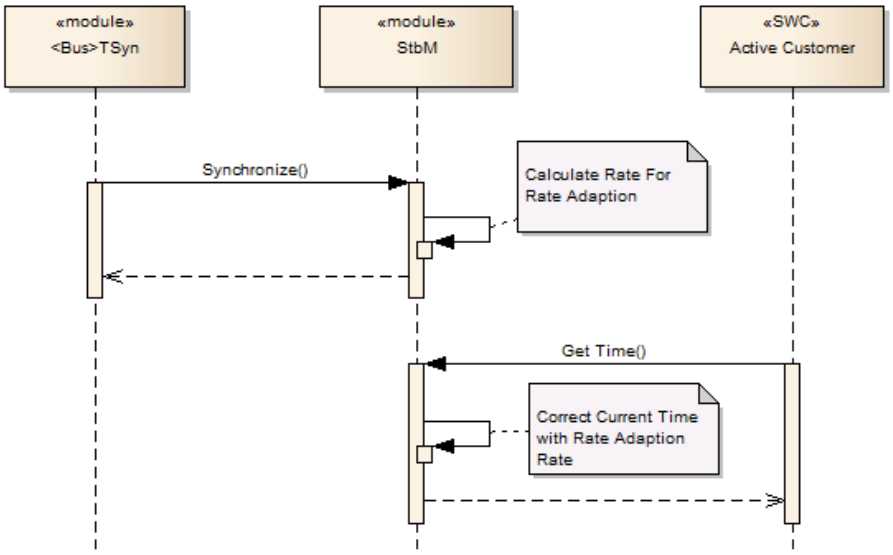


Figure 8: Offset Rate Adaption

3 Related documentation

3.1 Input documents

[1] Requirements on Synchronized Time-Base Manager
AUTOSAR_SRS_SynchronizedTimeBaseManager.pdf

[2] Layered Software Architecture
AUTOSAR_EXP_LayeredSoftwareArchitecture.pdf

[3] Specification of ECU Configuration
AUTOSAR_TPS_ECUConfiguration.pdf

[4] Specification of Operating System
AUTOSAR_SWS_OS.pdf

[5] Specification of FlexRay Interface
AUTOSAR_SWS_FlexRayInterface.pdf

[6] Specification of CAN Interface
AUTOSAR_SWS_CANInterface.pdf

[7] Virtual Functional Bus
AUTOSAR_EXP_VFB.pdf

[8] Software Component Template
AUTOSAR_TPS_SoftwareComponentTemplate.pdf

[9] Basic Software Module Description Template
AUTOSAR_TPS_BSWModuleDescriptionTemplate.pdf

[10] Specification of TimingExtensions
AUTOSAR_TPS_TimingExtensions.pdf

[13] General Requirements on Basic Software Modules
AUTOSAR_SRS_BSWGeneral.pdf

[14] General Specification of Basic Software Modules
AUTOSAR_SWS_BSWGeneral.pdf

[15] Specification of RTE
AUTOSAR_SWS_RTE.pdf

[16] Specification of Synchronized Time-Base Manager
AUTOSAR_EXP_CDDDesignAndIntegrationGuideline.pdf

3.2 Related standards and norms

[17] IEEE Standard 802.1AS™- 30 of March 2011
http://standards.ieee.org/getieee802/download/802.1AS-2011.pdf

3.3 Related specification

AUTOSAR provides a General Specification on Basic Software modules [14] (SWS BSW General), which is also valid for the Synchronized Time-Base Manager.

Thus, the specification SWS BSW General shall be considered as additional and required specification for the Synchronized Time-Base Manager.

4 Constraints and assumptions

4.1 Limitations

The current module proposal has a number of limitations for the application of the Synchronized Time-Base Manager within an AUTOSAR system.

4.1.1 OS ScheduleTable

The Synchronized Time-Base Manager shall perform the functionality of synchronizing OS ScheduleTables with a respective Synchronized Time Base. However, the StbM considers only the case when the targeted OS ScheduleTable is **explicitly** synchronized. The **implicit** synchronization does not affect the StbM, because the synchronization mechanism bypasses the module (for more information about the difference between explicit and implicit synchronization, please refer to [4]). Thus, when talking in the following about synchronization of OS ScheduleTables, always the explicit one is meant.

4.1.2 Synchronized Time Base Identifier

The `StbMSynchronizedTimeBaseIdentifier` range (128 .. 65535) is currently reserved and might still be used by legacy applications (implementing Triggered Customers). The ID range will however be reassigned to new features in the next release. Legacy applications will then no longer be supported.

4.1.3 Mode switches

The Synchronized Time-Base Manager does not deal with mode switches during runtime.

4.1.4 Configuration

Postbuild configuration of the StbM is limited to enabling or disabling the functionality of a system wide Global Time Master for a Time Base (refer to **ECUC_StbM_00036 :**).

4.1.5 Out of scope

- Errors, which occurred during Global Time establishment and which are not caused by the module itself (e.g. loss of FlexRay global time is a FlexRay issue is not an issue of the Synchronized Time-Base Manager).
- Errors, which occurred during interaction with *customers*.
  Example: Calling the explicit OS ScheduleTable synchronization may cause an exception, because the delta between the submitted parameter “counterValue” and the OS internal counter is higher than the tolerance range

of affected expiry points. Dealing with this exception is an OS issue, not an issue of the Synchronized Time-Base Manager.

4.2 Applicability to car domains

The concept is targeted at supporting time-critical and safety-related automotive applications such as airbag systems and braking systems. This doesn't mean that the concept has all that is required by such systems though, but crucial timing-related features that cannot be deferred to implementation are considered.

4.3 Conflicts

None.

5 Dependencies to other modules

5.1 Code file structure

For details refer to the chapter 5.1.6 “Code file structure” in SWS BSW General [14]

5.2 Header file structure

For details, refer to the section 5.1.7 " Header file structure" of the SWS BSW General [14].

In addition to the files defined in section 5.1.7 “Header file structure” of the SWS BSW General, the StbM needs to include the file Os.h, EthIf.h and Gpt.h.

[SWS_StbM_00065][
If a triggered customer is configured (refer to **ECUC_StbM_00004 :** `StbMTriggeredCustomer`), StbM.c shall include Os.h to have access to the schedule table interface of the OS.
] (SRS_BSW_00384)

[SWS_StbM_00246][
If time stamping via Ethernet shall be supported (refer to `EthIfGlobalTimeSupport`, which is referenced via `StbMLocalTimeHardware` **ECUC_StbM_00053 : ,** if set to `EthTSynGlobalTimeDomain`), StbM.c shall include EthIf.h to have access to the interface of the EthIf module.
] (SRS_BSW_00384)

[**SWS_StbM_00426][**
If time stamping via GPT shall be supported (which is referenced via `StbMLocalTimeHardware` (**ECUC_StbM_00053 :**), if set to `GptChannelConfiguration`), StbM.c shall include Gpt.h to have access to the interface of the GPT module.
] (RS_TS_00017, RS_TS_00002)

6 Requirements traceability

Requirement	Description	Satisfied by
RS_TS_00002	The Implementation of Time Synchronization, independently of the Role it is acting as, shall always maintain its own Time Base	SWS_StbM_00178, SWS_StbM_00180, SWS_StbM_00342, SWS_StbM_00413, SWS_StbM_00426, SWS_StbM_00433
RS_TS_00003	The Implementation of Time Synchronization shall initialize the Local Time Base with zero at startup	SWS_StbM_00170
RS_TS_00004	The Implementation of Time Synchronization shall initialize the Global Time Base with a configurable startup value.	SWS_StbM_00171
RS_TS_00005	The Implementation of Time Synchronization shall allow customers to have access to the Synchronized Time Base	SWS_StbM_00142, SWS_StbM_00173, SWS_StbM_00195, SWS_StbM_00200, SWS_StbM_00240, SWS_StbM_00244, SWS_StbM_00247, SWS_StbM_00248, SWS_StbM_00261, SWS_StbM_00262, SWS_StbM_00263, SWS_StbM_00267, SWS_StbM_00434, SWS_StbM_00435, SWS_StbM_00436, SWS_StbM_91005
RS_TS_00006	The Implementation of Time Synchronization shall provide time information to TSP modules	SWS_StbM_00173, SWS_StbM_00174, SWS_StbM_00175, SWS_StbM_00195, SWS_StbM_00205, SWS_StbM_00209, SWS_StbM_00434, SWS_StbM_00435, SWS_StbM_00436, SWS_StbM_00437, SWS_StbM_91005, SWS_StbM_91006
RS_TS_00007	The Implementation of Time Synchronization shall synchronize the Time Base of a Time Slave, on reception of a Time Master value	SWS_StbM_00179, SWS_StbM_00233, SWS_StbM_00393, SWS_StbM_00438, SWS_StbM_00439
RS_TS_00008	The Implementation of Time Synchronization shall continuously maintain its Time Bases based on a Time Base reference clock	SWS_StbM_00174, SWS_StbM_00175, SWS_StbM_00178, SWS_StbM_00180, SWS_StbM_00205, SWS_StbM_00209, SWS_StbM_00413, SWS_StbM_00433, SWS_StbM_00437, SWS_StbM_91006
RS_TS_00009	The Implementation of Time Synchronization shall maintain the synchronization status of a Time Base	SWS_StbM_00179, SWS_StbM_00181, SWS_StbM_00182, SWS_StbM_00183, SWS_StbM_00184, SWS_StbM_00185, SWS_StbM_00187, SWS_StbM_00194, SWS_StbM_00239, SWS_StbM_00305, SWS_StbM_00393, SWS_StbM_00399, SWS_StbM_00425, SWS_StbM_00438, SWS_StbM_00439, SWS_StbM_91003
RS_TS_00010	The Implementation of Time Synchronization shall allow customer on master side to	SWS_StbM_00213, SWS_StbM_00240, SWS_StbM_00244, SWS_StbM_00300, SWS_StbM_00342, SWS_StbM_00385

	set the Global Time	
RS_TS_00011	The Implementation of Time Synchronization shall allow customers on master side to trigger time transmission by the TSP module	SWS_StbM_00240, SWS_StbM_00344, SWS_StbM_00346, SWS_StbM_00347, SWS_StbM_00350, SWS_StbM_00351, SWS_StbM_00414
RS_TS_00012	The Implementation of Time Synchronization shall allow customers and TSP modules to read the offset value of an Offset Time Base	SWS_StbM_00191, SWS_StbM_00193, SWS_StbM_00228
RS_TS_00013	The Implementation of Time Synchronization shall allow the customers and TSP modules to set the offset value of an Offset Master Time Base	SWS_StbM_00177, SWS_StbM_00190, SWS_StbM_00191, SWS_StbM_00192, SWS_StbM_00193, SWS_StbM_00223, SWS_StbM_00240, SWS_StbM_00244, SWS_StbM_00304
RS_TS_00014	The Implementation of Time Synchronization shall allow customers to read User Data propagated via the TSP modules.	SWS_StbM_00173, SWS_StbM_00192, SWS_StbM_00195, SWS_StbM_00200, SWS_StbM_00243, SWS_StbM_00247, SWS_StbM_00248, SWS_StbM_00434, SWS_StbM_00435, SWS_StbM_00436, SWS_StbM_91005
RS_TS_00015	The Implementation of Time Synchronization shall allow customers to set User Data propagated via the TSP modules.	SWS_StbM_00190, SWS_StbM_00218, SWS_StbM_00240, SWS_StbM_00243, SWS_StbM_00244, SWS_StbM_00381, SWS_StbM_00398, SWS_StbM_00427
RS_TS_00016	The Implementation of Time Synchronization shall notify customers about status events	SWS_StbM_00277, SWS_StbM_00279, SWS_StbM_00280, SWS_StbM_00284, SWS_StbM_00285, SWS_StbM_00286, SWS_StbM_00287, SWS_StbM_00288, SWS_StbM_00290, SWS_StbM_00299, SWS_StbM_00345
RS_TS_00017	The Implementation of Time Synchronization shall notify customers about elapsed pre-defined time span.	SWS_StbM_00247, SWS_StbM_00270, SWS_StbM_00271, SWS_StbM_00272, SWS_StbM_00273, SWS_StbM_00274, SWS_StbM_00275, SWS_StbM_00276, SWS_StbM_00288, SWS_StbM_00301, SWS_StbM_00335, SWS_StbM_00336, SWS_StbM_00337, SWS_StbM_00409, SWS_StbM_00421, SWS_StbM_00426, SWS_StbM_00432, SWS_StbM_91004
RS_TS_00018	The Implementation of Time Synchronization shall support rate correction	SWS_StbM_00352, SWS_StbM_00353, SWS_StbM_00355, SWS_StbM_00356, SWS_StbM_00359, SWS_StbM_00360, SWS_StbM_00361, SWS_StbM_00362, SWS_StbM_00364, SWS_StbM_00366, SWS_StbM_00367, SWS_StbM_00368, SWS_StbM_00370, SWS_StbM_00371, SWS_StbM_00372, SWS_StbM_00373, SWS_StbM_00374, SWS_StbM_00375, SWS_StbM_00376, SWS_StbM_00377, SWS_StbM_00378, SWS_StbM_00390, SWS_StbM_00395, SWS_StbM_00396, SWS_StbM_00397, SWS_StbM_00400,

		SWS_StbM_00411, SWS_StbM_00412, SWS_StbM_00422, SWS_StbM_00424, SWS_StbM_00431, SWS_StbM_00440, SWS_StbM_00441, SWS_StbM_00442, SWS_StbM_00443
RS_TS_00019	The Implementation of Time Synchronization shall support damping offset correction	SWS_StbM_00356
RS_TS_00024	The Implementation of Time Synchronization shall support storage of the Time Base value at shutdown if configured as Time Master	SWS_StbM_00172
RS_TS_00025	The Implementation of Time Synchronization shall provide fault detection mechanisms	SWS_StbM_00031, SWS_StbM_00183, SWS_StbM_00187, SWS_StbM_00199
RS_TS_00029	The configuration of the Time Synchronization implementation shall allow the implementation to behave as a (vehicle wide) Time Master	SWS_StbM_00195, SWS_StbM_00213, SWS_StbM_00223, SWS_StbM_00228, SWS_StbM_00244, SWS_StbM_00408, SWS_StbM_91001, SWS_StbM_91002, SWS_StbM_91005
RS_TS_00030	The configuration of the Time Synchronization implementation shall allow the implementation to behave as a Time Slave	SWS_StbM_00195, SWS_StbM_00233, SWS_StbM_00248
RS_TS_00031	The configuration of the Time Synchronization implementation shall allow the implementation to behave as a Time Gateway	SWS_StbM_00195, SWS_StbM_00228, SWS_StbM_00233, SWS_StbM_00248, SWS_StbM_91005
RS_TS_00032	The Implementation of Time Synchronization shall trigger registered customers	SWS_StbM_00020, SWS_StbM_00022, SWS_StbM_00077, SWS_StbM_00084, SWS_StbM_00092, SWS_StbM_00093, SWS_StbM_00107, SWS_StbM_00142, SWS_StbM_00302, SWS_StbM_00303
RS_TS_00033	The Implementation of Time Synchronization shall use a time format with a resolution of 1 ns	SWS_StbM_00174, SWS_StbM_00175, SWS_StbM_00437
RS_TS_00034	The Implementation of Time Synchronization shall provide measurement data to the application	SWS_StbM_00233, SWS_StbM_00247, SWS_StbM_00306, SWS_StbM_00307, SWS_StbM_00308, SWS_StbM_00309, SWS_StbM_00310, SWS_StbM_00311, SWS_StbM_00312, SWS_StbM_00313, SWS_StbM_00314, SWS_StbM_00315, SWS_StbM_00316, SWS_StbM_00317, SWS_StbM_00318, SWS_StbM_00319, SWS_StbM_00320, SWS_StbM_00322, SWS_StbM_00323, SWS_StbM_00325, SWS_StbM_00326, SWS_StbM_00328, SWS_StbM_00329, SWS_StbM_00331,

		SWS_StbM_00332, SWS_StbM_00333, SWS_StbM_00334, SWS_StbM_00339, SWS_StbM_00382, SWS_StbM_00383, SWS_StbM_00384, SWS_StbM_00387, SWS_StbM_00388, SWS_StbM_00428
RS_TS_00035	The Implementation of Time Synchronization shall provide a system service interface to applications	SWS_StbM_00142, SWS_StbM_00240, SWS_StbM_00244, SWS_StbM_00247, SWS_StbM_00248, SWS_StbM_00275, SWS_StbM_00276, SWS_StbM_00286, SWS_StbM_00287, SWS_StbM_00288, SWS_StbM_00290
RS_TS_00036	The Implementation of Time Synchronization shall provide a bus independent customer interface	SWS_StbM_00241, SWS_StbM_00242
RS_TS_20001	The configuration of the Time Synchronization implementation shall allow the interaction with different types of customers	SWS_StbM_00020, SWS_StbM_00022, SWS_StbM_00093, SWS_StbM_00277, SWS_StbM_00278, SWS_StbM_00279, SWS_StbM_00282, SWS_StbM_00285, SWS_StbM_00303
SRS_BSW_00005	Modules of the µC Abstraction Layer (MCAL) may not have hard coded horizontal interfaces	SWS_StbM_00140
SRS_BSW_00006	The source code of software modules above the µC Abstraction Layer (MCAL) shall not be processor and compiler dependent.	SWS_StbM_00140
SRS_BSW_00007	All Basic SW Modules written in C language shall conform to the MISRA C 2012 Standard.	SWS_StbM_00140
SRS_BSW_00009	All Basic SW Modules shall be documented according to a common standard.	SWS_StbM_00140
SRS_BSW_00010	The memory consumption of all Basic SW Modules shall be documented for a defined configuration for all supported platforms.	SWS_StbM_00140
SRS_BSW_00101	The Basic Software Module shall be able to initialize variables and hardware in a separate initialization function	SWS_StbM_00052
SRS_BSW_00160	Configuration files of AUTOSAR Basic SW module shall be readable for human beings	SWS_StbM_00140
SRS_BSW_00161	The AUTOSAR Basic Software shall provide a microcontroller abstraction layer which provides a	SWS_StbM_00140

	standardized interface to higher software layers	
SRS_BSW_00162	The AUTOSAR Basic Software shall provide a hardware abstraction layer	SWS_StbM_00140
SRS_BSW_00164	The Implementation of interrupt service routines shall be done by the Operating System, complex drivers or modules	SWS_StbM_00140
SRS_BSW_00168	SW components shall be tested by a function defined in a common API in the Basis-SW	SWS_StbM_00140
SRS_BSW_00170	The AUTOSAR SW Components shall provide information about their dependency from faults, signal qualities, driver demands	SWS_StbM_00140
SRS_BSW_00172	The scheduling strategy that is built inside the Basic Software Modules shall be compatible with the strategy used in the system	SWS_StbM_00057, SWS_StbM_00407
SRS_BSW_00301	All AUTOSAR Basic Software Modules shall only import the necessary information	SWS_StbM_00051, SWS_StbM_00058, SWS_StbM_00059
SRS_BSW_00304	All AUTOSAR Basic Software Modules shall use the following data types instead of native C data types	SWS_StbM_00140
SRS_BSW_00305	Data types naming convention	SWS_StbM_00142
SRS_BSW_00307	Global variables naming convention	SWS_StbM_00140
SRS_BSW_00308	AUTOSAR Basic Software Modules shall not define global data in their header files, but in the C file	SWS_StbM_00140
SRS_BSW_00309	All AUTOSAR Basic Software Modules shall indicate all global data with read-only purposes by explicitly assigning the const keyword	SWS_StbM_00140
SRS_BSW_00312	Shared code shall be reentrant	SWS_StbM_00140
SRS_BSW_00314	All internal driver modules shall separate the interrupt frame definition from the	SWS_StbM_00140

	service routine	
SRS_BSW_00323	All AUTOSAR Basic Software Modules shall check passed API parameters for validity	noname, SWS_StbM_00041, SWS_StbM_00196, SWS_StbM_00197, SWS_StbM_00201, SWS_StbM_00202, SWS_StbM_00206, SWS_StbM_00210, SWS_StbM_00214, SWS_StbM_00215, SWS_StbM_00219, SWS_StbM_00220, SWS_StbM_00224, SWS_StbM_00225, SWS_StbM_00229, SWS_StbM_00230, SWS_StbM_00234, SWS_StbM_00235, SWS_StbM_00264, SWS_StbM_00268, SWS_StbM_00269, SWS_StbM_00296, SWS_StbM_00298, SWS_StbM_00327, SWS_StbM_00340, SWS_StbM_00341, SWS_StbM_00348, SWS_StbM_00349, SWS_StbM_00379, SWS_StbM_00380, SWS_StbM_00386, SWS_StbM_00391, SWS_StbM_00392, SWS_StbM_00394, SWS_StbM_00404, SWS_StbM_00405, SWS_StbM_00406, SWS_StbM_00415, SWS_StbM_00416, SWS_StbM_00417, SWS_StbM_00418, SWS_StbM_00444, SWS_StbM_00445, SWS_StbM_00447
SRS_BSW_00325	The runtime of interrupt service routines and functions that are running in interrupt context shall be kept short	SWS_StbM_00140
SRS_BSW_00327	Error values naming convention	SWS_StbM_00041
SRS_BSW_00328	All AUTOSAR Basic Software Modules shall avoid the duplication of code	SWS_StbM_00140
SRS_BSW_00333	For each callback function it shall be specified if it is called from interrupt context or not	SWS_StbM_00107, SWS_StbM_00273, SWS_StbM_00285
SRS_BSW_00334	All Basic Software Modules shall provide an XML file that contains the meta data	SWS_StbM_00140
SRS_BSW_00336	Basic SW module shall be able to shutdown	SWS_StbM_00140
SRS_BSW_00337	Classification of development errors	SWS_StbM_00041, SWS_StbM_00094
SRS_BSW_00339	Reporting of production relevant error status	SWS_StbM_00058, SWS_StbM_00059
SRS_BSW_00341	Module documentation shall contains all needed informations	SWS_StbM_00140
SRS_BSW_00342	It shall be possible to create an AUTOSAR ECU out of modules provided as source code and modules provided as object code, even mixed	SWS_StbM_00140

SRS_BSW_00344	BSW Modules shall support link-time configuration	SWS_StbM_00140
SRS_BSW_00347	A Naming seperation of different instances of BSW drivers shall be in place	SWS_StbM_00140
SRS_BSW_00353	All integer type definitions of target and compiler specific scope shall be placed and organized in a single type header	SWS_StbM_00140
SRS_BSW_00358	The return type of init() functions implemented by AUTOSAR Basic Software Modules shall be void	SWS_StbM_00052
SRS_BSW_00360	AUTOSAR Basic Software Modules callback functions are allowed to have parameters	SWS_StbM_00273, SWS_StbM_00285
SRS_BSW_00361	All mappings of not standardized keywords of compiler specific scope shall be placed and organized in a compiler specific type and keyword header	SWS_StbM_00140
SRS_BSW_00371	The passing of function pointers as API parameter is forbidden for all AUTOSAR Basic Software Modules	SWS_StbM_00140
SRS_BSW_00373	The main processing function of each AUTOSAR Basic Software Module shall be named according the defined convention	SWS_StbM_00057
SRS_BSW_00375	Basic Software Modules shall report wake-up reasons	SWS_StbM_00140
SRS_BSW_00378	AUTOSAR shall provide a boolean type	SWS_StbM_00140
SRS_BSW_00384	The Basic Software Module specifications shall specify at least in the description which other modules they require	SWS_StbM_00065, SWS_StbM_00246
SRS_BSW_00385	List possible error notifications	SWS_StbM_00041
SRS_BSW_00386	The BSW shall specify the configuration for detecting an error	noname, SWS_StbM_00041, SWS_StbM_00094, SWS_StbM_00196, SWS_StbM_00197, SWS_StbM_00201, SWS_StbM_00202, SWS_StbM_00206, SWS_StbM_00210, SWS_StbM_00214, SWS_StbM_00215, SWS_StbM_00219, SWS_StbM_00220, SWS_StbM_00224, SWS_StbM_00225, SWS_StbM_00229, SWS_StbM_00230, SWS_StbM_00234, SWS_StbM_00235, SWS_StbM_00264, SWS_StbM_00268,

		SWS_StbM_00269, SWS_StbM_00296, SWS_StbM_00298, SWS_StbM_00327, SWS_StbM_00340, SWS_StbM_00341, SWS_StbM_00348, SWS_StbM_00349, SWS_StbM_00379, SWS_StbM_00380, SWS_StbM_00386, SWS_StbM_00391, SWS_StbM_00392, SWS_StbM_00394, SWS_StbM_00404, SWS_StbM_00405, SWS_StbM_00406, SWS_StbM_00415, SWS_StbM_00416, SWS_StbM_00417, SWS_StbM_00418, SWS_StbM_00444, SWS_StbM_00445, SWS_StbM_00447
SRS_BSW_00398	The link-time configuration is achieved on object code basis in the stage after compiling and before linking	SWS_StbM_00140
SRS_BSW_00399	Parameter-sets shall be located in a separate segment and shall be loaded after the code	SWS_StbM_00140
SRS_BSW_00400	Parameter shall be selected from multiple sets of parameters after code has been loaded and started	SWS_StbM_00140
SRS_BSW_00404	BSW Modules shall support post-build configuration	SWS_StbM_00140
SRS_BSW_00405	BSW Modules shall support multiple configuration sets	SWS_StbM_00140
SRS_BSW_00406	A static status variable denoting if a BSW module is initialized shall be initialized with value 0 before any APIs of the BSW module is called	SWS_StbM_00100, SWS_StbM_00121
SRS_BSW_00407	Each BSW module shall provide a function to read out the version information of a dedicated module implementation	SWS_StbM_00066
SRS_BSW_00412	-	SWS_StbM_00140
SRS_BSW_00413	An index-based accessing of the instances of BSW modules shall be done	SWS_StbM_00140
SRS_BSW_00414	Init functions shall have a pointer to a configuration structure as single parameter	SWS_StbM_00052, SWS_StbM_00249
SRS_BSW_00415	Interfaces which are provided exclusively for one module shall be separated into a dedicated header file	SWS_StbM_00140
SRS_BSW_00416	The sequence of modules to be initialized shall be configurable	SWS_StbM_00140

SRS_BSW_00417	Software which is not part of the SW-C shall report error events only after the DEM is fully operational.	SWS_StbM_00140
SRS_BSW_00422	Pre-de-bouncing of error status information is done within the DEM	SWS_StbM_00140
SRS_BSW_00426	BSW Modules shall ensure data consistency of data which is shared between BSW modules	SWS_StbM_00140
SRS_BSW_00427	ISR functions shall be defined and documented in the BSW module description template	SWS_StbM_00140
SRS_BSW_00428	A BSW module shall state if its main processing function(s) has to be executed in a specific order or sequence	SWS_StbM_00140
SRS_BSW_00429	Access to OS is restricted	SWS_StbM_00020, SWS_StbM_00092
SRS_BSW_00432	Modules should have separate main processing functions for read/receive and write/transmit data path	SWS_StbM_00140
SRS_BSW_00433	Main processing functions are only allowed to be called from task bodies provided by the BSW Scheduler	SWS_StbM_00140
SRS_BSW_00437	Memory mapping shall provide the possibility to define RAM segments which are not to be initialized during startup	SWS_StbM_00140
SRS_BSW_00438	Configuration data shall be defined in a structure	SWS_StbM_00140
SRS_BSW_00439	Enable BSW modules to handle interrupts	SWS_StbM_00140
SRS_BSW_00440	The callback function invocation by the BSW module shall follow the signature provided by RTE to invoke servers via Rte_Call API	SWS_StbM_00140
SRS_BSW_00453	BSW Modules shall be harmonized	SWS_StbM_00140
SRS_BSW_00457	Callback functions of Application software components shall be invoked by the Basis SW	SWS_StbM_00273, SWS_StbM_00285

7 Functional specification

7.1 Startup behavior

This chapter describes the actions, which shall be performed during `StbM_Init()`. `StbM_Init()` shall establish the initial state of the module to prepare the module for the actual functionality of providing Global Time Bases to the *customers*.

7.1.1 Preconditions

Required basic software modules for the Synchronized Time-Base Manager must be available (running) before the Synchronized Time-Base Manager accesses them.

7.1.2 Initialization

[SWS_StbM_00170][
On invocation of `StbM_Init()` each configured Time Base (refer to `StbMSynchronizedTimeBase`, **ECUC_StbM_00003 :**) shall be initialized with zero and its synchronization status `timeBaseStatus` shall be set to `0x00`.
] (RS_TS_00003)

[SWS_StbM_00345][
For each Time Base the StbM shall initialize the corresponding event status `NotificationEvents` with 0.
] (RS_TS_00016)

[SWS_StbM_00344][
For each Time Base the StbM shall initialize the corresponding update counter `timeBaseUpdateCounter` with 0.
] (RS_TS_00011)

[SWS_StbM_00171][
For each Time Base configured to be stored non-volatile (`StbMStoreTimebaseNonVolatile == STORAGE_AT_SHUTDOWN`), the Time Base value shall be loaded from NvM. In case the restore is not successful, the Time Base shall start with zero.
] (RS_TS_00004)

Note: The further details on the NvM handling is intentionally left open. The implementer could choose e.g. between the ReadAll/WriteAll functionality from NvM; or explicit NvM-Block configuration and synchronization; also block restore via callback or via constant.

[SWS_StbM_00306][
If `StbMTimeRecordingSupport` (**ECUC_StbM_00038 :**) is set to `TRUE`, the StbM shall initialize all Block Elements of the measurement recording table with zero.

] (RS_TS_00034)

[**SWS_StbM_00427**][
For each Time Base the StbM shall initialize all of the corresponding User Data bytes with 0.
] (RS_TS_00015)

7.2 Shutdown behavior

[SWS_StbM_00172][
For each Time Base configured to be stored non-volatile (`StbMStoreTimebaseNonVolatile == STORAGE_AT_SHUTDOWN`), the value shall be stored to NvM latest at shutdown.
] (RS_TS_00024)

7.3 Normal operation

7.3.1 Introduction

A Global Time network contains of a Time Master and at least one Time Slave. The Time Master is distributing via Time Synchronization messages the Global Time Base to the connected Time Slaves for each Time Domain. For CAN and Ethernet, the Time Slave corrects the received Global Time Base by considering the Time Stamp at the transmitter side and the own generated receiver Time Stamp. For FlexRay, the Time Synchronization mechanism is based on the local time of the FlexRay bus.

The local instance of the Time Base (derived from a HW reference clock) will be updated with the latest received valid value of the Global Time Base and runs autonomously until the next value of the Global Time Base is received.

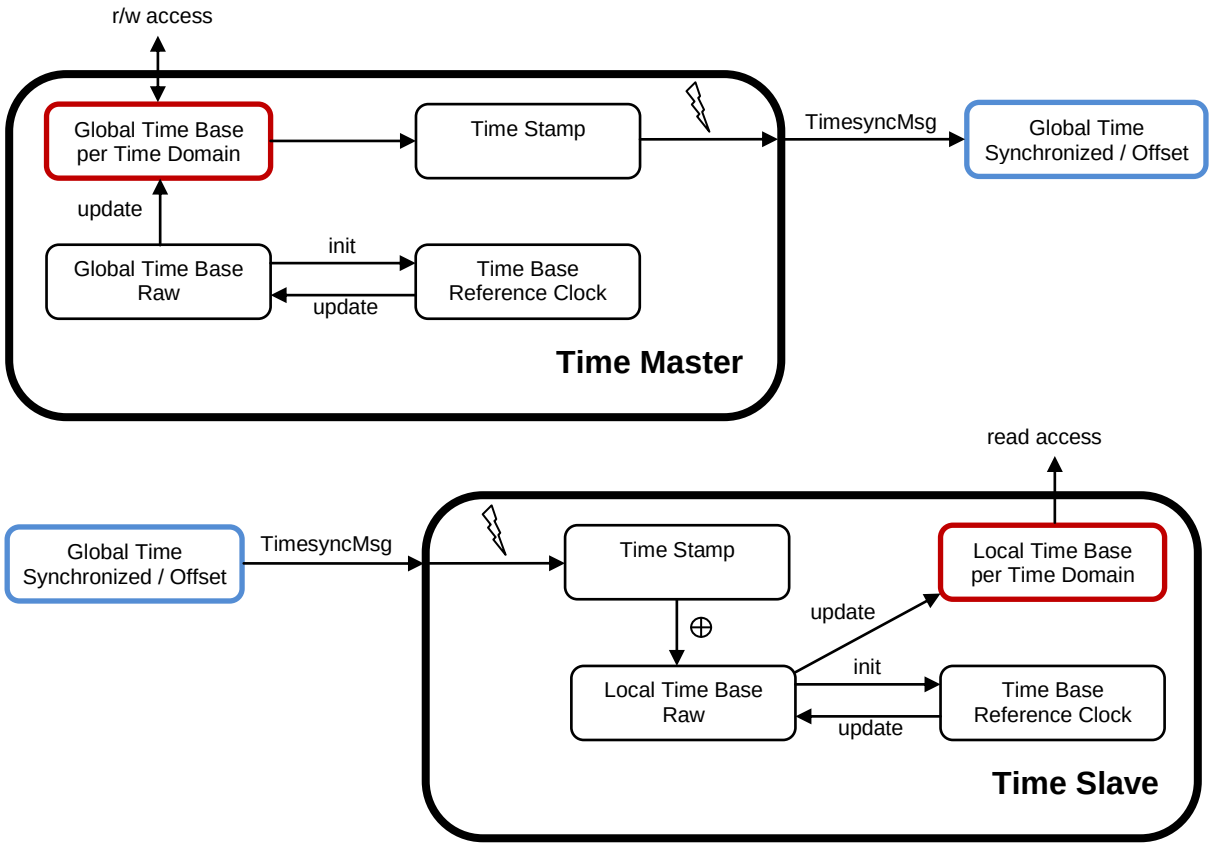


Figure 9: Global Time Base Distribution

7.3.1.1 Types of Time Bases

7.3.1.1.1 Synchronized and Offset Time Bases

The Time Domains 0 to 15 are Synchronized Time Bases.

The Time Domains 16 to 31 are Offset Time Bases. An Offset Time Base is linked to a Synchronized Time Base only by system wide configuration.

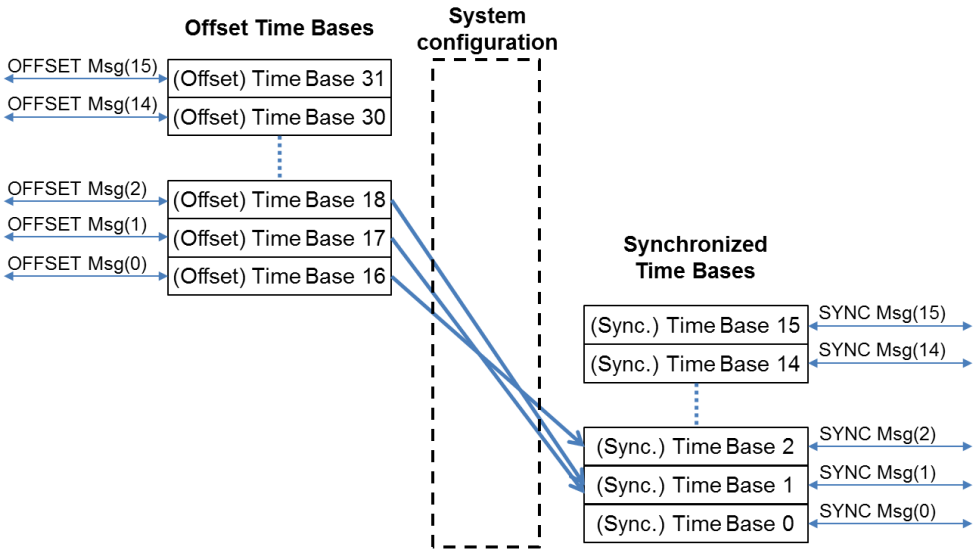


Figure 10: Offset Time Base to Synchronized Time Base relationship

Example:
For an Offset Time Base with Time Domain number 17 the OFFSET Timesync messages on CAN and FR always contain 17-16 = 1 in the Time Domain field
(Note that the OFS Sub-TLVs within the AUTOSAR TLV on Ethernet always contain 17 in the Time Domain field). However the underlying Synchronized Time Base could have Time Domain number 0, i.e., SYNC and FUP Timesync messages contain 0 in the Time Domain field. Another Offset Time Base with Time Domain number 18 (2 in the Time Domain field), is also based on the underlying Synchronized Time Base 0. An Offset Time Base might have leaps in time, e.g. after GPS time becomes available.

7.3.1.1.2 Pure Local Time Bases

For details of Pure Local Time Bases refer to 7.3.4.

7.3.1.2 Roles of the StbM

Depending on its configuration the StbM may take one of the following three roles for a Time Base:
- Global Time Master
- Time Slave
- Time Gateway

In each role specific functionality is supported or not supported.

7.3.1.2.1 Global Time Master

A Global Time Master is the system wide origin for a given Time Base. Its Time Base values are distributed via the network to the Time Slaves.

[SWS_StbM_00408][

`StbM_GetMasterConfig()` shall return the value of the configuration parameter `StbMIsSystemWideGlobalTimeMaster` (**ECUC_StbM_00036 :**) for the Time Base `timeBaseId`. This is to check, if the StbM is configured as system wide Global Time Master for a specific Time Base.
] (RS_TS_00029)

7.3.1.2.2 Time Slave

In the role of a Time Slave the StbM updates its internally maintained local Time Base based on Global Time Base values, which are provided by the corresponding Timesync module.

7.3.1.2.3 Time Gateway

A Time Gateway in the StbM is a Time Base which is referenced by one Time Slave and one or more Time Masters. The Time Slave, which references a StbM Time Gateway receives Timesync messages on the corresponding bus and passes the received Time Base values to the StbM (refer to 7.3.1 “Introduction” for the basic mechanisms). Every Time Master referencing the Time Gateway retrieves the Gateway Time Base values from the StbM and transmits those on the bus. Depending on configuration the reception on slave side can or can not automatically trigger the transmission on the master side.

So, Timesync messages are not routed directly through an AUTOSAR Time Gateway. This is because routing delays need to be compensated.

7.3.1.3 Interpolating the Global Time

The Synchronized Time-Base Manager has to interpolate the local instance of the Global Time Base between the updates

- from the Timesync Modules (for a Time Slave) and
- from the application (for a Time Master)

Interpolation is done based on the Virtual Local Time, which is a local time reference derived from some kind of HW counter (refer to **ECUC_StbM_00047**).

Interpolation is done in principle according to the formula

$TL = TG_{Sync} + (TV – TV_{Sync}) * r$

With

- TL: Current value of the local instance of the Global Time
- $TG_{Sync:}$ Global Time value (part of the Main Time Tuple)
- TV: Current value of the Virtual Local Time
- $TV_{Sync:}$ Virtual Local Time value (part of the Main Time Tuple)
- r: optional Rate and Offset-By-Rate correction – if not used set to 1 for Synchronized Time Bases and 0 for Offset Time Bases

TG_{Sync} and TV_{Sync} form the Main Time Tuple.

For every Time Base there is more than one Time Tuple but there is only one Time Tuple which is used to interpolate the local instance of the Time Base. This Time Tuple is denoted as the **Main Time Tuple**.

The precision of a Time Base depends on the handling of the Main Time Tuple:

- when and how is it interpolated by the StbM
- for a Time Master or Time Gateway: how is it transmitted by the Timesync Modules
- for a Time Slave or Time Gateway: how is it received by the Timesync Modules

Regarding the interpolation by the StbM it is obvious that the precision depends on rounding effects and the granularity of the HW counters, e.g., if the Main Time Tuple would be updated in every `StbM_MainFunction()` while the applied rate correction value is small.

If requesting a Global Time by the application would always lead to an update of the Main Tuple, the frequency of those requests would influence the precision as well.

It is therefore necessary to ensure that updates of the Main Time Tuple don't happen too often.

The Main Time Tuple shall be updated however

- after setting a new Global Time or a new Rate Correction value by the application
- after obtaining a new Time Tuple from a Timesync Module

The Main Time Tuple shall not be updated:

- on every invocation of `StbM_MainFunction()`
- every time a Global Time value is requested by either `StbM_GetCurrentTime()`, `StbM_GetCurrentTimeExtended()` or `StbM_BusGetCurrentTime()`

Once a new Time Tuple (denoted as **Received Time Tuple** [TG_{Rx};TV_{Rx}]) is obtained from a Timesync Module (i.e., after reception of Timesync message(s)), the StbM determines a Time Tuple (denoted as **Synclocal Time Tuple** [TL_{Sync};TV_{Sync}]) of the local instance of the Global Time by using the Virtual Local Time of the Received Time Tuple as reference (i.e., TV = TV_{Rx}).

In case of actually performing Offset Correction By Rate Adaption (i.e., the mechanism is enabled and the prerequisites are fulfilled), the Main Time Tuple is not overwritten by the Received Time Tuple, instead the Main Time Tuple is overwritten by the Synclocal Time Tuple of the local instance of the Global Time.
Otherwise the Main Time Tuple is overwritten by the Received Time Tuple.

The Main Time Tuple can be updated if a certain time has elapsed since the last update (refer to **[SWS_StbM_00433]**).

The Main Time Tuple [TG_{Sync};TV_{Sync}] is managed by the StbM. Each time TG_{Sync} is updated, TV_{Sync} has to be updated as well and vice versa.

Below the application, in the BSW, the Time of a Time Base is always managed via the Time Tuple structure:

- Timesync Modules provide the received Global Time in form of a Time Tuple to the StbM
- Timesync Modules obtain the Global Time to transmit as a Time Tuple
- A Global Time value set by the application is immediately extended to a Time Tuple by adding the current value of the Virtual Local Time

It is essential to always adhere to the integrity of the Time Tuple.

[SWS_StbM_00433]⌈
The Main Time Tuple shall only be updated

- after setting a new Global Time or a new Rate Correction value by the application
- after obtaining a Received Time Tuple (i.e., a new Time Tuple) from a Timesync Module
- after the Offset Correction By Rate Adaption interval (see **[SWS_StbM_00353]**)

However, the Main Time Tuple may be updated if there has been no update for more than 3s.
⌋ (RS_TS_00008, RS_TS_00002)

Note: The 3s interval is derived from the value range of 32 bit results (e.g., when calculating the Virtual Local Time difference, i.e., 4.29 sec) with some safety margin. This is to prevent too frequent updates of the Main Time Tuple, which would lead to accumulation of rounding errors.

7.3.2 Synchronized Time Bases

[SWS_StbM_00180]⌈
After initialization the StbM shall maintain the Local Time of each Time Base autonomously via a hardware reference clock (referenced by `StbMLocalTimeClock`).
⌋ (RS_TS_00008, RS_TS_00002)

Note: While no Global Time Base value has yet been set/received (`GLOBAL_TIME_BASE` bit is not yet set), the StbM shall maintain the Local Time of each Time Base (i.e., progress the time) starting at the value restored from NvM or at value 0 (depending on setting of `StbMStoreTimebaseNonVolatile`).

Note: Progressing the time means that the Virtual Local Time as part of the Main Time Tuple needs to be retrieved once the Global Time part of the Main Time Tuple was either set to 0 or to the value restored from NvM.

[SWS_StbM_00173]⌈

For Time Domains 0 to 15 `StbM_GetCurrentTime()` and `StbM_GetCurrentTimeExtended()` shall return for the requested Time Domain the time of the Time Base, the related Status and the User Data. The current time of the Time Base shall be derived from the associated Virtual Local Time, which is derived from either the referenced OS counter, a GPT or a referenced Ethernet controller (refer to `StbMLocalTimeHardware`).
⌋ (RS_TS_00005, RS_TS_00006, RS_TS_00014)

[SWS_StbM_00178]⌈
If `EthIfGlobalTimeSupport` (referenced via `StbMLocalTimeHardware` **ECUC_StbM_00053 : ,** if set to `EthTSynGlobalTimeDomain`) is set to `TRUE` for a Synchronized Time Base, the StbM shall get the current value of the freerunning HW counter from the corresponding Ethernet Controller via `EthIf_GetCurrentTime()`.
⌋ (RS_TS_00008, RS_TS_00002)

[SWS_StbM_00434]⌈
For Time Domains 0 to 15 `StbM_GetCurrentTime()`, `StbM_GetCurrentTimeExtended()`, and `StbM_BusGetCurrentTime()` shall return `E_NOT_OK` if the value of the associated Virtual Local Time could not be retrieved.
⌋ (RS_TS_00005, RS_TS_00006, RS_TS_00014)

Note: Retrieving a Virtual Local Time value may fail for several reasons, e.g., if the related hardware counter was not yet activated.

[SWS_StbM_00435]⌈
For Time Base 0 to 15 `StbM_BusGetCurrentTime()` shall return for the requested Time Domain the Time Tuple [TL;TV] of the Time Base, the related Status and the User Data. The current time of the Time Base shall be derived from the associated Virtual Local Time, which is derived from either the referenced OS counter, a GPT or a referenced Ethernet controller (refer to `StbMLocalTimeHardware`).
⌋ (RS_TS_00005, RS_TS_00006, RS_TS_00014)

[SWS_StbM_00436]⌈
Although the retrieved value of the Virtual Local Time and the time which is returned by `StbM_GetCurrentTime()`, `StbM_GetCurrentTimeExtended()`, and `StbM_BusGetCurrentTime()` form a new Time Tuple [TL;TV], this tuple shall only replace the Main Time Tuple if the requirements as specified in **[SWS_StbM_00433]** are met.
⌋ (RS_TS_00005, RS_TS_00006, RS_TS_00014)

Note: Prohibiting the update of the Main Time Tuple after e.g. every invocation of `StbM_BusGetCurrentTime()` and `StbM_GetCurrentTime()` prevents worsening the precision of the requested Time Base due to rounding errors.

[SWS_StbM_00352]⌈

In the scope of `StbM_GetCurrentTime()`, `StbM_GetCurrentTimeExtended()` and `StbM_BusGetCurrentTime()`, StbM shall use the factor (`StbMClockPrescaler/StbMClockFrequency`) to convert the time of its local hardware reference clock to the actual time of the Virtual Local Time.
] (RS_TS_00018)

Note: Rationale is that a tick duration of the hardware reference clock does not necessarily have to match the resolution of the Virtual Local Time.

[SWS_StbM_00174] {OBSOLETE} **[**
`StbM_GetCurrentTimeRaw()` shall return the nanoseconds part of the Virtual Local Time of the associated Time Base (refer **[SWS_StbM_00173]**).
] (RS_TS_00006,RS_TS_00008, RS_TS_00033)

[SWS_StbM_00175] {OBSOLETE} **[**
`StbM_GetCurrentTimeDiff()` shall return the time difference of the nanoseconds part of the Virtual Local Time of the associated Time Base (refer to **[SWS_StbM_00173]**) minus the time given by the paramerter `givenTimeStamp` in raw format.
] (RS_TS_00008, RS_TS_00033, RS_TS_00006)

[SWS_StbM_00437][
`StbM_GetCurrentVirtualLocalTime()` shall return the value of the Virtual Local Time of the associated Time Base.

If the Virtual Local Time could not be determined (e.g., the underlying hardware counter was not yet activated), `StbM_GetCurrentVirtualLocalTime()` shall return `E_NOT_OK`.
] (RS_TS_00006, RS_TS_00008, RS_TS_00033)

Note: `StbM_GetCurrentVirtualLocalTime()` is called by the Timesync modules with an established protection against interruptions.

7.3.2.1 Global Time Master

[SWS_StbM_00342][
On a valid invocation of `StbM_SetGlobalTime()` or `StbM_UpdateGlobalTime()` the StbM shall update the Main Time Tuple of the corresponding Synchronized Time Base.

Within the functions `StbM_SetGlobalTime()` and `StbM_UpdateGlobalTime()` the StbM shall retrieve the value of the Virtual Local Time (as part of the Local Time tuple) **as soon as possible** in order to improve precision of the Time Base.
] (RS_TS_00010, RS_TS_00002)

Note: In order to improve precision further it may be beneficial for applications to call `StbM_SetGlobalTime()` or `StbM_UpdateGlobalTime()` with locked interrupts.

7.3.2.2 Time Slave

[SWS_StbM_00179][
For Time Bases 0 to 15 each invocation of `StbM_BusSetGlobalTime()` shall update the corresponding Main Time Tuple and set the User Data and the Time Base Status accordingly.
] (RS_TS_00007, RS_TS_00009)

Note: To update the Main Time Tuple does not mean to automatically overwrite the Main Time Tuple with the Received Time Tuple.

[SWS_StbM_00438][
The StbM shall determine for Time Bases 0 to 15 on each invocation of `StbM_BusSetGlobalTime()` the Synclocal Time Tuple [TL_{Sync};TV_{Sync}] by using the value of the Virtual Local Time of the Received Time Tuple as reference (i.e., TV_{Rx} is used for TV when calculating TL in **[SWS_StbM_00355])**. The Synclocal Time Tuple shall be determined using the Main Time Tuple before the Main Time Tuple itself is updated.
] (RS_TS_00007, RS_TS_00009)

7.3.3 Offset Time Bases

An Offset Time Base only exists in combination with its underlying Synchronized Time Base.

The **Absolute Time** value of an Offset Time Base is given by adding the **Offset Time** value of an Offset Time Base to the time value of the underlying Synchronized Time Base.

[SWS_StbM_00191][
`StbM_SetOffset()` and `StbM_GetOffset()` shall only accept Offset Time Bases with a timeBaseId 16 to 31.
] (RS_TS_00012, RS_TS_00013)

[SWS_StbM_00177][
For Time Bases 16 to 31 the `StbM_GetCurrentTime()` and `StbM_GetCurrentTimeExtended()` shall return for the requested Time Base an absolute time value calculated by adding the given offset to the current Time Base of the referenced Time Base via `StbMOffsetTimeBase` (**ECUC_StbM_00030 :**).
] (RS_TS_00013)

[SWS_StbM_00193][

Configuration Constraint: The parameter StbMOffsetTimeBase shall only be valid for StbMSynchronizedTimeBaseIdentifier 16 to 31.
] (RS_TS_00012, RS_TS_00013)

7.3.3.1 Global Time Master

[SWS_StbM_00190][
Each invocation of StbM_SetOffset() shall update the Main Time Tuple of the corresponding Offset Time Base. The Offset Time value and the User Data shall be set accordingly.
] (RS_TS_00013, RS_TS_00015)

[SWS_StbM_00192][
Each invocation of StbM_GetOffset() shall return the Offset Time value and the User Data of the corresponding Offset Time Base.
] (RS_TS_00013, RS_TS_00014)

[SWS_StbM_00304][
On invocation of StbM_SetGlobalTime() or StbM_UpdateGlobalTime() for Time Bases 16 to 31 the StbM shall check the GLOBAL_TIME_BASE bit within timeBaseStatus of the underlying Synchronized Time Base and shall return E_NOT_OK if is not set.

If the GLOBAL_TIME_BASE bit is set:

1. the StbM shall calculate the Offset Time by obtaining the actual Time Base value of the underlying Synchronized Time Base and subtract that from the Absolute Time value which is passed by StbM_SetGlobalTime() or StbM_UpdateGlobalTime()
2.
   a) if the calculated Offset Time value is equal or greater than zero, the StbM shall update the corresponding Offset Time Base with the calculated Offset Time value and the User Data that was passed by StbM_SetGlobalTime() or StbM_UpdateGlobalTime(),
   b) otherwise (calculated Offset Time value is less than zero) the StbM shall return E_NOT_OK via StbM_SetGlobalTime() or StbM_UpdateGlobalTime(), respectively.

] (RS_TS_00013)

7.3.3.2 Time Slave

[SWS_StbM_00393][
For Time Bases 16 to 31 each invocation of StbM_BusSetGlobalTime() shall update the corresponding Main Time Tuple and set the User Data and the Time Base Status accordingly.
] (RS_TS_00007, RS_TS_00009)

Note: To update the Main Time Tuple does not mean to automatically overwrite the Main Time Tuple with the Received Time Tuple.

[SWS_StbM_00439]⌈
The StbM shall determine for Time Bases 16 to 31 on each invocation of `StbM_BusSetGlobalTime()` the Synclocal Time Tuple [TL_{Sync};TV_{Sync}] by using the value of the Virtual Local Time of the Received Time Tuple as reference (i.e., TV_{Rx} is used for TV when calculating TL in **[SWS_StbM_00355]**). The Synclocal Time Tuple shall be determined using the Main Time Tuple before the Main Time Tuple is updated.
⌋ (RS_TS_00007, RS_TS_00009)

7.3.4 Pure Local Time Bases

A Pure Local Time Base will only locally be set and read. A Pure Local Time Base behaves like a Synchronized Time Base since it progresses in time, however it is not synchronized via Timesync modules. So, only a subset of APIs is supported by Pure Local Time Base. Pure Local Time Bases behaving like an Offset Time Bases are not supported.

[SWS_StbM_00413]⌈
After initialization the StbM shall maintain the Time of each Pure Local Time Base autonomously via a hardware reference clock (referenced by `StbMLocalTimeClock`).
⌋ (RS_TS_00008, RS_TS_00002)

Note: While no Time Base value has yet been set (`GLOBAL_TIME_BASE` bit is not yet set), the StbM shall maintain the time value of each Pure Local Time Base (i.e., progress the time) starting at the value 0.

[SWS_StbM_00398]⌈
For Pure Local Time Bases `StbM_GetCurrentTime()` and `StbM_GetCurrentTimeExtended()` shall return the User Data as set by `StbM_SetGlobalTime()`, `StbM_UpdateGlobalTime()` or `StbM_SetUserData()` by the local Pure Local Time Master.
⌋ (RS_TS_00015)

[SWS_StbM_00399]⌈
For Pure Local Time Bases all bits of the Time Base status `timeBaseStatus` shall be set to 0, except for bit `GLOBAL_TIME_BASE`.

`GLOBAL_TIME_BASE` shall be set to 1, by a valid invocation of `StbM_SetGlobalTime()` or `StbM_UpdateGlobalTime()` and only set to 0 by `StbM_Init()`.
⌋ (RS_TS_00009)

7.3.5 Synchronization State

[SWS_StbM_00261][
For Offset Time Bases `StbM_GetCurrentTime()` and `StbM_GetCurrentTimeExtended()` shall derive the status `timeBaseStatus` to be returned with the actual time value as follows from the status of the actual Offset Time Base and the Synchronized Time Base (referenced via parameter `StbMOffsetTimeBase` (**ECUC_StbM_00030 :**):

Bit Name	Bit Position	Description
`TIMEOUT`	Bit 0 (LSB)	0: No Timeout occurred - neither for Offset nor for referenced Synchronized Time Base
		1: Timeout occurred for Offset or for referenced Synchronized Time Base
Reserved	Bit 1	Bit 1: Always 0 (reserved for future usage)
`SYNC_TO_GATEWAY`	Bit 2	0: Local Offset and referenced Synchronized Time Base is synchronous to Global Offset Time Master
		1: Local Offset or referenced Synchronized Time Base updates are based on a Time Gateway below the Global Time Master
`GLOBAL_TIME_BASE`	Bit 3	0: Local Offset or referenced Synchronized Time Base are based on Local Time Base reference clock only (never synchronized with Global Time Base)
		1: Local Offset and referenced Synchronized Time Base have been synchronized with Global Time Base at least once
`TIMELEAP_FUTURE`	Bit 4	0: No leap into the future within the received time for the Offset and referenced Synchronized Time Base
		1: Leap into the future within the received time for the Offset or referenced Synchronized Time Base exceeds a configured threshold
`TIMELEAP_PAST`	Bit 5	0: No leap into the past within the received time for the Offset and referenced Synchronized Time Base
		1: Leap into the past within the received time for the Offset or referenced Synchronized Time Base exceeds a configured threshold

] (RS_TS_00005)

[SWS_StbM_00262][
For Synchronized Time Bases `StbM_GetTimeBaseStatus()` shall return

- the status of the corresponding Synchronized Time Base via `syncTimeBaseStatus` and
- 0 via `offsetTimeBaseStatus`

For Offset Time Bases `StbM_GetTimeBaseStatus()` shall return

- the status of the corresponding Offset Time Base via `offsetTimeBaseStatus` and
- the status of the related Synchronized Time Base (referenced by ECUC_StbM_00030 :) via `syncTimeBaseStatus`.

For Pure Local Time Bases `StbM_GetTimeBaseStatus()` shall return

- the status of the corresponding Time Base (refer to **[SWS_StbM_00399]**) via `syncTimeBaseStatus` and
- 0 via `offsetTimeBaseStatus`

] (RS_TS_00005)

7.3.5.1 Global Time Master

[SWS_StbM_00181][
On a valid invocation of `StbM_SetGlobalTime()`, `StbM_UpdateGlobalTime()`, or `StbM_SetOffset()` the StbM shall set the `GLOBAL_TIME_BASE` bit within `timeBaseStatus` of the corresponding Time Base and shall clear all other bits.
] (RS_TS_00009)

7.3.5.2 Time Slaves

Usually a Time Slave starts its local Time Base from 0. So, after initialization the 1st check against `StbMTimeLeapFutureThreshold` / `StbMTimeLeapPastThreshold` would most likely always fail and the `TIMELEAP_FUTURE` / `TIMELEAP_PAST` bit would be always set. To avoid this, threshold monitoring will start only after a first valid Time Base value has been received.

[SWS_StbM_00182][
For each Time Base where a Time Slave or a Time Gateway Slave Port belongs to, an invocation of `StbM_BusSetGlobalTime()` shall check, if the Global Time difference between the Received Time (i.e., the updated Time Base value) and the Synclocal Time (i.e., the current Time Base value) exceeds the configured threshold of `StbMTimeLeapFutureThreshold` (**ECUC_StbM_00041 :**), i.e., TG_{Rx} - TL_{Sync} > `StbMTimeLeapFutureThreshold`, if at least one Time Base value has been successfully received before.

With:

- TL_{Sync} = Global Time part of the Synclocal Time Tuple
- TG_{Rx} = Global Time part of the Received Time Tuple

In case the threshold is exceeded the StbM shall set the `TIMELEAP_FUTURE` bit within `timeBaseStatus` of the Time Base.

If the next StbMClearTimeleapCount updates are within the threshold of StbMTimeLeapFutureThreshold the StbM shall clear the TIMELEAP_FUTURE bit within timeBaseStatus of the Time Base.

A threshold of 0 shall deactivate this check.
] (RS_TS_00009)

[SWS_StbM_00305][
For each Time Base where a Time Slave or a Time Gateway Slave Port belongs to, an invocation of StbM_BusSetGlobalTime() shall check, if the Global Time difference between the Synclocal Time (i.e., the current Time Base value) and the Received Time (i.e., the updated Time Base value) exceeds the configured threshold of StbMTimeLeapPastThreshold (**ECUC_StbM_00042 :**), i.e., TL_{Sync} - TG_{Rx} > StbMTimeLeapPastThreshold, if at least one Time Base value has been successfully received before.

With:
- TL_{Sync} = Global Time part of the Synclocal Time Tuple
- TG_{Rx} = Global Time part of the Received Time Tuple

In case the threshold is exceeded the StbM shall set the TIMELEAP_PAST bit within timeBaseStatus of the Time Base.

If the next StbMClearTimeleapCount updates are within the threshold of StbMTimeLeapPastThreshold the StbM shall clear the TIMELEAP_PAST bit within timeBaseStatus of the Time Base.

A threshold of 0 shall deactivate this check.
] (RS_TS_00009)

Note: After a longer timeout a time leap is likely to be detected (either StbMTimeLeapFutureThreshold or StbMTimeLeapPastThreshold is exceeded), although the time drift was within the acceptable range. A time leap could also occur if a Time Slaves continues operating while a Time Master performs a restart.

Additional measures could be taken on application level to cope with those situations.

Note: If set, a TIMELEAP_FUTURE/TIMELEAP_PAST bit remains set while a timeout is active (i.e., while the TIMEOUT bit is set) and also beyond, if StbMClearTimeleapCount updates within the threshold of StbMTimeLeapFutureThreshold/StbMTimeLeapPastThreshold have not yet happened.

[SWS_StbM_00425][
For Time Slaves and Time Gateways StbM_GetTimeLeap() shall return the Global Time difference between the Received Time and the Synclocal Time, i.e., TG_{Rx} -

TL_{Sync}, which is calculated upon each, except the very first, valid invocation of `StbM_BusSetGlobalTime()` for the corresponding Time Base.

With

- TL_{Sync} = Global Time part of the Synclocal Time Tuple
- TG_{Rx} = Global Time part of the Received Time Tuple

If the calculated time difference exceeds the value range of the `timeJump` parameter of `StbM_GetTimeLeap()` the returned time difference shall be limited to either the maximum negative or the maximum positive value of the type of `timeJump` (refer to StbM_TimeDiffType).

`StbM_GetTimeLeap()` shall return `E_NOT_OK` until the second valid invocation of `StbM_BusSetGlobalTime()` for the corresponding Time Base.
] (RS_TS_00009)

[SWS_StbM_00183][
For each Time Base where a Time Slave belongs to, the StbM shall observe the timeout `StbMSyncLossTimeout` (**ECUC_StbM_00028 :**). The timeout shall be measured from last invocation of `StbM_BusSetGlobalTime()`.

If the timeout occurs, the StbM shall set the `TIMEOUT` bit within `timeBaseStatus` of the Time Base.

An invocation of `StbM_BusSetGlobalTime()` shall clear the `TIMEOUT` bit.
] (RS_TS_00025, RS_TS_00009)

Note: Refer to notes beneath **[SWS_StbM_00187]** for suitable time references for determining the `StbMSyncLossTimeout` (**ECUC_StbM_00028 :**) timeout.

[SWS_StbM_00187][
For each Time Base where a Time Gateway Slave Port belongs to, the StbM shall observe the timeout `StbMSyncLossTimeout` (**ECUC_StbM_00028 :**). The timeout shall be measured from last invocation of `StbM_BusSetGlobalTime()`.

If the timeout occurs, the StbM shall set the `TIMEOUT` bit within `timeBaseStatus` of the Time Base.

An invocation of `StbM_BusSetGlobalTime()` shall clear the `TIMEOUT` bit.

If the timeout occurs, the StbM shall set the `SYNC_TO_GATEWAY` bit within `timeBaseStatus` of the Time Base.
] (RS_TS_00025, RS_TS_00009)

Note: The Global Time is only suitable as a time reference for determining the `StbMSyncLossTimeout` (**ECUC_StbM_00028 :**) timeout, if time leap detection is configured appropriately - otherwise time leaps may shorten or lengthen the time interval unacceptably.

Instead the timeout StbMSyncLossTimeout (**ECUC_StbM_00028 :**) should be measured either

- based on the Virtual Local Time or
- by counting invocations of the main function StbM_MainFunction()

In case of time span measurement based on the Virtual Local Time, the StbM shall check for a timeout condition of a Time Base within StbM_MainFunction() and all API functions, which return the Time Base Status (e.g. StbM_GetTimeBaseStatus() or StbM_GetCurrentTime().

In case of time span measurement based on counting invocations of the StbM_MainFunction the StbM shall check for a timeout condition of a Time Base within StbM_MainFunction(). When determining the number of invocations based on StbMMainFunctionPeriod (**ECUC_StbM_00027 :**) and StbMSyncLossTimeout (**ECUC_StbM_00028 :**), it has to be ensured, that the resulting timespan is not shorter than StbMSyncLossTimeout.

Since a Status Notification is triggered inside StbM_MainFunction(), the other functions like e.g StbM_GetTimeBaseStatus() might detect a timeout condition sooner than the corresponding Status Notification is actually triggered. Such a delayed Status Notification is considered acceptable.

[SWS_StbM_00184][
Every invocation of StbM_BusSetGlobalTime() shall set the SYNC_TO_GATEWAY bit within timeBaseStatus of the Time Base to the value of the SYNC_TO_GATEWAY bit within timeBaseStatus of the timeStampPtr argument passed to StbM_BusSetGlobalTime().
] (RS_TS_00009)

[SWS_StbM_00185][
For each Time Base where a Time Slave or a Time Gateway Slave Port belongs to an invocation of StbM_BusSetGlobalTime() shall set the GLOBAL_TIME_BASE bit within timeBaseStatus of the Time Base. Once set, the bit is never cleared.
] (RS_TS_00009)

7.3.6 Immediate Time Synchronization

All Timesync Modules are working independently of the StbM regarding the handling of the bus-specific Time Synchronization protocol (i.e. autonomous transmission of Timesync messages on the bus).

Nevertheless it is necessary, that the StbM provides an interface, based on a timeBaseUpdateCounter, to allow the Timesync Modules to detect, if a Time Base has been updated or not and thus may perform an immediate transmission of Timesync messages, e.g. to speed up re-synchronization.

`StbM_GetTimeBaseUpdateCounter()` allows the Timesync Modules to detect, whether a Time Base should be transmitted immediately in the subsequent `<Bus>TSyn_MainFunction()` cycle.

[SWS_StbM_00414]⌈
`StbM_GetTimeBaseUpdateCounter()` shall return the value of the `timeBaseUpdateCounter` of the corresponding Time Base.
⌋ (RS_TS_00011)

[SWS_StbM_00351]⌈
For Synchronized and Offset Time Bases, the `timeBaseUpdateCounter` of a Time Base shall have the value range 0 to 255.
⌋ (RS_TS_00011)

[SWS_StbM_00350]⌈
- For Synchronized and Offset Time Bases on a valid invocation of `StbM_SetGlobalTime()`, `StbM_BusSetGlobalTime()`, or `StbM_TriggerTimeTransmission()` and
- for Offset Time Bases on a valid invocation of `StbM_SetOffset()`,

the StbM shall increment the `timeBaseUpdateCounter` of the corresponding Time Base by 1 (one).

At 255 the `timeBaseUpdateCounter` shall wrap around to 0.
⌋ (RS_TS_00011)

Note: For Offset Time Bases the term “corresponding Time Base” refers to the Offset Time Base only and not to the underlying Synchronized Time Base.

Note: `StbM_UpdateGlobalTime()` can be used instead of `StbM_SetGlobalTime()`, if the StbM shall not increment the `timeBaseUpdateCounter` of the corresponding Time Base.

7.3.7 User Data

User Data is part of each Global Time Base. User Data is set by the Global Time Master of each Time Base and distributed as part of the Timesync messages.
User Data can be used to characterize the Time Base, e.g., regarding the quality of the underlying clock source or regarding the progress of time.

User Data consists of up to three bytes. Due to the frame format of various Timesync messages it is not possible to transmit all three bytes on every bus system. It is the responsibility of the system designer to only use those User Data bytes that can be distributed inside the vehicle network.

[SWS_StbM_00381]⌈

All functions that are setting User Data shall only set as many User Data bytes as defined within the `userDataLength` element of the `StbM_UserDataType` structure.
If `userDataLength` is equal to 0, no User Data bytes shall be set. User Data bytes that are not set shall remain at their previous value.
] (RS_TS_00015)

7.3.8 Time Correction

The Synchronized Time-Base Manager provides the ability for Time Slaves to perform Rate and Offset Correction.

For Global Time Masters the StbM provides the ability to perform Rate Correction of their Time Base(s).

Time Correction can be configured individually for each Time Base.

7.3.8.1 Rate Correction Measurement (for Time Slaves)

Rate Correction detects and eliminates rate deviations of local instances of Time Bases. Rate Correction determines the rate deviation in the scope of a measurement. This rate deviation is used as correction factor which the StbM uses to correct the Time Base's time whenever it is determined (e.g., in the scope of `StbM_GetCurrentTime()` or `StbM_BusGetCurrentTime()`).

Note: Applying rate correction is inaccurate for short intervals (and for small rate deviation values).

[SWS_StbM_00377][
The StbM shall not perform Rate Correction when the measurement duration `StbMRateCorrectionMeasurementDuration` (**ECUC_StbM_00054 :**) is set to zero.
] (RS_TS_00018)

[SWS_StbM_00376][
For Rate Correction measurements, the StbM shall evaluate the `TIMELEAP_FUTURE` and `TIMELEAP_PAST` flags during measurements. The StbM shall discard the measurement, if any of the flags equals „Set".
] (RS_TS_00018)

[SWS_StbM_00375][
For Rate Correction measurements, the StbM shall evaluate state changes of the `SYNC_TO_GATEWAY` flag during measurements. The StbM shall discard the measurement if the flag state changes.
] (RS_TS_00018)

[SWS_StbM_00374][
For Rate Correction measurements, the StbM shall evaluate the `TIMEOUT` flag. The StbM shall discard the measurement, if the flag equals „Set“.
] (RS_TS_00018)

[SWS_StbM_00373][
For Rate Correction, the StbM shall evaluate the `TIMELEAP_FUTURE/ TIMELEAP_PAST` flags during the start of a measurement. The StbM shall not start a Rate Correction measurement when the state of any of the flags equals „Set“.
] (RS_TS_00018)

[SWS_StbM_00372][
The StbM shall perform Rate Correction measurements to determine the rate deviation of each configured Time Base.
] (RS_TS_00018)

[SWS_StbM_00371][
The StbM shall perform Rate Correction measurements continuously. The end of a measurement marks the start of the next measurement.
The start and end of measurements are always triggered by and aligned to the reception of time values for Synchronized or Offset Time Bases.
] (RS_TS_00018)

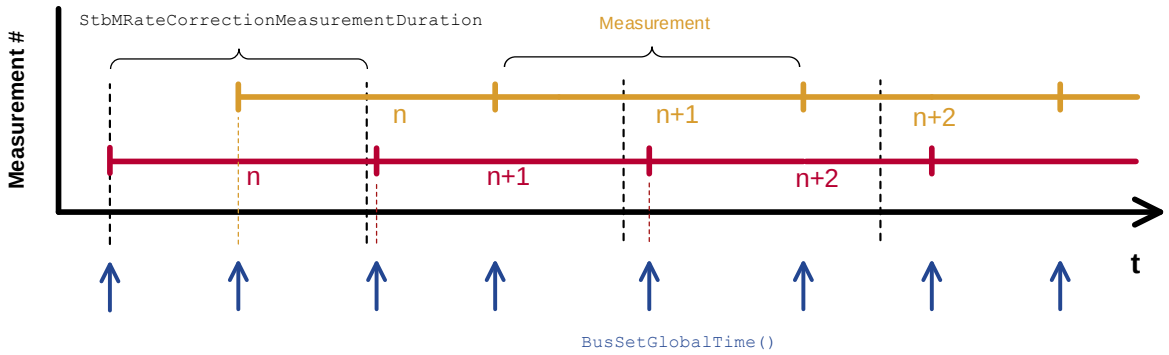


Figure 11: Visualization of two parallel measurements

[SWS_StbM_00370][
During runtime the StbM shall determine the timespan of a Rate Correction measurement on the basis of the Virtual Local Time.
](RS_TS_00018)

Note: Simply counting `StbM_BusSetGlobalTime()` calls (caused by incoming Timesync messages) and deriving the timespan, which has passed from the cycle time, may lead to incorrect results, because the Timesync cycle time is allowed to vary.

The Global Time is only suitable as a time reference for determining the timespan of a Rate Correction measurement, if time leap detection is configured appropriately - otherwise time leaps may shorten or lengthen the time interval unacceptably.

Instead the timespan should be determined either

- based on the Virtual Local Time or
- by counting invocations of the main function `StbM_MainFunction()`

In the latter case, when determining the number of invocations based on `StbMMainFunctionPeriod` (**ECUC_StbM_00027 :**) and `StbMRateCorrectionMeasurementDuration` (**ECUC_StbM_00054 :**), it has to be ensured, that the resulting timespan is not shorter than `StbMRateCorrectionMeasurementDuration`.

Note: For implementation details of the timespan measurement refer to Note after **[SWS_StbM_00370]**.

[SWS_StbM_00368]⌈
The StbM shall perform as many simultaneous Rate Correction measurements as configured by parameter: `StbMRateCorrectionsPerMeasurementDuration` (**ECUC_StbM_00055 :**).
⌋ (RS_TS_00018)

[SWS_StbM_00367]⌈
Simultaneous Rate Correction measurements shall be started with a defined offset (to_n) to yield Rate Corrections evenly distributed over the measurement duration.
to_n = n * (`StbMRateCorrectionMeasurementDuration` / `StbMRateCorrectionsPerMeasurementDuration`) (where ‘n’ is the zero-based index of the current measurement).
⌋ (RS_TS_00018)

Note: If a Rate Correction measurement start is delayed e.g. due to a late reception of time values for Synchronized or Offset Time Bases (refer also to **[SWS_StbM_00371]**) such, that it would coincide with the start of a later simultaneous Rate Correction measurement, then the delayed measurement should be discarded and only the most recent one should be started. That is, only one of the simultaneous measurements is started at any reception of time values for Synchronized or Offset Time Bases.

Note: The implementation can, e.g., be realized by storing the relevant time snapshots in chained lists. Alternatively, measurements can be seen as objects, which store their relevant data and can be used independently.

[SWS_StbM_00366]⌈
At the start of a Rate Correction measurement, the StbM shall store the Received Time Tuple that is passed in the scope of the function `StbM_BusSetGlobalTime()`. The elements of the stored Time Tuple have the following denotation:

- TG_{Start} – Global Time part of the Received Time Tuple
- TV_{Start} –Virtual Local Time part of the Received Time Tuple

⌋ (RS_TS_00018)

Note: This is equivalent to an atomic Time Tuple assigment: [TG_{Start};TV_{Start}] = [TG_{Rx};TV_{Rx}]

[SWS_StbM_00364]⌈
At the end of the Rate Correction measurement, the StbM shall store the Received Time Tuple that is passed in the scope of the function `StbM_BusSetGlobalTime()`. The elements of the stored Time Tuple have the following denotation:

- TG_{Stop} – Global Time part of the Received Time Tuple
- TV_{Stop} – Virtual Local Time part of the Received Time Tuple

⌋ (RS_TS_00018)

Note: This is equivalent to an atomic Time Tuple assigment: [TG_{Stop};TV_{Stop}] = [TG_{Rx};TV_{Rx}]

[SWS_StbM_00361]⌈
At the end of a Rate Correction measurement, the StbM shall calculate the resulting correction rate (r_{rc}) for Synchronized Time Bases as shown:

$r_{rc} = (TG_{Stop} - TG_{Start}) / (TV_{Stop} - TV_{Start})$

⌋ (RS_TS_00018)

Note: To determine the resulting rate deviation the value 1 has to be subtracted from r_{rc}.

[SWS_StbM_00362]⌈
The StbM shall use the same value for r_{rc} and r_{orc} until a new value has been calculated.
⌋ (RS_TS_00018)

Note: A newly calculated Rate Correction r_{rc} or r_{orc} is only applied to following time calculations.

[SWS_StbM_00360]⌈
At the end of a Rate Correction measurement, the StbM shall calculate the resulting correction rate (r_{orc}) for Offset Time Bases as shown:

$r_{orc} = (TG_{Stop} - TG_{Start}) / (TV_{Stop} - TV_{Start}) + 1$

⌋ (RS_TS_00018)

Note: +1 is added for formal reasons in the formula for r_{orc}. This is to have in **[SWS_StbM_00397]** and **[SWS_StbM_00412]** aligned value ranges for rate correction r_{orc} and r_{rc} and the corresponding rate deviation values.

[SWS_StbM_00397]⌈

For Time Bases with `StbMSynchronizedTimeBaseIdentifier` 0 to 31 (**ECUC_StbM_00021 :**) and `StbMIsSystemWideGlobalTimeMaster = False` (**ECUC_StbM_00036 :**), the StbM shall return on invocation of `StbM_GetRateDeviation()` the rate deviation, which has been calculated for that Time Base (i.e., r_{rc} -1 for Synchronized Time Bases or r_{orc} - 1 for Offset Time Bases).

If no rate deviation has been calculated, `StbM_GetRateDeviation()` shall return `E_NOT_OK`.
] (RS_TS_00018)

[SWS_StbM_00412][
For a Synchronized Time Base the StbM shall use r_{rc} = 1, if a valid correction rate (r_{rc}) has not yet been calculated or is not being calculated (refer **[SWS_StbM_00377]**) but shall be applied (refer to 7.3.8.2).

For an Offset Time Base the StbM shall use r_{orc} = 1, if a valid correction rate (r_{orc}) has not yet been calculated or is not being calculated (refer **[SWS_StbM_00377]**) but shall be applied (refer to 7.3.8.2).
] (RS_TS_00018)

7.3.8.2 Time Interpolation, Rate and Offset Correction (for Time Slaves)

Time interpolation happens whenever the current value of the local instance of a Time Base shall be determined. The calculation is based on the Main Time Tuple.

If Rate Correction is enabled for a given Time Base the calculation includes the Calculated Rate Correction value (r_{rc} for Synchronized Time Bases, r_{orc} for Offset Time Bases).

Whenever a new Global Time Tuple is received, there is a difference between the received Global Time and the Global Time of the Synclocal Time Tuple (see **[SWS_StbM_00438]**, **[SWS_StbM_00439]**). This difference is denoted as offset.

Offset Correction can be done in two ways:

- Offset Correction By Jump: the Main Time Tuple is overwritten by the Received Time Tuple, i.e., the time of the local instance of the Time Base jumps to the value of the received Global Time.
- Offset Correction By Rate Adaption: the Main Time Tuple is not overwritten by the Received Time Tuple, instead the applied Rate Correction is adapted such that the existing offset is steadily reduced to zero within a configured time span. Offset Correction By Rate Adaption can only be applied if Rate Correction is enabled, of course.

[SWS_StbM_00359][
The StbM shall calculate the Global Time offset (i.e., difference) between the Received Time and the Synclocal Time upon each, except the very first, valid invocation of `StbM_BusSetGlobalTime()`. The elements of the Time Tuples used for calculating the Global Time offset have the following denotation:

- TL_{Sync} = Global Time part of the Synclocal Time Tuple
- TG_{Rx} = Global Time part of the Received Time Tuple

] (RS_TS_00018)

[SWS_StbM_00355][
The StbM shall calculate the current value of a Time Base based on the Main Tuple and the current rate correction term according to:

$TL = TG_{Sync} + (TV - TV_{Sync}) * r$

With:

- TL = Current value of the Time Base
- TV = Current value of the Virtual Local Time
- TV_{Sync} = Virtual Local Time part of the Main Time Tuple
- TG_{Sync} = Global Time part of the Main Time Tuple
- r = Current rate for correcting the local instance of the Time Base

] (RS_TS_00018)

[SWS_StbM_00440][
For Synchronized Time Bases and if rate correction is enabled (see **[SWS_StbM_00377])** and if the absolute value of the time offset between the Received Time and the Synclocal Time (abs(TG_{Rx} - TL_{Sync})) is equal or greater than `StbMOffsetCorrectionJumpThreshold` (**ECUC_StbM_00056 :**), the StbM shall use the factor r_{rc} for the rate correction term r:

$r = r_{rc}$

Otherwise r shall be set to 1, unless r shall be set accordingly to **[SWS_StbM_00356]** or **[SWS_StbM_00353]**.
] (RS_TS_00018)

[SWS_StbM_00441][
For Offset Time Bases and if rate correction is enabled (see **[SWS_StbM_00377])** and if the absolute value of the time offset between the Received Time and the Synclocal Time (abs(TG_{Rx} - TL_{Sync})) is equal or greater than `StbMOffsetCorrectionJumpThreshold` (**ECUC_StbM_00056 :**), the StbM shall use the factor r_{orc} for the rate correction term r:

$r = r_{orc} - 1$

Otherwise r shall be set to 0, unless r shall be set accordlingly to **[SWS_StbM_00356]** or **[SWS_StbM_00355]**.
] (RS_TS_00018)

[SWS_StbM_00356][
If rate correction is enabled (see **[SWS_StbM_00377])** and if the absolute value of the time offset between the Received Time and the Synclocal Time (abs(TG_{Rx} - TL_{Sync})) is smaller than `StbMOffsetCorrectionJumpThreshold`

(**ECUC_StbM_00056 :**), the StbM shall correct the time offset by temporarily applying an additional rate (r_{oc}) to r:

$r = r_{rc} + r_{oc}$ (for Synchronized Time Bases)

$r = (r_{orc} – 1) + r_{oc}$ (for Offset Time Bases)

This rate correction term shall be applied for the duration defined by parameter `StbMOffsetCorrectionAdaptionInterval` (**ECUC_StbM_00057 :**), starting when obtaining the Received Time Tuple (i.e., it shall be applied as long as (TV - TV_{Sync}) (see **[SWS_StbM_00355]**) is smaller than `StbMOffsetCorrectionAdaptionInterval`).

r_{oc} shall be calculated as shown:

$r_{oc} = (TG_{Rx} – TL_{Sync}) / (T_{CorrInt})$

With:

- $T_{CorrInt}$ = `StbMOffsetCorrectionAdaptionInterval`
- TL_{Sync} = Global Time part of the Synclocal Time Tuple
- TG_{Rx} = Global Time part of the Received Time Tuple

] (RS_TS_00018, RS_TS_00019)

[SWS_StbM_00353][
If an additional rate has been applied (Offset Correction By Rate Adaption according to **[SWS_StbM_00356]**), the StbM shall **after** the period of `StbMOffsetCorrectionAdaptionInterval` (i.e., (TV - TV_{Sync}) (see **[SWS_StbM_00355]**) is larger or equal than `StbMOffsetCorrectionAdaptionInterval)` insert the following two steps if it needs to calculate the current value of a Time Base as defined by **[SWS_StbM_00355]:**

1. It shall first calculate a temporary Time Tuple [TL_{Temp};TV_{Temp}] using the formula in **[SWS_StbM_00355]** with
   $TV = TV_{Temp} = TV_{Sync}$ + `StbMOffsetCorrectionAdaptionInterval`
   $r = r_{rc} + r_{oc}$ (for Synchronized Time Bases)
   $r = (r_{orc} – 1) + r_{oc}$ (for Offset Time Bases)
   TL_{Temp} shall be set to the resulting value TL
2. Afterwards the Main Time Tuple [TG_{Sync};TV_{Sync}] shall be set by an atomic operation to the values of the temporary Time Tuple [TL_{Temp};TV_{Temp}].

Then the calculation in **[SWS_StbM_00355]** shall be done by using the updated Main Time Tuple, the current value of the Virtual Local Time and $r = r_{rc}$ respective $r = (r_{orc} – 1)$.
] (RS_TS_00018)

Note: It is possible for the StbM to perform the first two steps (i.e., to update the Main Time Tuple) in its Main Function after expiration of `StbMOffsetCorrectionAdaptionInterval` without being requested to calculate the current time. However, since a request to calculate the current time might occur after expiration of `StbMOffsetCorrectionAdaptionInterval` but

before the next Main Function invocation, it is not possible to always decouple the first two steps from the last one.

[SWS_StbM_00400]⌈
If `StbMOffsetCorrectionJumpThreshold` (**ECUC_StbM_00056 :**) is set to 0, Offset Correction shall be performed by Jump Correction only.
⌋ (RS_TS_00018)

7.3.8.3 Time Interpolation and Rate Correction for Global Time Masters

Rate correction in Global Time Masters can be applied to Synchronized and Offset Time Bases (including Pure Local Time Bases).

Use cases are setting the rate of a Pure Local Time Base to the rate of a received Synchronized Time Base or adjusting the rate of Synchronized Time Bases to external time sources (e.g., GPS).

Rate correction is applied by setting a correction factor which the StbM uses to correct the Time Base's time whenever it is read (e.g., in the scope of `StbM_GetCurrentTime()` or `StbM_BusGetCurrentTime()`).

The interpolation of the Time Base is based on the Main Time Tuple, the current value of the Virtual Local Time and the current Rate Correction value.

[SWS_StbM_00395]⌈
If `StbMAllowMasterRateCorrection` equals `TRUE`, an invocation of `StbM_SetRateCorrection()` shall set the rate correction value. Otherwise `StbM_SetRateCorrection()` shall do nothing and return `E_NOT_OK`.
⌋ (RS_TS_00018)

[SWS_StbM_00411]⌈
The StbM shall apply rate correction to a Time Base, if `StbMAllowMasterRateCorrection` (**ECUC_StbM_00043 :**) equals `TRUE` and a valid rate correction value has been set by `StbM_SetRateCorrection()`.
⌋ (RS_TS_00018)

[SWS_StbM_00396]⌈
If the absolute value of the rate correction parameter `rateDeviation`, which is passed to `StbM_SetRateCorrection()`, is greater than `StbMMasterRateDeviationMax`, `StbM_SetRateCorrection` shall set the actually applied rate correction value to either (`StbMMasterRateDeviationMax`) or (`-StbMMasterRateDeviationMax`) (depending on sign of `rateDeviation`).
⌋ (RS_TS_00018)

Note: The actual applied resulting rate will be

- for Synchronized Time Bases: `rateDeviation` + 1 (= r_{rc} as given in **[SWS_StbM_00424]**)

- for Offset Time Bases: `rateDeviation` (= r_{orc} – 1 as given in **[SWS_StbM_00424]**)

with `rateDeviation`: deviation value passed to `StbM_SetRateCorrection()`

If aligning the rate of one Time Base to the rate of another one, it is possible to use `StbM_GetRateDeviation()` and pass the value as argument to `StbM_SetRateCorrection()`.

[SWS_StbM_00424][
The StbM shall calculate the (rate corrected) time (TL) of its local instance of the Time Base as:

$TL = TG_{Sync} + (TV - TV_{Sync}) * r$

With:

- TV = Current value of the Virtual Local Time
- TV_{Sync} = Virtual Local Time part of the Main Time Tuple
- TG_{Sync} = Global Time part of the Main Time Tuple
- r = Rate for correcting the Time Base with
  r = r_{rc} for Synchronized Time Bases
  r = r_{orc} -1 for Offset Time Bases

If `StbMAllowMasterRateCorrection` (**ECUC_StbM_00043 :**) equals `FALSE` r shall be set to

- 1 for Synchronized Time Bases
- 0 for Offset Time Bases

(i.e., no rate correction is applied).

] (RS_TS_00018)

Note: TL and TV form a new temporary Time Tuple.

[SWS_StbM_00442][
For Synchronized Time Bases the Main Time Tuple shall be updated according to **[SWS_StbM_00441]** and **[SWS_StbM_00342]**.

In case of `StbM_SetRateCorrection()` the StbM shall calculate a temporary Time Tuple according to **[SWS_StbM_00424]** and replace the Main Time Tuple by this temporary Time Tuple.
] (RS_TS_00018)

[SWS_StbM_00443][
For Offset Time Bases the Main Time Tuple shall be updated according to **[SWS_StbM_00441]**, **[SWS_StbM_00190]** and **[SWS_StbM_00304]**.

In case of `StbM_SetRateCorrection()` the StbM shall calculate a temporary Time Tuple according to **[SWS_StbM_00424]** and replace the Main Time Tuple by this temporary Time Tuple.

] (RS_TS_00018)

[SWS_StbM_00422][

- For Time Bases with `StbMSynchronizedTimeBaseIdentifier` 32 to 127 (**ECUC_StbM_00021 :**) and
- for Time Bases with `StbMSynchronizedTimeBaseIdentifier` 0 to 31 and `StbMIsSystemWideGlobalTimeMaster` equals `True` (**ECUC_StbM_00036 :**)

the StbM shall return on invocation of `StbM_GetRateDeviation()` the rate deviation that has been set by `StbM_SetRateCorrection()` for that Time Base.

If no rate deviation has been set, `StbM_GetRateDeviation()` shall return `E_NOT_OK`.
] (RS_TS_00018)

[SWS_StbM_00431][
For the Time Master of a Synchronized Time Base the StbM shall use $r_{rc} = 1$, if a valid correction rate (r_{rc}) has not yet been set.

For the Time Master of an Offset Time Base the StbM shall use $r_{orc} = 1$, if a valid correction rate (r_{orc}) has not yet been set.
] (RS_TS_00018)

7.3.9 Notification of Customers

The StbM allows Notification Customers (i.e., SW-Cs or other BSW modules) either to register to be notified of status change events for a Time Base or to be notified if an alarm expires.

7.3.9.1 Time Notifications

The StbM allows Notification Customers to register to be notified if a Customer specific alarm expires.

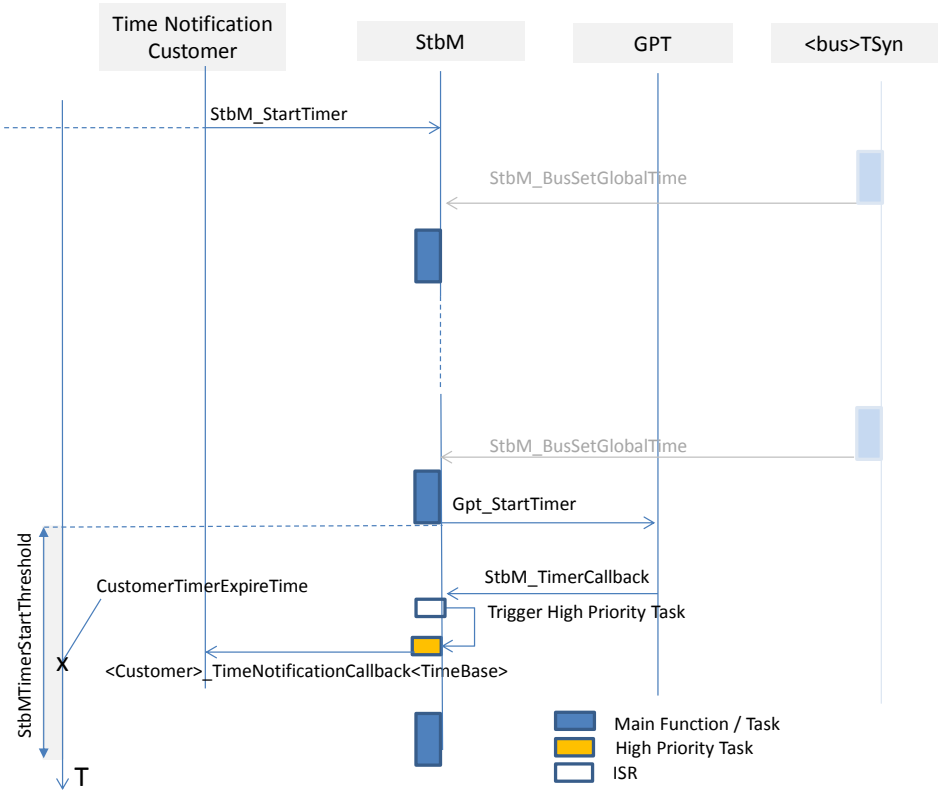


Figure 12: Basic mechanism of Time Notification

[SWS_StbM_00421][
If any `StbMNotificationCustomer` (**ECUC_StbM_00050 :**) is configured, the StbM shall use one additional GPT source (referenced by `StbMGptTimerRef` **ECUC_StbM_00039 :**), which is not used for other purposes.
] (RS_TS_00017)

[SWS_StbM_00270][
On invocation of `StbM_StartTimer` for a Time Notification Customer of a Time Base the StbM shall calculate the time `CustomerTimerExpireTime` when that Customer Timer will expire based on the corresponding Time Base.
] (RS_TS_00017)

[SWS_StbM_00335][
For currently active Time Notification Customers the StbM shall cyclically calculate and monitor in its `StbM_MainFunction` the difference between the current value of the corresponding Time Base and the expiration time `'CustomerTimerExpireTime'`.
] (RS_TS_00017)

Note: Cyclic recalculation accounts for asynchronous updates of the Time Base e.g. by `StbM_BusSetGlobalTime()`.

[SWS_StbM_00336][

A time interval StbMTimerStartThreshold (**ECUC_StbM_00063 :**) before a Customer Timer expires, the StbM shall calculate the time difference between CustomerTimerExpireTime and the current value of the corresponding Time Base.

The StbM shall then start a GPT timer (**ECUC_StbM_00039 :**) via Gpt_StartTimer() to be notified, when the time difference has elapsed.
] (RS_TS_00017)

Note: StbMTimerStartThreshold should be set to a value greater than StbMMainFunctionPeriod to account for the jitter of the StbM_MainFunction.

If the GPT timer expires for a Time Notification Customer, StbM_TimerCallback is called by the GPT.

[SWS_StbM_00271][
Upon invocation of StbM_TimerCallback, the StbM shall calculate the time difference between CustomerTimerExpireTime and the current value of the corresponding Time Base.

If StbMTimeNotificationCallback (**ECUC_StbM_00064 :**) is not NULL,

- the StbM shall call the function <Customer>_TimeNotificationCallback<TimeBase>()

else

- the StbM shall call the service operation NotifyTime of the required port GlobalTime_TimeEvent_{TBName}_{CName}

to inform the corresponding Time Notification Customer and return the value of the calculated time difference in the parameter deviationTime.
] (RS_TS_00017)

Note: StbM_TimerCallback() is called in interrupt context. The operation NotifyTime may however only be called from task context. Therefore, the StbM has to decouple the interrupt context from the task context (e.g. by triggering an ExternalTriggerOccurredEvent). The details are considered to be implementation specific.

Note: The StbM_TimerCallback notification function, which is implemented by the StbM and called by the Gpt, conforms to the <Gpt_Notification_<channel>> prototype. The configured notification function (StbM_TimerCallback) is declared via Gpt header.

[SWS_StbM_00432][
If the CustomerTimerExpireTime has been already passed, when the StbM checks for the first time if StbMTimerStartThreshold has been reached, the StbM shall call StbM_TimeNotificationCallback() immediately.
] (RS_TS_00017)

Note: This can happen, if the Time Base jumps over the expiration time (i.e., `CustomerTimerExpireTime`) due to an invocation of `StbM_BusSetGlobalTime` but the GPT timer was not yet started.

[SWS_StbM_00337]⌈
If multiple Customer Timers run and expire within the same interval `StbMTimerStartThreshold`, the StbM shall calculate all expiry points within the `StbMTimerStartThreshold` interval and re-start the same GPT timer for next expiry point after the previous expiry point has been reached.
⌋ (RS_TS_00017)

Caveat: If a `StbM_BusSetGlobalTime` function call occurs and updates the Time Base, for which a GPT timer is running, the newly received Global Time value could be in the future relative to the Local Time of the Time Base. Depending on how far, that value is in the future, it could mean, that the timer expires too late (based on the new Global Time).

7.3.9.2 Status Notifications

The StbM allows Notification Customers to register to be notified of status change events for a Time Base. The StbM tracks for each registered Notification Customer the occurence of various Time Base related events. Notification Customers can configure the StbM such, that they will be informed by a notification callback, if one or more events occur.

[SWS_StbM_00277]⌈
For Synchronized, Offset and Pure Local Time Bases:

- If parameter `StbMNotificationInterface` (**ECUC_StbM_00068 :**) is set to either `SR_INTERFACE` or `CALLBACK_AND_SR_INTERFACE`, the StbM shall notify the application via the `StatusNotification` service interface.
- If parameter `StbMNotificationInterface` is set to either `CALLBACK` or `CALLBACK_AND_SR_INTERFACE`, the StbM shall use the callback `StatusNotificationCallback<TimeBase>` to notify a CDD about status related events.
- If parameter `StbMNotificationInterface` is set to `NO_NOTIFICATION` the notification mechanism shall be disabled for the given Time Base.

The callback `StatusNotificationCallback<TimeBase>` shall be set via configuration parameter `StbMStatusNotificationCallback` (**ECUC_StbM_00046 :**).
⌋ (RS_TS_20001, RS_TS_00016)

[SWS_StbM_00279]⌈
For each Time Base the StbM has a configurable mask `StbMStatusNotificationMask` (**ECUC_StbM_00045 :**), which allows to mask individually status event notifications.
⌋ (RS_TS_20001, RS_TS_00016)

[SWS_StbM_00284]⌈
The StbM shall detect the following status events:

Status Event Name	Status Event Set Condition
EV_GLOBAL_TIME_BASE	1: GLOBAL_TIME_BASE in timeBaseStatus has changed from 0 to 1 0: otherwise
EV_TIMEOUT_OCCURED	1: TIMEOUT bit in timeBaseStatus has changed from 0 to 1 0: otherwise
EV_TIMEOUT_REMOVED	1: TIMEOUT bit in timeBaseStatus has changed from 1 to 0 0: otherwise
EV_TIMELEAP_FUTURE	1: TIMELEAP_FUTURE bit in timeBaseStatus has changed from 0 to 1 0: otherwise
EV_TIMELEAP_FUTURE_REMOVED	1: TIMELEAP_FUTURE bit in timeBaseStatus has changed from 1 to 0 0: otherwise
EV_TIMELEAP_PAST	1: TIMELEAP_PAST bit in timeBaseStatus has changed from 0 to 1 0: otherwise
EV_TIMELEAP_PAST_REMOVED	1: TIMELEAP_PAST bit in timeBaseStatus has changed from 1 to 0 0: otherwise
EV_SYNC_TO_SUBDOMAIN	1: SYNC_TO_GATEWAY bit in timeBaseStatus has changed from 0 to 1 0: otherwise
EV_SYNC_TO_GLOBAL_MASTER	1: SYNC_TO_GATEWAY bit in timeBaseStatus has changed from 1 to 0 0: otherwise
EV_RESYNC	1: resynchronization has occurred and a new time value has been applied 0: otherwise
EV_RATECORRECTION	1: a valid rate correction has been calculated (not beyond limits) 0: otherwise

⌋(RS_TS_00016)

[SWS_StbM_00278]⌈
For Synchronized and Offset Time Bases the StbM shall use a variable NotificationEvents of type StbM_TimeBaseNotificationType to keep track, if any status event (refer to **[SWS_StbM_00284]**) for the referenced Time Base occurs.

If any status event occurs and the corresponding bit in the NotificationMask mask is set, the corresponding bit in the NotificationEvents variable is set , i.e., NotificationEvents contains the bits for the events, which are enabled within the NotificationMask mask (refer to **[SWS_StbM_00284]**).
] (RS_TS_20001)

[SWS_StbM_00282][
If any status event (refer to **[SWS_StbM_00284]**) occurs and the corresponding bit in the NotificationMask mask is set, the StbM shall report the value of the NotificationEvents variable

- via the callback function StatusNotificationCallback<TimeBase> (refer to parameter eventNotifications) and/or
- via StatusNotification service interface (refer to data element eventNotification)

depending on the setting of parameter StbMNotificationInterface (**ECUC_StbM_00068 :**).

If multiple status events occur simultaneously for the same Time Base, the StbM shall trigger the callback function StatusNotificationCallback<TimeBase> and the StatusNotification service interface only once.
] (RS_TS_20001)

Note: If e.g. a (re)synchronization takes place several of the following events may occur simultaneously: EV_RESYNC, EV_TIMEOUT_REMOVED, EV_GLOBAL_TIME_BASE, EV_TIMELEAP_FUTURE, EV_TIMELEAP_PAST, EV_TIMELEAP_FUTURE_REMOVED / EV_TIMELEAP_PAST_REMOVED, EV_RATECORRECTION, EV_SYNC_TO_SUBDOMAIN and EV_SYNC_TO_GLOBAL_MASTER.

[SWS_StbM_00280][
After reporting a status event via the StatusNotificationCallback<TimeBase> API and the StatusNotification service interface the StbM shall reset NotificationEvents to 0.
] (RS_TS_00016)

7.3.10 Triggering Customers

The OS provides the API SyncScheduleTable() to synchronize a schedule table to a counter value.

[SWS_StbM_00020][
The Synchronized Time-Base Manager must be able to interact with the OS as Triggered Customer. The module calls the OS API for synchronizing OS ScheduleTables.
] (SRS_BSW_00429, RS_TS_20001, RS_TS_00032)

[SWS_StbM_00022]⌈
The Synchronized Time-Base Manager shall provide means to configure the Time Base to which the OS ScheduleTable should be synchronized (see container **ECUC_StbM_00004 :** `StbMTriggeredCustomer`).
⌋ (RS_TS_20001, RS_TS_00032)

The schedule table to be synchronized is given by `StbMOSScheduleTableRef` (refer to **ECUC_StbM_00007 :**) and the Time Base, which synchronizes the schedule table, is given by `StbMSynchronizedTimeBaseRef`.

It is configurable at pre-compile time if an OS ScheduleTable shall be synchronized with a Synchronized Time Base.

[SWS_StbM_00084]⌈
Customers of type Triggered Customer shall be invoked periodically by the Synchronized Time-Base Manager.
⌋ (RS_TS_00032)

[SWS_StbM_00093]⌈
The triggering period `StbMTriggeredCustomerPeriod` (refer to **ECUC_StbM_00020 :**) shall be configurable for each Triggered Customer.
⌋ (RS_TS_20001, RS_TS_00032)

Based on the configuration, the Synchronized Time-Base Manager synchronizes the OS counter value of the associated OS ScheduleTable.

[SWS_StbM_00302]⌈
The StbM shall set the synchronization count of the OS ScheduleTable via `SyncScheduleTable()`.
⌋ (RS_TS_00032)

The Synchronized Time-Base Manager is not responsible for starting and stopping the execution of OS ScheduleTables.

[SWS_StbM_00303]⌈
The StbM shall derive the synchronization count of the OS ScheduleTable in microseconds by calculating the modulus of the current Time Base value (converted to microseconds) and `OsScheduleTableDuration` (see `OsScheduleTable` container referenced by **ECUC_StbM_00007 :**).
⌋ (RS_TS_20001, RS_TS_00032)

Note: This requires, that the ticks of an OS counter, which drives a schedule table, have a duration of 1 us.

[SWS_StbM_00077]⌈
The Synchronized Time-Base Manager shall synchronize OS ScheduleTables only when the associated Synchronized Time Base is synchronized.
⌋ (RS_TS_00032)

[SWS_StbM_00092][
The Synchronized Time-Base Manager shall check the OS for the status of the OS ScheduleTable by calling `GetScheduleTableStatus()` before performing the synchronization.

The Synchronized Time-Base Manager shall synchronize only OS ScheduleTables that are in one of the states `SCHEDULETABLE_WAITING`, `SCHEDULETABLE_RUNNING` or `SCHEDULETABLE_RUNNING_SYNCHRONOUS`.
] (SRS_BSW_00429, RS_TS_00032)

Note: The Synchronized Time-Base Manager should ignore possible errors caused by the sequential execution of a) getting OS ScheduleTable status and b) performing the synchronization (e.g., someone else might have called a service to stop the OS ScheduleTable in the meantime).

7.3.11 Global Time Precision Measurement Support

To verify the precision of each Local Time Base compared to the Global Time Base a recording mechanism shall be optionally supported for Time Slaves and Time Gateways.
In principle, the StbM takes a snapshot of all required data at the point in time, where a synchronization event takes place. The StbM provides access to those values by an actively pushed API function on each successful assembled data block. An Off-Board Tester collects each block and calculates the precision afterwards and maintains a history of recorded blocks and their elements accordingly.
How and by which protocol the data will be transferred to the Off-Board Tester will be specified by the Application.

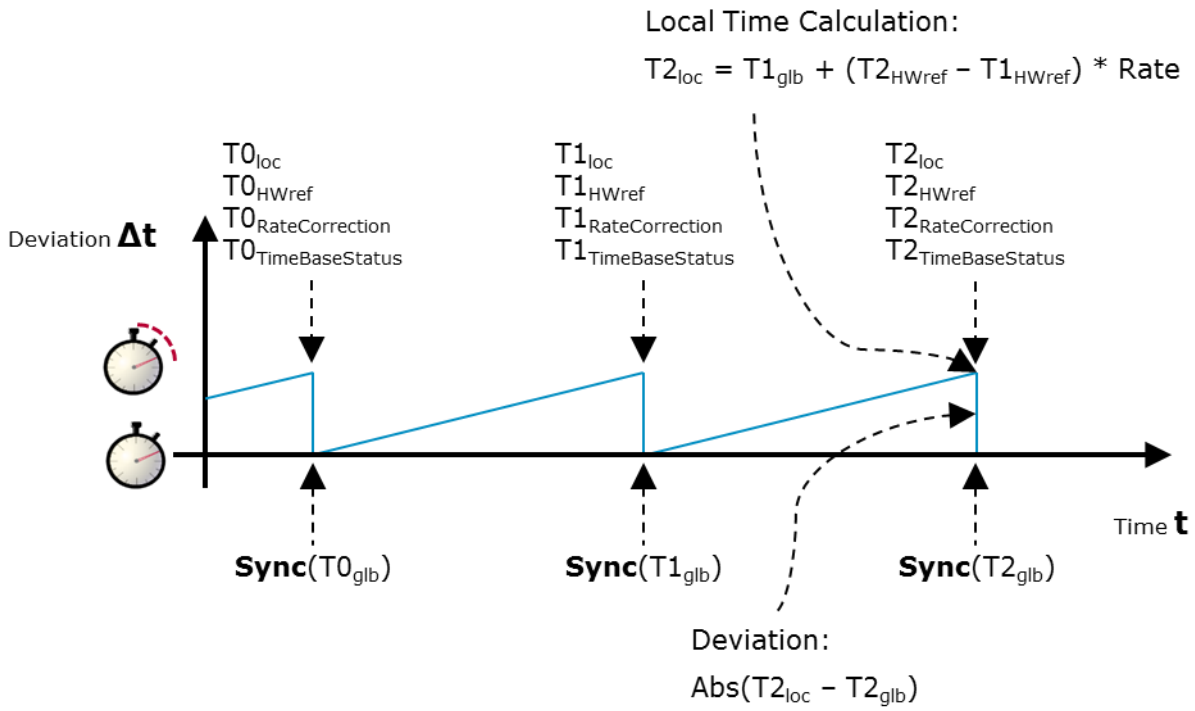


Figure 13: Simplified view how the recorded Time Base related snapshot data are taken

[SWS_StbM_00307]⌈
The StbM shall support the Global Time precision measurement, if `StbMTimeRecordingSupport` (**ECUC_StbM_00038 :**) is set to `TRUE`.
⌋ (RS_TS_00034)

[SWS_StbM_00428]⌈
The StbM shall do Global Time precision measurement only for Synchronized Time Bases and Offset Time Bases, for which `StbMIsSystemWideGlobalTimeMaster` (**ECUC_StbM_00036 : :**) is set to `FALSE`.
⌋ (RS_TS_00034)

7.3.11.1 Synchronized Time Base Record Table

[SWS_StbM_00308]⌈
If Global Time Precision Measurement is enabled (refer to **[SWS_StbM_00428]** and **[SWS_StbM_00307]**) for the Time Base, the StbM shall establish a table to record values depending on the Synchronized Time Base with the following structure:

	Record Table Element	Multi-plicity	Range	Bytes	Type / Unit
Header		1		9	
	SynchronizedTimeDomain	1	0..15	1	uint8
	HWfrequency	1	0..4294967295	4	uint32 / Hz
	HWprescaler	1	0..4294967295	4	uint32
Block 0		1		27	

	GlbSeconds	1	0..4294967295	4	StbM_TimeStampType. seconds
	GlbNanoSeconds	1	0..999999999	4	StbM_TimeStampType. nanoseconds
	TimeBaseStatus	1	0..255	1	StbM_TimeStampType. StbM_TimeBaseStatusType
	VirtualLocalTimeLow	1	0..4294967295	4	uint32 / nanoseconds
	RateDeviation	1	0..+-32000	2	StbM_RateDeviationType / ppm
	LocSeconds	1	0..4294967295	4	StbM_TimeStampType. seconds
	LocNanoSeconds	1	0..999999999	4	StbM_TimeStampType. nanoseconds
	PathDelay	1	0..4294967295	4	uint32 / nanoseconds
Block 1	…				
…					
Block (Block-Count-1)	…				

] (RS_TS_00034)

[SWS_StbM_00309][
If Global Time Precision Measurement is enabled (refer to **[SWS_StbM_00428]** and **[SWS_StbM_00307]**) for the Time Base, `StbMClockfrequency` (**ECUC_StbM_00051 :**) shall be mapped to the Header Element `HWfrequency` of the table belonging to the Synchronized Time Base unless the Virtual Local Time for the Time Base is provided by a Timesync module. In this case, `HWfrequency` shall be set to 1000000000.
] (RS_TS_00034)

[SWS_StbM_00310][
If Global Time Precision Measurement is enabled (refer to **[SWS_StbM_00428]** and **[SWS_StbM_00307]**) for the Time Base, `StbMClockprescaler` (**ECUC_StbM_00052 :**) shall be mapped to the Header Element `HWprescaler` of the table belonging to the Synchronized Time Base unless the Virtual Local Time for the Time Base is provided by a Timesync module. In this case, `HWprescaler` shall be set to 1.
] (RS_TS_00034)

[SWS_StbM_00382][
If Global Time Precision Measurement is enabled (refer to **[SWS_StbM_00428]** and **[SWS_StbM_00307]**) for the Time Base, the Synchronized Time Base Record Table shall contain as many blocks as configured by `StbMSyncTimeRecordTableBlockCount` (**ECUC_StbM_00058 :**).
] (RS_TS_00034)

7.3.11.2 Offset Time Base Record Table

[SWS_StbM_00311][
If Global Time Precision Measurement is enabled (refer to **[SWS_StbM_00428]** and **[SWS_StbM_00307]**) for the Time Base, the StbM shall establish a table to record values depending on the Offset Time Base with the following structure:

	Record Table Element	Multi-plicity	Range	Bytes	Type / Unit
Header		1		1	
	OffsetTimeDomain	1	16..31	1	uint8
Block 0		1		9	
	GlbSeconds	1	0..4294967295	4	StbM_TimeStampType. seconds
	GlbNanoSeconds	1	0..999999999	4	StbM_TimeStampType. nanoseconds
	TimeBaseStatus	1	0..255	1	StbM_TimeStampType. StbM_TimeBaseStatusType
Block 1	…				
…					
Block (Block-Count-1)	…				

] (RS_TS_00034)

[SWS_StbM_00383][
If Global Time Precision Measurement is enabled (refer to **[SWS_StbM_00428]** and **[SWS_StbM_00307]**) for the Time Base, the Offset Time Base Record Table shall contain as many blocks as configured by `StbMOffsetTimeRecordTableBlockCount` (**ECUC_StbM_00059 :**).
] (RS_TS_00034)

7.3.11.3 Record Table Snapshot Conditions

[SWS_StbM_00312][
If Global Time Precision Measurement is enabled (refer to **[SWS_StbM_00428]** and **[SWS_StbM_00307]**) for the Time Base, on an invocation of `StbM_BusSetGlobalTime()` the StbM shall update all elements of the block of the recording table.

If all blocks have been written and no notification via `SyncTimeRecordBlockCallback<TimeBase>` or `OffsetTimeRecordBlockCallback<TimeBase>` has yet occurred to pass all blocks with their elements to the application, the StbM shall again overwrite the block containing the oldest measurement data with the incoming measurement data.
] (RS_TS_00034)

Note: From the implementation point of view, this mechanism belongs to a ring buffer concept in case data cannot be forwarded to the Application fast enough.

[SWS_StbM_00313]⌈
For Synchronized Time Bases, if Global Time Precision Measurement is enabled (refer to **[SWS_StbM_00428]** and **[SWS_StbM_00307]**) for the Time Base, on an invocation of `StbM_BusSetGlobalTime()` the StbM shall write the block elements `LocSeconds` and `LocNanoSeconds` to the related measurement recording table before updating the Main Time Tuple (i.e., updating the Local Time Base by the Global Time Base). `LocSeconds` and `LocNanoSeconds` are the elements of the Global Time part of the Synclocal Time Tuple (i.e., TL_{Sync} , see **[SWS_StbM_00438]**).
⌋ (RS_TS_00034)

[SWS_StbM_00314]⌈
For Synchronized Time Bases, if Global Time Precision Measurement is enabled (refer to **[SWS_StbM_00428]** and **[SWS_StbM_00307]**) for the Time Base, on an invocation of `StbM_BusSetGlobalTime()` the StbM shall write the block elements `GlbSeconds`, `GlbNanoSeconds`, `VirtualLocalTimeLow`, `RateDeviation`, `TimeBaseStatus` and `PathDelay` to the related measurement recording table after updating the Main Time Tuple (i.e., after updating the Local Time Base by the Global Time Base). `GlbSeconds`, `GlbNanoSeconds` are the elements of the Global Time part of the Received Time Tuple (i.e., TG_{Rx}); `VirtualLocalTimeLow` is the `nanosecondsLo` element of the Virtual Local Time part of the Received Time Tuple (i.e., TV_{Rx}).
⌋ (RS_TS_00034)

Note: `PathDelay` will be retrieved from the <Bus>TSyn module as `PathDelay` member of parameter `measureDataPtr` of `StbM_BusSetGlobalTime()`.

[SWS_StbM_00388]⌈
For Offset Time Bases, if Global Time Precision Measurement is enabled (refer to **[SWS_StbM_00428]** and **[SWS_StbM_00307]**) for the Time Base, on an invocation of `StbM_BusSetGlobalTime()` the StbM shall write the block elements `GlbSeconds`, `GlbNanoSeconds` and `TimeBaseStatus` to the related measurement recording table.
⌋ (RS_TS_00034)

[SWS_StbM_00315]⌈
If Global Time Precision Measurement is enabled (refer to **[SWS_StbM_00428]** and **[SWS_StbM_00307]**) for the Time Base, the application collects the contents of the header of the Synchronized Time Base Record Table by calling `StbM_GetSyncTimeRecordHead()`.
⌋ (RS_TS_00034)

[SWS_StbM_00316]⌈
If Global Time Precision Measurement is enabled (refer to **[SWS_StbM_00428]** and **[SWS_StbM_00307]**) for the Time Base, the application collects the contents of the

header of the Offset Time Base Record Table by calling `StbM_GetOffsetTimeRecordHead()`.
] (RS_TS_00034)

[SWS_StbM_00317][
If Global Time Precision Measurement is enabled (refer to **[SWS_StbM_00428]** and **[SWS_StbM_00307]**) for the Time Base, the StbM shall notify the Application by calling `SyncTimeRecordBlockCallback<TimeBase>` in the next `StbM_MainFunction()` call cycle block by block (i.e., repeatedly) for all unread blocks (i.e., containing data that has yet not been passed to the Application), starting with the block containing the oldest data, and followed by the blocks in ascending order regarding their age (i.e., FIFO order), the block containing the newest data shall be passed last.

The StbM shall ensure data integrity: a block shall not be passed if it currently being overwritten and a block that is passed shall be prevented from being overwritten until processed by the Application.
] (RS_TS_00034)

[SWS_StbM_00318][
If Global Time Precision Measurement is enabled (refer to **[SWS_StbM_00428]** and **[SWS_StbM_00307]**) for the Time Base, the StbM shall notify the Application by calling `OffsetTimeRecordBlockCallback<TimeBase>` in the next `StbM_MainFunction()` call cycle block by block (i.e., repeatedly) for all unread blocks (i.e., containing data that has yet not been passed to the Application), starting with the block containing the oldest data, and followed by the blocks in ascending order regarding their age (i.e., FIFO order), the block containing the newest data shall be passed last.

The StbM shall ensure data integrity: a block shall not be passed if it currently being overwritten and a block that is passed shall be prevented from being overwritten until processed by the Application.
] (RS_TS_00034)

7.3.12 Interaction with User Defined Timesync Module (CDD)

User defined Time Base Providers are implemented by a CDD module. Details of the interaction between the StbM and such a CDD module are described in section “Interfacing with StbM module” of [16].

7.4 Error Handling

[SWS_StbM_00031][
If a triggered customer is configured (refer to **ECUC_StbM_00004 :** `StbMTriggeredCustomer`), the Synchronized Time-Base Manager shall monitor the cyclic execution of the `StbM_MainFunction()` (see section 8.1.3.24). This is to guarantee cyclic synchronization of OS schedule tables.

] (RS_TS_00025)

[SWS_StbM_00199][
For any StbM API service other then `StbM_Init()` and `StbM_GetVersion()` all out parameters shall remain untouched, if an error occurs during execution of that API service.
] (RS_TS_00025)

For further details refer to the chapter 7.2 “Error Handling” in *SWS_BSWGeneral* and chapter 8 for API specific error handling.

7.5 Error Classification

7.5.1 Development Errors

[SWS_StbM_00041][
The following errors and exceptions shall be detectable by the Synchronized Time-Base Manager depending on its build version (development/production mode).

Type or error	***Related error code***	***Value [hex]***
StbM_Init called with an invalid configuration pointer	`STBM_E_INIT_FAILED`	0x11
API called while StbM is not initialized	`STBM_E_UNINIT`	0x0B
API called with wrong parameter	`STBM_E_PARAM`	0x0A
API called with invalid pointer in parameter list	`STBM_E_PARAM_POINTER`	0x10
API disabled by configuration	`STBM_E_SERVICE_DISABLED`	0x12

] (SRS_BSW_00337, SRS_BSW_00385, SRS_BSW_00386, SRS_BSW_00327, SRS_BSW_00323)

Note:
There exist errors, which are of interest for the user of the Synchronized Time-Base Manager, but the source of failure is somewhere else (e.g., the FlexRay Time Base is not synchronized). Thus, they do not appear in the above-mentioned error list and the Synchronized Time-Base Manager does not perform an error handling for those kinds of errors.

7.5.2 Runtime Errors

No Runtime Errors defined.

7.5.3 Transient Faults

No Transient Faults defined.

7.5.4 Production Errors

No Production Errors defined.

7.5.5 Extended Production Errors

No Extended Production Errors defined.

7.6 Version Check

For details refer to the chapter 5.1.8 “Version Check” in *SWS_BSWGeneral.*

8 API specification

8.1 API

8.1.1 Imported types

In this chapter, all types included from the following modules are listed:

[SWS_StbM_00051] [

Module	*Header File*	*Imported Type*
Eth_GeneralTypes	Eth_GeneralTypes.h	Eth_TimeStampQualType
	Eth_GeneralTypes.h	Eth_TimeStampType
Gpt	Gpt.h	Gpt_ChannelType
	Gpt.h	Gpt_ValueType
Os	Os.h	ScheduleTableStatusRefType
	Os.h	ScheduleTableType
	Os.h	StatusType
	Os.h	TickRefType
	Os.h	TickType
	Rte_Os_Type.h	CounterType
Std_Types	StandardTypes.h	Std_ReturnType
	StandardTypes.h	Std_VersionInfoType

] (SRS_BSW_00301)

8.1.2 Type definitions

8.1.2.1 StbM_ConfigType

[SWS_StbM_00249] [

Name:	`StbM_ConfigType`	
Type:	`Structure`	
Range:	`implementation specific`	--
Description:	Configuration data structure of the StbM module.	
Available via:	`StbM.h`	

] (SRS_BSW_00414)

8.1.2.2 {Obsolete} StbM_TimeStampRawType

[SWS_StbM_00194] [

Name:	`StbM_TimeStampRawType (obsolete)`		
Type:	`uint32`		
Range:	`0..4294967295`	--	nanoseconds (0x000 00000 .. 0xFFFF FFFF)
Description:	Variables of this type are used for expressing time stamps in raw format in nanoseconds only. **Tags:** atp.Status=obsolete		
Available via:	`StbM.h`		

] (RS_TS_00009)

8.1.2.3 StbM_VirtualLocalTimeType

[SWS_StbM_91003] [

Name:	`StbM_VirtualLocalTimeType`		
Type:	`Structure`		
Element:	`uint32`	`nanosecondsLo`	Least significant 32 bits of the 64 bit Virtual Local Time
	`uint32`	`nanosecondsHi`	Most significant 32 bits of the 64 bit Virtual Local Time
Description:	Variables of this type store time stamps of the Virtual Local Time. The unit is nanoseconds.		
Available via:	`StbM.h`		

] (RS_TS_00009)

8.1.2.4 StbM_MeasurementType

[SWS_StbM_00384] [

Name:	`StbM_MeasurementType`

Type:	`Structure`		
Element:	`uint32`	`pathDelay`	Propagation delay in nanoseconds
Description:	Structure which contains additional measurement data		
Available via:	`StbM.h`		

] (RS_TS_00034)

8.1.3 Function definitions

This is a list of functions provided for upper layer modules.

8.1.3.1 StbM_GetVersionInfo

[SWS_StbM_00066] ⌈

Service name:	StbM_GetVersionInfo	
Syntax:	`void StbM_GetVersionInfo( Std_VersionInfoType* versioninfo )`	
Service ID[hex]:	0x05	
Sync/Async:	Synchronous	
Reentrancy:	Reentrant	
Parameters (in):	None	
Parameters (inout):	None	
Parameters (out):	versioninfo	Pointer to the memory location holding the version information of the module.
Return value:	None	
Description:	Returns the version information of this module.	
Available via:	`StbM.h`	

⌋ (SRS_BSW_00407)

[SWS_StbM_00094]⌈
If development error detection for the StbM module is enabled the function `StbM_GetVersionInfo` shall raise the development error `STBM_E_PARAM_POINTER` and return if versioninfo is a NULL pointer (`NULL_PTR`).
⌋(SRS_BSW_00386, SRS_BSW_00337)

8.1.3.2 StbM_Init

[SWS_StbM_00052] ⌈

Service name:	StbM_Init	
Syntax:	`void StbM_Init( const StbM_ConfigType* ConfigPtr )`	
Service ID[hex]:	0x00	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	ConfigPtr	Pointer to the selected configuration set.
Parameters (inout):	None	
Parameters (out):	None	
Return value:	None	
Description:	Initializes the Synchronized Time-base Manager	
Available via:	`StbM.h`	

⌋ (SRS_BSW_00101, SRS_BSW_00358, SRS_BSW_00414)

The ECU State Manager calls the function `StbM_Init()` during the startup phase of the ECU in order to initialize the module. The StbM is not functional until this function has been called.

[SWS_StbM_00100]⌈
A static status variable denoting if the StbM is initialized shall be initialized with value 0 before any APIs of the StbM are called.
⌋ (SRS_BSW_00406)

[SWS_StbM_00121]⌈
StbM_Init shall set the static status variable to a value not equal to 0.
⌋ (SRS_BSW_00406)

8.1.3.3 StbM_GetCurrentTime

[SWS_StbM_00195] ⌈

Service name:	StbM_GetCurrentTime	

Syntax:	`Std_ReturnType StbM_GetCurrentTime(`
	`  StbM_SynchronizedTimeBaseType timeBaseId,`
	`  StbM_TimeStampType* timeStamp,`
	`  StbM_UserDataType* userData`
	`)`	

Service ID[hex]:	0x07	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	timeBaseId	time base reference
Parameters (inout):	None	
Parameters (out):	timeStamp	Current time stamp that is valid at this time
	userData	User data of the Time Base
Return value:	Std_ReturnType	E_OK: successful E_NOT_OK: failed
Description:	Returns a time value (Local Time Base derived from Global Time Base) in standard format. Note: This API shall be called with locked interrupts / within an Exclusive Area to prevent interruption (i.e., the risk that the time stamp is outdated on return of the function call).	
Available via:	`StbM.h`	

⌋ (RS_TS_00005, RS_TS_00006, RS_TS_00029, RS_TS_00030, RS_TS_00031, RS_TS_00014)

[SWS_StbM_00196]⌈
If the switch `StbMDevErrorDetect` (**ECUC_StbM_00012 :**) is set to `TRUE`, `StbM_GetCurrentTime()` shall report to DET the development error `STBM_E_PARAM`, if called with a parameter `timeBaseId`, which is

- not configured or
- within the reserved value range.

⌋ (SRS_BSW_00386, SRS_BSW_00323)

[SWS_StbM_00197]⌈
If the switch `StbMDevErrorDetect` (**ECUC_StbM_00012 :**) is set to `TRUE`, `StbM_GetCurrentTime()` shall report to DET the development error `STBM_E_PARAM_POINTER`, if called with a NULL pointer for parameter `timeStamp` or `userData`.
⌋ (SRS_BSW_00386, SRS_BSW_00323)

8.1.3.4 StbM_GetCurrentTimeExtended

[SWS_StbM_00200] ⌈

Service name:	StbM_GetCurrentTimeExtended	

Syntax:	`Std_ReturnType StbM_GetCurrentTimeExtended(`
	`  StbM_SynchronizedTimeBaseType timeBaseId,`
	`  StbM_TimeStampExtendedType* timeStamp,`
	`  StbM_UserDataType* userData`
	`)`	

Service ID[hex]:	0x08	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	timeBaseId	time base reference
Parameters (inout):	None	
Parameters (out):	timeStamp	Current time stamp that is valid at this time
	userData	User data of the Time Base
Return value:	Std_ReturnType	E_OK: successful E_NOT_OK: failed
Description:	Returns a time value (Local Time Base derived from Global Time Base) in extended format. Note: This API shall be called with locked interrupts / within an Exclusive Area to prevent interruption (i.e., the risk that the time stamp is outdated on return of the function call).	
Available via:	`StbM.h`	

⌋ (RS_TS_00005, RS_TS_00014)

[SWS_StbM_00201]⌈
If the switch `StbMDevErrorDetect` (**ECUC_StbM_00012 :**) is set to `TRUE`, `StbM_GetCurrentTimeExtended()` shall report to DET the development error `STBM_E_PARAM`, if called with a parameter `timeBaseId`, which is

- not configured or
- within the reserved value range.

⌋ (SRS_BSW_00386, SRS_BSW_00323)

[SWS_StbM_00202]⌈
If the switch `StbMDevErrorDetect` (**ECUC_StbM_00012 :**) is set to `TRUE`, `StbM_GetCurrentTimeExtended()` shall report to DET the development error `STBM_E_PARAM_POINTER`, if called with a NULL pointer for parameter `timeStamp` or `userData`.
⌋ (SRS_BSW_00386, SRS_BSW_00323)

8.1.3.5 StbM_GetCurrentVirtualLocalTime

[SWS_StbM_91006] ⌈

Service name:	StbM_GetCurrentVirtualLocalTime	
Syntax:	`Std_ReturnType StbM_GetCurrentVirtualLocalTime( StbM_SynchronizedTimeBaseType timeBaseId, StbM_VirtualLocalTimeType* localTimePtr )`	
Service ID[hex]:	0x1e	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	timeBaseId	Time Base reference
Parameters (inout):	None	
Parameters (out):	localTimePtr	Current Virtual Local Time value
Return value:	Std_ReturnType	E_OK: successful E_NOT_OK: failed
Description:	Returns the Virtual Local Time of the referenced Time Base.	
Available via:	`StbM.h`	

⌋ (RS_TS_00006, RS_TS_00008)

[SWS_StbM_00444]⌈
If the switch `StbMDevErrorDetect` (**ECUC_StbM_00012 :**) is set to `TRUE`, `StbM_GetCurrentVirtualLocalTime ()` shall report to DET the development error `STBM_E_PARAM_POINTER`, if called with a NULL pointer for parameter `localTimePtr`.
⌋ (SRS_BSW_00386, SRS_BSW_00323)

[SWS_StbM_00445]⌈ If the switch `StbMDevErrorDetect` (**ECUC_StbM_00012 :**) is set to `TRUE`, `StbM_GetCurrentVirtualLocalTime ()` shall report to DET the development error `STBM_E_PARAM`, if called with a parameter `timeBaseId`, which

- is not configured or
- is within the reserved value range.

⌋ (SRS_BSW_00386, SRS_BSW_00323)

8.1.3.6 {Obsolete} StbM_GetCurrentTimeRaw

[SWS_StbM_00205] ⌈

Service name:	StbM_GetCurrentTimeRaw (obsolete)	
Syntax:	`Std_ReturnType StbM_GetCurrentTimeRaw( StbM_SynchronizedTimeBaseType timeBaseId, StbM_TimeStampRawType* timeStampRawPtr )`	
Service ID[hex]:	0x09	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	timeBaseId	Time Base reference
Parameters	None	

(inout):		
Parameters (out):	timeStampRawPtr	Current time stamp that is valid at this time
Return value:	Std_ReturnType	E_OK: successful E_NOT_OK: failed
Description:	Returns nanosecond part of the Virtual Local Time of the referenced Time Base. **Tags:** atp.Status=obsolete	
Available via:	`StbM.h`	

] (RS_TS_00006, RS_TS_00008)

[SWS_StbM_00206] {Obsolete}**[**
If the switch `StbMDevErrorDetect` (**ECUC_StbM_00012 :**) is set to `TRUE`, `StbM_GetCurrentTimeRaw()` shall report to DET the development error `STBM_E_PARAM_POINTER`, if called with a NULL pointer for parameter `timeStampRawPtr`.
] (SRS_BSW_00386, SRS_BSW_00323)

[SWS_StbM_00417] {Obsolete}**[**
If the switch `StbMDevErrorDetect` (**ECUC_StbM_00012 :**) is set to `TRUE`, `StbM_GetCurrentTimeRaw()` shall report to DET the development error `STBM_E_PARAM`, if called with a parameter `timeBaseId`, which
- is referring to Offset time base
- is not configured or
- is within the reserved value range.

] (SRS_BSW_00386, SRS_BSW_00323)

8.1.3.7 {Obsolete} StbM_GetCurrentTimeDiff

[SWS_StbM_00209] [

Service name:	StbM_GetCurrentTimeDiff (obsolete)	

Syntax:	`Std_ReturnType StbM_GetCurrentTimeDiff(`
	`  StbM_SynchronizedTimeBaseType timeBaseId,`
	`  StbM_TimeStampRawType givenTimeStamp,`
	`  StbM_TimeStampRawType* timeStampDiffPtr`
	`)`	

Service ID[hex]:	0x0a	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	timeBaseId	Time Base reference
	givenTimeStamp	Given time stamp as difference calculation basis
Parameters (inout):	None	
Parameters (out):	timeStampDiffPtr	Time difference of current time stamp that is valid at this time minus given time stamp
Return value:	Std_ReturnType	E_OK: successful E_NOT_OK: failed
Description:	Returns time difference of the nanoseconds part of the Virtual Local Time of the referenced Time Base minus the time given by the parameter givenTimeStamp. **Tags:** atp.Status=obsolete	
Available via:	`StbM.h`	

] (RS_TS_00006, RS_TS_00008)

[SWS_StbM_00210] {Obsolete}**[**
If the switch `StbMDevErrorDetect` (ECUC_StbM_00012 :) is set to `TRUE`, `StbM_GetCurrentTimeDiff()` shall report to DET the development error `STBM_E_PARAM_POINTER`, if called with a NULL pointer for parameter `timeStampDiffPtr`.
] (SRS_BSW_00386, SRS_BSW_00323)

[SWS_StbM_00418] {Obsolete}**[**
If the switch `StbMDevErrorDetect` (**ECUC_StbM_00012 :**) is set to `TRUE`, `StbM_GetCurrentTimeDiff()` shall report to DET the development error `STBM_E_PARAM`, if called with a parameter `timeBaseId`, which
- is referring to Offset time base
- is not configured or
- is within the reserved value range.

] (SRS_BSW_00386, SRS_BSW_00323)

8.1.3.8 StbM_SetGlobalTime

[SWS_StbM_00213] [

Service name:	StbM_SetGlobalTime	
Syntax:	`Std_ReturnType StbM_SetGlobalTime( StbM_SynchronizedTimeBaseType timeBaseId, const StbM_TimeStampType* timeStamp, const StbM_UserDataType* userData )`	
Service ID[hex]:	0x0b	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	timeBaseId	time base reference
	timeStamp	New time stamp
	userData	New user data (if not NULL)
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	E_OK: successful E_NOT_OK: failed
Description:	Allows the Customers to set the new global time that has to be valid for the system, which will be sent to the busses. This function will be used if a Time Master is present in this ECU.	
Available via:	`StbM.h`	

] (RS_TS_00029, RS_TS_00010)

[SWS_StbM_00214][
If the switch `StbMDevErrorDetect` (**ECUC_StbM_00012 :**) is set to `TRUE`, `StbM_SetGlobalTime()` shall report to DET the development error `STBM_E_PARAM`, if called with a parameter `timeBaseId`, which is
- not configured or
- within the reserved value range.

] (SRS_BSW_00386, SRS_BSW_00323)

[SWS_StbM_00215][
If the switch `StbMDevErrorDetect` (ECUC_StbM_00012 :) is set to `TRUE`, `StbM_SetGlobalTime()` shall report to DET the development error `STBM_E_PARAM_POINTER`, if called with a NULL pointer for parameter `timeStamp`.
] (SRS_BSW_00386, SRS_BSW_00323)

8.1.3.9 StbM_UpdateGlobalTime

[SWS_StbM_00385] [

Service name:	StbM_UpdateGlobalTime	
Syntax:	`Std_ReturnType StbM_UpdateGlobalTime( StbM_SynchronizedTimeBaseType timeBaseId, const StbM_TimeStampType* timeStamp, const StbM_UserDataType* userData )`	
Service ID[hex]:	0x10	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	timeBaseId	time base reference
	timeStamp	New time stamp
	userData	New user data (if not NULL)
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	E_OK: successful E_NOT_OK: failed
Description:	Allows the Customers to set the Global Time that will be sent to the buses. This function will be used if a Time Master is present in this ECU. Using UpdateGlobalTime will not lead to an immediate transmission of the Global Time.	
Available via:	`StbM.h`	

] (RS_TS_00010)

[SWS_StbM_00340][
If the switch `StbMDevErrorDetect` (ECUC_StbM_00012 :) is set to `TRUE`, `StbM_UpdateGlobalTime()` shall report to DET the development error `STBM_E_PARAM`, if called with a parameter `timeBaseId`, which is

- not configured or
- within the reserved value range.

] (SRS_BSW_00386, SRS_BSW_00323)

[SWS_StbM_00341][
If the switch `StbMDevErrorDetect` (ECUC_StbM_00012 :) is set to `TRUE`, `StbM_UpdateGlobalTime()` shall report to DET the development error `STBM_E_PARAM_POINTER`, if called with a NULL pointer for parameter `timeStamp`.
] (SRS_BSW_00386, SRS_BSW_00323)

8.1.3.10 StbM_SetUserData

[SWS_StbM_00218] [

Service name:	StbM_SetUserData	
Syntax:	`Std_ReturnType StbM_SetUserData( StbM_SynchronizedTimeBaseType timeBaseId, const StbM_UserDataType* userData )`	
Service ID[hex]:	0x0c	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	timeBaseId	Time Base reference
	userData	New User Data
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	E_OK: successful E_NOT_OK: failed
Description:	Allows the Customers to set the new User Data that has to be valid for the system, which will be sent to the busses.	
Available via:	`StbM.h`	

] (RS_TS_00015)

[SWS_StbM_00219][
If the switch `StbMDevErrorDetect` (**ECUC_StbM_00012 :**) is set to `TRUE`, `StbM_SetUserData()` shall report to DET the development error `STBM_E_PARAM`, if called with a parameter `timeBaseId`, which

- is not configured or
- is within the reserved value range.

] (SRS_BSW_00386, SRS_BSW_00323)

[SWS_StbM_00220][
If the switch `StbMDevErrorDetect` (ECUC_StbM_00012 :) is set to `TRUE`, `StbM_SetUserData()` shall report to DET the development error `STBM_E_PARAM_POINTER`, if called with a NULL pointer for parameter `userData`.
] (SRS_BSW_00386, SRS_BSW_00323)

8.1.3.11 StbM_SetOffset

[SWS_StbM_00223] [

Service name:	StbM_SetOffset	
Syntax:	`Std_ReturnType StbM_SetOffset( StbM_SynchronizedTimeBaseType timeBaseId, const StbM_TimeStampType* timeStamp, const StbM_UserDataType* userData )`	
Service ID[hex]:	0x0d	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	timeBaseId	time base reference
	timeStamp	New offset time stamp

	userData	New User Data
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	E_OK: successful E_NOT_OK: failed
Description:	Allows the Customers and the Timesync Modules to set the Offset Time and the User Data.	
Available via:	`StbM.h`	

] (RS_TS_00029, RS_TS_00013)

[SWS_StbM_00224][
If the switch `StbMDevErrorDetect` (**ECUC_StbM_00012 :**) is set to `TRUE`, `StbM_SetOffset()` shall report to DET the development error `STBM_E_PARAM`, if called with a parameter `timeBaseId`, which

- is not configured or
- refers to a Synchronized or Pure Local Time Base or
- is within the reserved value range.

] (SRS_BSW_00386, SRS_BSW_00323)

[SWS_StbM_00225][
If the switch `StbMDevErrorDetect` (ECUC_StbM_00012 :) is set to `TRUE`, `StbM_SetOffset()` shall report to DET the development error `STBM_E_PARAM_POINTER`, if called with a NULL pointer for parameter `timeStamp` or `userData`.
] (SRS_BSW_00386, SRS_BSW_00323)

8.1.3.12 StbM_GetOffset

[SWS_StbM_00228] [

Service name:	StbM_GetOffset	

Syntax:	`Std_ReturnType StbM_GetOffset(`
	`  StbM_SynchronizedTimeBaseType timeBaseId,`
	`  StbM_TimeStampType* timeStamp,`
	`  StbM_UserDataType* userData`
	`)`	

Service ID[hex]:	0x0e	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	timeBaseId	Time Base reference
Parameters (inout):	None	
Parameters (out):	timeStamp	Current Offset Time value
	userData	Current User Data
Return value:	Std_ReturnType	E_OK: successful E_NOT_OK: failed
Description:	Allows the Timesync Modules to get the current Offset Time and User Data.	
Available via:	`StbM.h`	

] (RS_TS_00012, RS_TS_00029, RS_TS_00031)

[SWS_StbM_00229][
If the switch `StbMDevErrorDetect` (ECUC_StbM_00012 :) is set to `TRUE`, `StbM_GetOffset()` shall report to DET the development error `STBM_E_PARAM`, if called with a parameter `timeBaseId`, which

- is not configured or
- refers to a Synchronized or Pure Local Time Base or
- is within the reserved value range.

] (SRS_BSW_00386, SRS_BSW_00323)

[SWS_StbM_00230][
If the switch `StbMDevErrorDetect` (ECUC_StbM_00012 :) is set to `TRUE`, `StbM_GetOffset()` shall report to DET the development error `STBM_E_PARAM_POINTER`, if called with a NULL pointer for parameter `timeStamp` or `userData`.
] (SRS_BSW_00386, SRS_BSW_00323)

8.1.3.13 StbM_BusGetCurrentTime

[SWS_StbM_91005] [

Service name:	StbM_BusGetCurrentTime	
Syntax:	`Std_ReturnType StbM_BusGetCurrentTime( StbM_SynchronizedTimeBaseType timeBaseId, StbM_TimeStampType* globalTimePtr, StbM_VirtualLocalTimeType* localTimePtr, StbM_UserDataType* userData )`	
Service ID[hex]:	0x07	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	timeBaseId	Time Base reference
Parameters (inout):	None	
Parameters (out):	globalTimePtr	Value of the local instance of the Global Time, which is sampled when the function is called
	localTimePtr	Value of the Virtual Local Time, which is sampled when the function is called
	userData	User data of the Time Base
Return value:	Std_ReturnType	E_OK: successful E_NOT_OK: failed
Description:	Returns the current Time Tuple, status and User Data of the Time Base.	
Available via:	`StbM.h`	

] (RS_TS_00005, RS_TS_00006, RS_TS_00029, RS_TS_00031, RS_TS_00014)

[SWS_StbM_00446][[
If the switch `StbMDevErrorDetect` (**ECUC_StbM_00012 :**) is set to `TRUE`, `StbM_BusGetCurrentTime()` shall report to DET the development error `STBM_E_PARAM`, if called with a parameter `timeBaseId`, which is

- referring to an Offset Time Base
- not configured or

- within the reserved value range.

] (SRS_BSW_00386, SRS_BSW_00323)

[SWS_StbM_00447][
If the switch `StbMDevErrorDetect` (**ECUC_StbM_00012 :**) is set to `TRUE`, `StbM_BusGetCurrentTime()` shall report to DET the development error `STBM_E_PARAM_POINTER`, if called with a NULL pointer for parameter `globalTimePtr`, `localTimePtr` or `userData`.
] (SRS_BSW_00386, SRS_BSW_00323)

8.1.3.14 StbM_BusSetGlobalTime

[SWS_StbM_00233] [

Service name:	StbM_BusSetGlobalTime	
Syntax:	`Std_ReturnType StbM_BusSetGlobalTime( StbM_SynchronizedTimeBaseType timeBaseId, const StbM_TimeStampType* globalTimePtr, const StbM_UserDataType* userDataPtr, const StbM_MeasurementType* measureDataPtr, const StbM_VirtualLocalTimeType* localTimePtr )`	
Service ID[hex]:	0x0f	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	timeBaseId	Time Base reference
	globalTimePtr	New Global Time value
	userDataPtr	New User Data (if not NULL)
	measureDataPtr	New measurement data
	localTimePtr	Value of the Virtual Local Time associated to the new Global Time
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	E_OK: successful E_NOT_OK: failed
Description:	Allows the Time Base Provider Modules to forward a new Global Time tuple (i.e., the Received Time Tuple) to the StbM.	
Available via:	`StbM.h`	

] (RS_TS_00007, RS_TS_00030, RS_TS_00031, RS_TS_00034)

[SWS_StbM_00234][
If the switch `StbMDevErrorDetect` (**ECUC_StbM_00012 :**) is set to `TRUE`, `StbM_BusSetGlobalTime()` shall report to DET the development error `STBM_E_PARAM`, if called with a parameter `timeBaseId`, which

- is not configured or
- refers to a Pure Local Time Base

] (SRS_BSW_00386, SRS_BSW_00323)

Note:
A parameter `timeBaseId` within the reserved value range indicates legacy use.

[SWS_StbM_00235][
If the switch `StbMDevErrorDetect` (ECUC_StbM_00012 :) is set to `TRUE`, `StbM_BusSetGlobalTime()` shall report to DET the development error `STBM_E_PARAM_POINTER`, if called with a NULL pointer for parameter

- `globalTimePtr`
- `measureDataPtr`
- `localTimePtr`

] (SRS_BSW_00386, SRS_BSW_00323)

8.1.3.15 StbM_GetRateDeviation

[SWS_StbM_00378] [

Service name:	StbM_GetRateDeviation	
Syntax:	`Std_ReturnType StbM_GetRateDeviation( StbM_SynchronizedTimeBaseType timeBaseId, StbM_RateDeviationType* rateDeviation )`	
Service ID[hex]:	0x11	
Sync/Async:	Synchronous	
Reentrancy:	Reentrant	
Parameters (in):	timeBaseId	Time Base reference
Parameters (inout):	None	
Parameters (out):	rateDeviation	Value of the current rate deviation of a Time Base
Return value:	Std_ReturnType	E_OK: successful E_NOT_OK: failed
Description:	Returns value of the current rate deviation of a Time Base	
Available via:	`StbM.h`	

] (RS_TS_00018)

[SWS_StbM_00379][
If the switch `StbMDevErrorDetect` (ECUC_StbM_00012 :) is set to `TRUE`, `StbM_GetRateDeviation()` shall report to DET the development error `STBM_E_PARAM`, if called with a parameter `timeBaseId`, which

- is not configured or
- is within the reserved value range.

] (SRS_BSW_00386, SRS_BSW_00323)

[SWS_StbM_00380][
If the switch `StbMDevErrorDetect` (ECUC_StbM_00012 :) is set to `TRUE`, `StbM_GetRateDeviation()` shall report to DET the development error `STBM_E_PARAM_POINTER`, if called with a NULL pointer for parameter `rateDeviation`.
] (SRS_BSW_00386, SRS_BSW_00323)

8.1.3.16 StbM_SetRateCorrection

[SWS_StbM_00390] ⌈

Service name:	StbM_SetRateCorrection	
Syntax:	`Std_ReturnType StbM_SetRateCorrection( StbM_SynchronizedTimeBaseType timeBaseId, StbM_RateDeviationType rateDeviation )`	
Service ID[hex]:	0x12	
Sync/Async:	Synchronous	
Reentrancy:	Reentrant	
Parameters (in):	timeBaseId	Time Base reference
	rateDeviation	Value of the applied rate deviation
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	E_OK: successful E_NOT_OK: failed
Description:	Allows to set the rate of a Synchronized Time Base (being either a Pure Local Time Base or not).	
Available via:	`StbM.h`	

⌋ (RS_TS_00018)

[SWS_StbM_00391]⌈
If the switch `StbMDevErrorDetect` (ECUC_StbM_00012 :) is set to `TRUE`, `StbM_SetRateCorrection()` shall report to DET the development error `STBM_E_PARAM`, if called with a parameter `timeBaseId`, which

- is not configured or
- is within the reserved value range.

⌋ (SRS_BSW_00386, SRS_BSW_00323)

[SWS_StbM_00392]⌈
If the switch `StbMDevErrorDetect` (ECUC_StbM_00012 :) is set to `TRUE`, `StbM_SetRateCorrection()` shall report to DET the development error `STBM_E_SERVICE_DISABLED`, if `StbMAllowMasterRateCorrection` is set to `FALSE` for the corresponding Time Base, i.e., it is not allowed to call `StbM_SetRateCorrection()`.
⌋ (SRS_BSW_00386, SRS_BSW_00323)

8.1.3.17 StbM_GetTimeLeap

[SWS_StbM_00267] ⌈

Service name:	StbM_GetTimeLeap
Syntax:	`Std_ReturnType StbM_GetTimeLeap( StbM_SynchronizedTimeBaseType timeBaseId, StbM_TimeDiffType* timeJump )`
Service ID[hex]:	0x13
Sync/Async:	Synchronous
Reentrancy:	Reentrant

Parameters (in):	timeBaseId	Time Base reference
Parameters (inout):	None	
Parameters (out):	timeJump	Time leap value
Return value:	Std_ReturnType	E_OK: successful E_NOT_OK: failed
Description:	Returns value of Time Leap.	
Available via:	`StbM.h`	

] (RS_TS_00005)

[SWS_StbM_00268][
If the switch `StbMDevErrorDetect` (ECUC_StbM_00012 :) is set to `TRUE`, `StbM_GetTimeLeap()` shall report to DET the development error `STBM_E_PARAM`, if called with a parameter `timeBaseId`, which

- is not configured or
- refers to a Pure Local Time Base or
- is within the reserved value range.

] (SRS_BSW_00386, SRS_BSW_00323)

[SWS_StbM_00269][
If the switch `StbMDevErrorDetect` (ECUC_StbM_00012 :) is set to `TRUE`, `StbM_GetTimeLeap()` shall report to DET the development error `STBM_E_PARAM_POINTER`, if called with a NULL pointer for parameter `timeJump`.
] (SRS_BSW_00386, SRS_BSW_00323)

8.1.3.18 StbM_GetTimeBaseStatus

[SWS_StbM_00263] [

Service name:	StbM_GetTimeBaseStatus	

Syntax:	`Std_ReturnType StbM_GetTimeBaseStatus(`
	`  StbM_SynchronizedTimeBaseType timeBaseId,`
	`  StbM_TimeBaseStatusType* syncTimeBaseStatus,`
	`  StbM_TimeBaseStatusType* offsetTimeBaseStatus`
	`)`	

Service ID[hex]:	0x14	
Sync/Async:	Synchronous	
Reentrancy:	Reentrant	
Parameters (in):	timeBaseId	Time Base reference
Parameters (inout):	None	
Parameters (out):	syncTimeBaseStatus	Status of the Synchronized (or Pure Local) Time Base
	offsetTimeBaseStatus	Status of the Offset Time Base
Return value:	Std_ReturnType	E_OK: successful E_NOT_OK: failed
Description:	Returns detailed status information for a Synchronized (or Pure Local) Time Base and, if called for an Offset Time Base, for the Offset Time Base and the underlying Synchronized Time Base.	
Available via:	`StbM.h`	

] (RS_TS_00005)

[SWS_StbM_00264]⌈
If the switch `StbMDevErrorDetect` (**ECUC_StbM_00012 :**) is set to `TRUE`, `StbM_GetTimeBaseStatus()` shall report to DET the development error `STBM_E_PARAM`, if called with a parameter `timeBaseId`, which

- is not configured or
- is within the reserved value range.

⌋ (SRS_BSW_00386, SRS_BSW_00323)

[SWS_StbM_00386]⌈
If the switch `StbMDevErrorDetect` (ECUC_StbM_00012 :) is set to `TRUE`, `StbM_GetTimeBaseStatus()` shall report to DET the development error `STBM_E_PARAM_POINTER`, if called with a NULL pointer for parameter `syncTimeBaseStatus` or `offsetTimeBaseStatus`.
⌋ (SRS_BSW_00386, SRS_BSW_00323)

8.1.3.19 StbM_StartTimer

[SWS_StbM_00272] ⌈

Service name:	StbM_StartTimer	
Syntax:	`Std_ReturnType StbM_StartTimer( StbM_SynchronizedTimeBaseType timeBaseId, StbM_CustomerIdType customerId, const StbM_TimeStampType* expireTime )`	
Service ID[hex]:	0x15	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	timeBaseId	Time Base reference
	customerId	Status of the Synchronized Time Base
	expireTime	Time value relative to current Time Base value of the Notification Customer, when the Timer shall expire
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	E_OK: successful E_NOT_OK: failed
Description:	Sets a time value, which the Time Base value is compared against	
Available via:	`StbM.h`	

⌋ (RS_TS_00017)

[SWS_StbM_00296]⌈
If the switch `StbMDevErrorDetect` (**ECUC_StbM_00012 :**) is set to `TRUE`, `StbM_StartTimer()` shall report to DET the development error `STBM_E_PARAM`, if called with a parameter `timeBaseId`, which

- is not configured or
- is within the reserved value range.

⌋ (SRS_BSW_00386, SRS_BSW_00323)

[SWS_StbM_00406]⌈

If the switch StbMDevErrorDetect (**ECUC_StbM_00012 :**) is set to TRUE, StbM_StartTimer() shall report to DET the development error STBM_E_PARAM, if called with a parameter customerId, which is not configured.
] (SRS_BSW_00386, SRS_BSW_00323)

[SWS_StbM_00298][
If the switch StbMDevErrorDetect (ECUC_StbM_00012 :) is set to TRUE, StbM_StartTimer() shall report to DET the development error STBM_E_PARAM_POINTER, if called with an invalid pointer of parameter expireTime.
] (SRS_BSW_00386, SRS_BSW_00323)

8.1.3.20 StbM_GetSyncTimeRecordHead

[SWS_StbM_00319] [

Service name:	StbM_GetSyncTimeRecordHead	
Syntax:	`Std_ReturnType StbM_GetSyncTimeRecordHead( StbM_SynchronizedTimeBaseType timeBaseId, StbM_SyncRecordTableHeadType* syncRecordTableHead )`	
Service ID[hex]:	0x16	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	timeBaseId	Time Base reference
Parameters (inout):	None	
Parameters (out):	syncRecordTableHead	Header of the table
Return value:	Std_ReturnType	E_OK: Table access done E_NOT_OK: Table contains no data or access invalid
Description:	Accesses to the recorded snapshot data Header of the table belonging to the Synchronized Time Base.	
Available via:	StbM.h	

] (RS_TS_00034)

[SWS_StbM_00320][
The function StbM_GetSyncTimeRecordHead() shall be pre compile time configurable ON/OFF by the configuration parameter: StbMTimeRecordingSupport (**ECUC_StbM_00038 :**).
] (RS_TS_00034)

[SWS_StbM_00394][
If the switch StbMDevErrorDetect (**ECUC_StbM_00012 :**) is set to TRUE, StbM_GetSyncTimeRecordHead() shall report to DET the development error STBM_E_PARAM, if called with a parameter timeBaseId, which

- is not configured or
- refers to a Pure Local or a Offset Time Base or
- is within the reserved value range.

] (SRS_BSW_00386, SRS_BSW_00323)

[SWS_StbM_00405][
If the switch `StbMDevErrorDetect` (ECUC_StbM_00012 :) is set to `TRUE`, `GetSyncTimeRecordHead` shall report to DET the development error `STBM_E_PARAM_POINTER`, if called with an invalid pointer of parameter `syncRecordTableHead`.
] (SRS_BSW_00386, SRS_BSW_00323)

8.1.3.21 StbM_GetOffsetTimeRecordHead

[SWS_StbM_00325] [

Service name:	StbM_GetOffsetTimeRecordHead	
Syntax:	`Std_ReturnType StbM_GetOffsetTimeRecordHead( StbM_SynchronizedTimeBaseType timeBaseId, StbM_OffsetRecordTableHeadType* offsetRecordTableHead )`	
Service ID[hex]:	0x17	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	timeBaseId	Time Base reference
Parameters (inout):	None	
Parameters (out):	offsetRecordTableHead	Header of the table
Return value:	Std_ReturnType	E_OK: Table access done E_NOT_OK: Table contains no data or access invalid
Description:	Accesses to the recorded snapshot data Header of the table belonging to the Offset Time Base.	
Available via:	`StbM.h`	

] (RS_TS_00034)

[SWS_StbM_00326][
The function `StbM_GetOffsetTimeRecordHead()` shall be pre compile time configurable `ON`/`OFF` by the configuration parameter: `StbMTimeRecordingSupport` (**ECUC_StbM_00038 :**) .
] (RS_TS_00034)

[SWS_StbM_00327][
If the switch `StbMDevErrorDetect` (ECUC_StbM_00012 :) is set to `TRUE`, `StbM_GetOffsetTimeRecordHead`() shall report to DET the development error `STBM_E_PARAM`, if called with a parameter `timeBaseId`, which

- is not configured or
- refers to a Pure Local or a Synchronized Time Base or
- is within the reserved value range.

] (SRS_BSW_00386, SRS_BSW_00323)

[SWS_StbM_00404][
If the switch `StbMDevErrorDetect` (ECUC_StbM_00012 :) is set to `TRUE`, `GetOffsetTimeRecordHead` shall report to DET the development error

STBM_E_PARAM_POINTER, if called with an invalid pointer of parameter offsetRecordTableHead.
] (SRS_BSW_00386, SRS_BSW_00323)

8.1.3.22 StbM_TriggerTimeTransmission

[SWS_StbM_00346] [

Service name:	StbM_TriggerTimeTransmission	
Syntax:	`Std_ReturnType StbM_TriggerTimeTransmission( StbM_SynchronizedTimeBaseType timeBaseId )`	
Service ID[hex]:	0x1c	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	timeBaseId	Time Base reference
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	E_OK: Operation successful E_NOT_OK: Operation not successful
Description:	Called by the <Upper Layer> to force the Timesync Modules to transmit the current Time Base again due to an incremented timeBaseUpdateCounter[timeBaseId]	
Available via:	StbM.h	

] (RS_TS_00011)

[SWS_StbM_00349][
If the switch StbMDevErrorDetect (**ECUC_StbM_00012 :**) is set to TRUE, StbM_TriggerTimeTransmission() shall report to DET the development error STBM_E_PARAM, if called with a parameter timeBaseId, which

- is not configured or
- refers to a Pure Local Time Base or
- is within the reserved value range.

] (SRS_BSW_00386, SRS_BSW_00323)

8.1.3.23 StbM_GetTimeBaseUpdateCounter

[SWS_StbM_00347] [

Service name:	StbM_GetTimeBaseUpdateCounter	
Syntax:	`uint8 StbM_GetTimeBaseUpdateCounter( StbM_SynchronizedTimeBaseType timeBaseId )`	
Service ID[hex]:	0x1b	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	timeBaseId	Time Base reference
Parameters (inout):	None	
Parameters (out):	None	
Return value:	uint8	Counter value belonging to the Time Base, that indicates a Time

		Base update to the Timesync Modules
Description:	Allows the Timesync Modules to detect, whether a Time Base should be transmitted immediately in the subsequent <Bus>TSyn_MainFunction() cycle.	
Available via:	`StbM.h`	

] (RS_TS_00011)

[SWS_StbM_00348][
If the switch `StbMDevErrorDetect` (**ECUC_StbM_00012 :**) is set to `TRUE`, `StbM_GetTimeBaseUpdateCounter`() shall report to DET the development error `STBM_E_PARAM`, if called with a parameter `timeBaseId`, which

- is not configured or
- refers to a Pure Local Time Base or
- is within the reserved value range.

] (SRS_BSW_00386, SRS_BSW_00323)

8.1.3.24 StbM_GetMasterConfig

[SWS_StbM_91002] [

Service name:	StbM_GetMasterConfig	
Syntax:	`Std_ReturnType StbM_GetMasterConfig( StbM_SynchronizedTimeBaseType timeBaseId, StbM_MasterConfigType* masterConfig )`	
Service ID[hex]:	0x1d	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	timeBaseId	Time Base reference
Parameters (inout):	None	
Parameters (out):	masterConfig	Indicates, if system wide master functionality is supported
Return value:	Std_ReturnType	E_OK: successful E_NOT_OK: failed
Description:	Indicates if the functionality for a system wide master (e.g. StbM_SetGlobalTime) for a given Time Base is available or not.	
Available via:	`StbM.h`	

] (RS_TS_00029)

[SWS_StbM_00415][
If the switch `StbMDevErrorDetect` (**ECUC_StbM_00012 :**) is set to `TRUE`, `StbM_GetMasterConfig()` shall report to DET the development error `STBM_E_PARAM`, `if` called with a parameter `timeBaseId`, which

- is not configured or
- is within the reserved value range.

](SRS_BSW_00386, SRS_BSW_00323)

[SWS_StbM_00416][
If the switch `StbMDevErrorDetect` (**ECUC_StbM_00012 :**) is set to `TRUE`, `StbM_GetMasterConfig()` shall report to DET the development error

STBM_E_PARAM_POINTER, if called with a NULL pointer for parameter masterConfig.
](SRS_BSW_00386, SRS_BSW_00323)

8.1.4 Scheduled functions

8.1.4.1 StbM_MainFunction

[SWS_StbM_00057] [

Service name:	StbM_MainFunction

Syntax:	`void StbM_MainFunction(`
	`  void`
	`)`

Service ID[hex]:	0x04
Description:	This function will be called cyclically by a task body provided by the BSW Schedule. It will invoke the triggered customers and synchronize the referenced OS ScheduleTables.
Available via:	SchM_StbM.h

] (SRS_BSW_00172, SRS_BSW_00373)

[SWS_StbM_00407][
The frequency of invocations of StbM_MainFunction is determined by the configuration parameter StbMMainFunctionPeriod.
] (SRS_BSW_00172)

[SWS_StbM_00107][
If OS is configured as triggered customer, the function StbM_MainFunction shall synchronize the referenced OS ScheduleTable.
] (RS_TS_00032, SRS_BSW_00333)

8.1.5 Expected Interfaces

In this chapter all interfaces required from other modules are listed.

8.1.5.1 Mandatory Interfaces

This chapter defines all interfaces which are required to fulfill the core functionality of the Synchronized Time-Base Manager.

[SWS_StbM_00058] [

API function	***Header File***	***Description***
Det_ReportError	Det.h	Service to report development errors.

] (SRS_BSW_00301, SRS_BSW_00339)

8.1.5.2 Optional Interfaces

This chapter defines all interfaces which are required to fulfill an optional functionality of the Synchronized Time-Base Manager.

[SWS_StbM_00059] [

API function	*Header File*	*Description*
EthIf_GetCurrentTime	EthIf.h	Returns a time value out of the HW registers according to the capability of the HW. Is the HW resolution is lower than the Eth_TimeStampType resolution resp. range, the remaining bits will be filled with 0. Important Note: EthIf_GetCurrentTime may be called within an exclusive area.
GetCounterValue	Os.h	This service reads the current count value of a counter (returning either the hardware timer ticks if counter is driven by hardware or the software ticks when user drives counter).
GetElapsedValue	Os.h	This service gets the number of ticks between the current tick value and a previously read tick value.
GetScheduleTableStatus	Os.h	This service queries the state of a schedule table (also with respect to synchronization).
Gpt_StartTimer	Gpt.h	Starts a timer channel.
SyncScheduleTable	Os.h	This service provides the schedule table with a synchronization count and start synchronization.

] (SRS_BSW_00301, SRS_BSW_00339)

8.1.5.3 Configurable Interfaces

8.1.5.3.1 SyncTimeRecordBlockCallback

[SWS_StbM_00322] [

Service name:	SyncTimeRecordBlockCallback<TimeBase>	
Syntax:	`Std_ReturnType SyncTimeRecordBlockCallback<TimeBase>( const StbM_SyncRecordTableBlockType* syncRecordTableBlock )`	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	syncRecordTableBlock	Block of the table
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	E_OK: Table access done E_NOT_OK: Table contains no data or access invalid
Description:	Provides a recorded snapshot data block of the measurement data table belonging to the Synchronized Time Base.	
Available via:	`StbM_Externals.h`	

] (RS_TS_00034)

[SWS_StbM_00323][

The function `SyncTimeRecordBlockCallback<timeBaseId>()` shall be set by the parameter `StbMSyncTimeRecordBlockCallback` (**ECUC_StbM_00060 :**).
] (RS_TS_00034)

8.1.5.3.2 OffsetTimeRecordBlockCallback

[SWS_StbM_00328] [

Service name:	OffsetTimeRecordBlockCallback<TimeBase>	
Syntax:	`Std_ReturnType OffsetTimeRecordBlockCallback<TimeBase>( const StbM_OffsetRecordTableBlockType* offsetRecordTableBlock )`	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	offsetRecordTableBlock	Block of the table
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	E_OK: Table access done E_NOT_OK: Table contains no data or access invalid
Description:	Provides a recorded snapshot data block of the measurement data table belonging to the Offset Time Base.	
Available via:	`StbM_Externals.h`	

] (RS_TS_00034)

[SWS_StbM_00329][
The function `OffsetTimeRecordBlockCallback<timeBaseId>` shall set by the parameter `StbMOffsetTimeRecordBlockCallback` (**ECUC_StbM_00061 :**).
] (RS_TS_00034)

8.1.5.3.3 StatusNotificationCallback

[SWS_StbM_00285] [

Service name:	StatusNotificationCallback<TimeBase>	
Syntax:	`Std_ReturnType StatusNotificationCallback<TimeBase>( StbM_TimeBaseNotificationType eventNotification )`	
Service ID[hex]:	0x19	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	eventNotification	Holds the notification bits for the different Time Base related events
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	E_OK: successful E_NOT_OK: failed
Description:	The callback notifies the customers, when a <TimeBase> related event occurs, which is enabled by the notification mask	
Available via:	`StbM_Externals.h`	

] (RS_TS_20001, RS_TS_00016, SRS_BSW_00457, SRS_BSW_00360, SRS_BSW_00333)

[SWS_StbM_00299][
The status notification callback function shall be set by the parameter `StbMStatusNotificationCallback` (**ECUC_StbM_00046 :**).
] (RS_TS_00016)

Note: The event notification callback might be called in interrupt context only, if there is no callback configured in StbM which belongs to a SW-C.

8.1.5.3.4 <Customer>_TimeNotificationCallback

[SWS_StbM_00273] [

Service name:	<Customer>_TimeNotificationCallback<TimeBase>	
Syntax:	`Std_ReturnType <Customer>_TimeNotificationCallback<TimeBase>( StbM_TimeDiffType deviationTime )`	
Service ID[hex]:	0x18	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	deviationTime	Difference time value when callback is called by StbM.
Parameters (inout):	None	
Parameters (out):	None	
Return value:	Std_ReturnType	E_OK: successful E_NOT_OK: failed
Description:	This callback notifies the <Customer>, when a Time Base reaches the time value set by StbM_StartTimer for the <TimeBase>	
Available via:	`StbM_Externals.h`	

] (RS_TS_00017, SRS_BSW_00457 , SRS_BSW_00360, SRS_BSW_00333)

[SWS_StbM_00274][
The event notification callback function shall be set by the parameter `StbMTimeNotificationCallback` (**ECUC_StbM_00064 :** .)
] (RS_TS_00017)

8.2 Service Interfaces

This chapter defines the AUTOSAR Interfaces and Ports of the AUTOSAR Service “Synchronized Time-base Manager” (StbM).

The interfaces and ports described here will be visible on the VFB and are used to generate the RTE between application software components and the Synchronized Time-Base Manager.

8.2.1 Provided Ports

8.2.1.1 GlobalTime_Master

[SWS_StbM_00244] ⌈

Name	GlobalTime_Master_{Name}		
Kind	ProvidedPort	Interface	GlobalTime_Master_{Name}
Description	--		
Port Defined Argument Value(s)	Type	StbM_SynchronizedTimeBaseType	
	Value	{ecuc(StbM/StbMSynchronizedTimeBase/ StbMSynchronizedTimeBaseIdentifier.value)}	
Variation	(({ecuc(StbM/StbMSynchronizedTimeBase/StbMIsSystemWideGlobalTimeMaster)} == TRUE) ||({ecuc(StbM/StbMSynchronizedTimeBase/ StbMAllowSystemWideGlobalTimeMaster)} == TRUE))&&({ecuc(StbM/ StbMSynchronizedTimeBase/StbMSynchronizedTimeBaseIdentifier)} < 128) Name = {ecuc(StbM/StbMSynchronizedTimeBase.SHORT-NAME)}		

⌋ (RS_TS_00005, RS_TS_00035, RS_TS_00029, RS_TS_00010, RS_TS_00013, RS_TS_00015)

8.2.1.2 GlobalTime_Slave

[SWS_StbM_00248] ⌈

Name	GlobalTime_Slave_{Name}		
Kind	ProvidedPort	Interface	GlobalTime_Slave_{Name}
Description	--		
Port Defined Argument Value(s)	Type	StbM_SynchronizedTimeBaseType	
	Value	{ecuc(StbM/StbMSynchronizedTimeBase/ StbMSynchronizedTimeBaseIdentifier.value)}	
Variation	Name = {ecuc(StbM/StbMSynchronizedTimeBase.SHORT-NAME)}		

⌋ (RS_TS_00005, RS_TS_00030, RS_TS_00031, RS_TS_00035, RS_TS_00014)

8.2.1.3 GlobalTime_StatusEvent

[SWS_StbM_00290] ⌈

Name	GlobalTime_StatusEvent_{TBName}		
Kind	ProvidedPort	Interface	StatusNotification
Description	--		
Variation	(({ecuc(StbM/StbMSynchronizedTimeBase/StbMNotificationInterface)} ==		

	SR_INTERFACE|| {ecuc(StbM/StbMSynchronizedTimeBase/StbMNotificationInterface)} == CALLBACK_AND_SR_INTERFACE))&& ({ecuc(StbM/StbMSynchronizedTimeBase/ StbMSynchronizedTimeBaseIdentifier)} < 128) TBName = {ecuc(StbM/StbMSynchronizedTimeBase.SHORT-NAME)}

] (RS_TS_00035, RS_TS_00016)

8.2.1.4 StartTimer

[SWS_StbM_91004] [

Name	StartTimer_{TimeBase}_{Customer}		
Kind	ProvidedPort	Interface	StartTimer
Description	--		
Port Defined Argument Value(s)	Type	StbM_SynchronizedTimeBaseType	
	Value	{ecuc(StbM/StbMSynchronizedTimeBase/ StbMSynchronizedTimeBaseIdentifier.value)}	
	Type	StbM_CustomerIdType	
	Value	{ecuc(StbM/StbMSynchronizedTimeBase/ StbMNotificationCustomer/StbMNotificationCustomerId.value)}	
Variation	{ecuc(StbM/StbMSynchronizedTimeBase/ StbMSynchronizedTimeBaseIdentifier)} < 128 TimeBase = {ecuc(StbM/StbMSynchronizedTimeBase.SHORT-NAME)} Customer = {ecuc(StbM/StbMSynchronizedTimeBase/ StbMNotificationCustomer.SHORT-NAME)}		

] (RS_TS_00017)

8.2.2 Required Ports

8.2.2.1 GlobalTime_TimeEvent

[SWS_StbM_00276] [

Name	GlobalTime_TimeEvent_{TBName}_{CName}		
Kind	RequiredPort	Interface	TimeNotification
Description	--		
Variation	({ecuc(StbM/StbMSynchronizedTimeBase/StbMNotificationCustomer/ StbMTimeNotificationCallback)}==NULL) && ({ecuc(StbM/StbMSynchronizedTimeBase/ StbMSynchronizedTimeBaseIdentifier)} < 128) TBName={ecuc(StbM/StbMSynchronizedTimeBase.SHORT-NAME)} CName={ecuc(StbM/StbMSynchronizedTimeBase/StbMNotificationCustomer.SHORT-NAME)}		

] (RS_TS_00035, RS_TS_00017)

8.2.2.2 GlobalTime_Measurement

[SWS_StbM_00387] [

Name	MeasurementNotification_{TBName}		
Kind	RequiredPort	Interface	MeasurementNotification_{TB_Name}
Description	--		
Variation	(({ecuc(StbM/StbMSynchronizedTimeBase/StbMIsSystemWideGlobalTimeMaster)} == FALSE) &&({ecuc(StbM/StbMSynchronizedTimeBase/ StbMAllowSystemWideGlobalTimeMaster)} == FALSE)) &&({ecuc(StbM/StbMGeneral/ StbMTimeRecordingSupport)} == True) &&({ecuc(StbM/StbMSynchronizedTimeBase/ StbMSynchronizedTimeBaseIdentifier)} < 32) TBName={ecuc(StbM/StbMSynchronizedTimeBase.SHORT-NAME)}		

] (RS_TS_00034)

8.2.3 Sender-Receiver Interfaces

8.2.3.1 StatusNotification

[SWS_StbM_00286] [

Name	StatusNotification	
Comment	Notification about a Time Base related status change	
IsService	false	
Variation	--	
Data Elements	eventNotification	
	Type	StbM_TimeBaseNotificationType
	Variation	--

] (RS_TS_00035, RS_TS_00016)

8.2.4 Client-Server-Interfaces

8.2.4.1 GlobalTime_Master

[SWS_StbM_00240] [

Name	GlobalTime_Master_{Name}
Comment	--

IsService	true	
Variation	(({ecuc(StbM/StbMSynchronizedTimeBase/StbMIsSystemWideGlobalTimeMaster)} == TRUE) || ({ecuc(StbM/StbMSynchronizedTimeBase/ StbMAllowSystemWideGlobalTimeMaster)} == TRUE))&& ({ecuc(StbM/ StbMSynchronizedTimeBase/StbMSynchronizedTimeBaseIdentifier)} < 128) Name = {ecuc(StbM/StbMSynchronizedTimeBase.SHORT-NAME)}	
Possible Errors	0	E_OK
	1	E_NOT_OK

Operations

GetMasterConfig			
Comments	Indicates in postbuild use case, if the StbM is actually configured as system wide master		
Variation	{ecuc(StbM/StbMSynchronizedTimeBase/StbMAllowSystemWideGlobalTimeMaster)} != NULL		
Parameters	masterConfig	Comment	--
		Type	StbM_MasterConfigType
		Variation	--
		Direction	OUT
Possible Errors	E_OK	Operation successful	
	E_NOT_OK	Operation failed	

SetGlobalTime			
Comments	Allows the Customers to set the Global Time that will be sent to the buses and modify HW registers behind the providers, if supported. This function will be used if a Time Master is present in this ECU. Using SetGlobalTimecan lead to an immediate transmission of the Global Time.		
Variation	--		
Parameters	timeStamp	Comment	--
		Type	StbM_TimeStampType
		Variation	--
		Direction	IN
	userData	Comment	--
		Type	StbM_UserDataType
		Variation	--

		Direction	IN
Possible Errors	E_OK	Operation successful	
	E_NOT_OK	Operation failed	

SetOffset			
Comments	Allows the Customers and the Timesync Modules to set the Offset Time.		
Variation	{ecuc(StbM/StbMSynchronizedTimeBase/StbMSynchronizedTimeBaseIdentifier)} > 15 &&{ecuc(StbM/StbMSynchronizedTimeBase/StbMSynchronizedTimeBaseIdentifier)} < 32		
Parameters	timeStamp	Comment	--
		Type	StbM_TimeStampType
		Variation	--
		Direction	IN
	userData	Comment	--
		Type	StbM_UserDataType
		Variation	--
		Direction	IN
Possible Errors	E_OK	Operation successful	
	E_NOT_OK	Operation failed	

SetRateCorrection			
Comments	Allows to set the rate of a Synchronized Time Base (being either a Pure Local Time Base or not).		
Variation	--		
Parameters	rateDeviation	Comment	Value of the applied rate deviation
		Type	StbM_RateDeviationType
		Variation	--
		Direction	IN
Possible Errors	E_OK	Operation successful	
	E_NOT_OK	Operation failed	

SetUserData

Comments	Allows the Customers to set the User Data that will be sent to the buses.		
Variation	--		
Parameters	userData	Comment	New user data
		Type	StbM_UserDataType
		Variation	--
		Direction	IN
Possible Errors	E_OK	Operation successful	
	E_NOT_OK	Operation failed	

TriggerTimeTransmission		
Comments	Allows the Customers to force the Timesync Modules to transmit the current Time Base due to an incremented timeBaseUpdateCounter	
Variation	{ecuc(StbM/StbMSynchronizedTimeBase/StbMSynchronizedTimeBaseIdentifier)} < 32	
Possible Errors	E_OK	Operation successful
	E_NOT_OK	Operation failed

UpdateGlobalTime			
Comments	Allows the Customers to set the Global Time that will be sent to the buses and modify HW registers behind the providers, if supported. This function will be used if a Time Master is present in this ECU. Using UpdateGlobalTime will not lead to an immediate transmission of the Global Time.		
Variation	--		
Parameters	timeStamp	Comment	--
		Type	StbM_TimeStampType
		Variation	--
		Direction	IN
	userData	Comment	--
		Type	StbM_UserDataType
		Variation	--
		Direction	IN
Possible Errors	E_OK	Operation successful	
	E_NOT_OK	Operation failed	

] (RS_TS_00005, RS_TS_00035, RS_TS_00010, RS_TS_00013, RS_TS_00015, RS_TS_00011)

8.2.4.2 GlobalTime_Slave

[SWS_StbM_00247] [

Name	GlobalTime_Slave_{Name}	
Comment	--	
IsService	true	
Variation	{ecuc(StbM/StbMSynchronizedTimeBase/StbMSynchronizedTimeBaseIdentifier)} < 128 Name = {ecuc(StbM/StbMSynchronizedTimeBase.SHORT-NAME)}	
Possible Errors	0	E_OK
	1	E_NOT_OK

Operations

GetCurrentTime			
Comments	Returns a time value (Local Time Base derived from Global Time Base) in standard format.		
Variation	--		
Parameters	timeStamp	Comment	--
		Type	StbM_TimeStampType
		Variation	--
		Direction	OUT
	userData	Comment	--
		Type	StbM_UserDataType
		Variation	--
		Direction	OUT
Possible Errors	E_OK	Operation successful	
	E_NOT_OK	Operation failed	
GetCurrentTimeExtended			
Comments	Returns a time value (Local Time Base derived from Global Time Base) in extended format.		

Variation	{ecuc(StbM/StbMGeneral/StbMGetCurrentTimeExtendedAvailable)}		
Parameters	timeStamp	Comment	--
		Type	StbM_TimeStampExtendedType
		Variation	--
		Direction	OUT
	userData	Comment	--
		Type	StbM_UserDataType
		Variation	--
		Direction	OUT
Possible Errors	E_OK	Operation successful	
	E_NOT_OK	Operation failed	

GetOffsetTimeRecordHead			
Comments	Reads the header of the table with recorded measurement data belonging to the Offset Time Base		
Variation	(({ecuc(StbM/StbMSynchronizedTimeBase/StbMIsSystemWideGlobalTimeMaster)} == FALSE) &&({ecuc(StbM/StbMSynchronizedTimeBase/ StbMAllowSystemWideGlobalTimeMaster)} == FALSE)) &&({ecuc(StbM/StbMGeneral/ StbMTimeRecordingSupport)} == True) &&({ecuc(StbM/StbMSynchronizedTimeBase/ StbMSynchronizedTimeBaseIdentifier)} > 15) && {ecuc(StbM/ StbMSynchronizedTimeBase/StbMSynchronizedTimeBaseIdentifier)} < 32		
Parameters	offsetRecordTableHead	Comment	Header of the table
		Type	StbM_OffsetRecordTableHeadType
		Variation	--
		Direction	OUT
Possible Errors	E_OK	Operation successful	
	E_NOT_OK	Operation failed	

GetRateDeviation			
Comments	Returns value of the current rate deviation of a Time Base		
Variation	--		
Parameters	rateDeviation	Comment	Value of the current rate deviation of a Time Base
		Type	StbM_RateDeviationType

		Variation	--
		Direction	OUT
Possible Errors	E_OK	Operation successful	
	E_NOT_OK	Operation failed	

GetSyncTimeRecordHead			
Comments	Reads the header of the table with recorded measurement data belonging to the Synchronized Time Base		
Variation	(({ecuc(StbM/StbMSynchronizedTimeBase/StbMIsSystemWideGlobalTimeMaster)} == FALSE) &&({ecuc(StbM/StbMSynchronizedTimeBase/ StbMAllowSystemWideGlobalTimeMaster)} == FALSE)) &&({ecuc(StbM/StbMGeneral/ StbMTimeRecordingSupport)} == True) &&({ecuc(StbM/StbMSynchronizedTimeBase/ StbMSynchronizedTimeBaseIdentifier)} < 16)		
Parameters	syncRecordTableHead	Comment	Header of the table
		Type	StbM_SyncRecordTableHeadType
		Variation	--
		Direction	OUT
Possible Errors	E_OK	Record head read successfully.	
	E_NOT_OK	Read access to record head failed.	

GetTimeBaseStatus			
Comments	Returns detailed status information for a Synchronized (or Pure Local) Time Base and, if called for an Offset Time Base, for the Offset Time Base and the underlying Synchronized Time Base.		
Variation	--		
Parameters	syncTimeBaseStatus	Comment	Status of the Synchronized (or Pure Local) Time Base
		Type	StbM_TimeBaseStatusType
		Variation	--
		Direction	OUT
	offsetTimeBaseStatus	Comment	Status of the Offset Time Base.
		Type	StbM_TimeBaseStatusType
		Variation	--
		Direction	OUT
Possible	E_OK	Operation successful	

Errors	E_NOT_OK	Operation failed	
GetTimeLeap			
Comments	Returns value of time leap.		
Variation	{ecuc(StbM/StbMSynchronizedTimeBase/StbMSynchronizedTimeBaseIdentifier)} < 32		
Parameters	timeJump	Comment	Time leap value
		Type	StbM_TimeDiffType
		Variation	--
		Direction	OUT
Possible Errors	E_OK	Operation successful	
	E_NOT_OK	Operation failed	

] (RS_TS_00005, RS_TS_00035, RS_TS_00014, RS_TS_00017, RS_TS_00034)

8.2.4.3 StartTimer

[SWS_StbM_00409] [

Name	StartTimer	
Comment	Interface, which starts a timer for a Time Base	
IsService	true	
Variation	--	
Possible Errors	0	E_OK
	1	E_NOT_OK

Operations

StartTimer			
Comments	Starts a StbM internal timer, which expires at the given expireTime and which triggers a time notification callback.		
Variation	--		
Parameters	expireTime	Comment	--
		Type	StbM_TimeStampType
		Variation	--
		Direction	IN

Possible Errors	E_OK	Operation successful
	E_NOT_OK	Operation failed

] (RS_TS_00017)

8.2.4.4 TimeNotification

[SWS_StbM_00275] [

Name	TimeNotification	
Comment	Notification, which indicates, that the timer has expired, which has been set by StartTimer	
IsService	true	
Variation	--	
Possible Errors	0	E_OK
	1	E_NOT_OK

Operations

NotifyTime			
Comments	Notification, which indicates, that the timer has expired, which has been set by StbM_StartTimer		
Variation	--		
Parameters	deviationTime	Comment	--
		Type	StbM_TimeDiffType
		Variation	--
		Direction	IN
Possible Errors	E_OK	Operation successful	
	E_NOT_OK	Operation failed	

] (RS_TS_00035, RS_TS_00017)

8.2.4.5 MeasurementNotification

[SWS_StbM_00339] [

Name	MeasurementNotification_{TB_Name}
Comment	Notifies about the availability of a new recorded measurement data block belonging to the Time Base.

IsService	true	
Variation	(ecuc(StbM/StbMGeneral/StbMTimeRecordingSupport)} == True) &&({ecuc(StbM/StbMSynchronizedTimeBase/StbMSynchronizedTimeBaseIdentifier)} < 32) TBName={ecuc(StbM/StbMSynchronizedTimeBase.SHORT-NAME)}	
Possible Errors	0	E_OK
	1	E_NOT_OK

Operations

SetOffsetTimeRecordTable			
Comments	Provides to the recorded snapshot data Block of the table belonging to the Offset Time Base.		
Variation	{ecuc(StbM/StbMSynchronizedTimeBase/StbMSynchronizedTimeBaseIdentifier)} > 15 &&{ecuc(StbM/StbMSynchronizedTimeBase/StbMSynchronizedTimeBaseIdentifier)} < 32		
Parameters	offsetRecordTableBlock	Comment	Header of the table
		Type	StbM_OffsetRecordTableBlockType
		Variation	--
		Direction	IN
Possible Errors	E_OK	Measurement data access completed successfully	
	E_NOT_OK	Measurement data access failed	

SetSyncTimeRecordTable			
Comments	Provides the recorded snapshot data Block of the table belonging to the Synchronized Time Base.		
Variation	{ecuc(StbM/StbMSynchronizedTimeBase/StbMSynchronizedTimeBaseIdentifier)} < 16		
Parameters	syncRecordTableBlock	Comment	Block of the table
		Type	StbM_SyncRecordTableBlockType
		Variation	--
		Direction	IN
Possible Errors	E_OK	Measurement data access completed successfully	
	E_NOT_OK	Measurement data access failed	

] (RS_TS_00034)

8.2.5 Implementation Data Types

This chapter specifies the data types which will be used for the service port interfaces for accessing the Synchronized Time-Base Manager service.

The implementation header defines additionally those data types, which are listed in chapter 8.1.2, if not included by the application types header.

8.2.5.1 StbM_SynchronizedTimeBaseType

[SWS_StbM_00142] [

Name	StbM_SynchronizedTimeBaseType		
Kind	Type		
Derived from	uint16		
Description	Variables of this type are used to represent the kind of synchronized time-base.		
Range	0..2^16-1		--
Variation	--		
Available via	Rte_StbM_Type.h		

] (SRS_BSW_00305, RS_TS_00005, RS_TS_00032, RS_TS_00035)

8.2.5.2 StbM_TimeBaseStatusType

[SWS_StbM_00239] [

Name	StbM_TimeBaseStatusType			
Kind	Bitfield			
Derived from	uint8			
Elements	Kind	Name	Mask	Description
	bit	TIMEOUT	0x01	Bit 0 (LSB): 0x00: No Timeout on receiving Synchronisation Messages 0x01: Timeout on receiving Synchronisation Messages
	bit	SYNC_TO_GATEWAY	0x04	Bit 2 0x00: Local Time Base is synchronous to Global Time Master 0x04: Local Time Base updates are based on a Time Gateway below the Global Time Master
	bit	GLOBAL_TIME_BASE	0x08	Bit 3 0x00: Local Time Base is based on Local Time Base reference clock only (never

				synchronized with Global Time Base) 0x08: Local Time Base was at least synchronized with Global Time Base one time
	bit	TIMELEAP_FUTURE	0x10	Bit 4 0x00: No leap into the future within the received time for Time Base 0x10: Leap into the future within the received time for Time Base exceeds a configured threshold
	bit	TIMELEAP_PAST	0x20	Bit 5 0x00: No leap into the past within the received time for Time Base 0x20: Leap into the past within the received time for Time Base exceeds a configured threshold
Description	Bit 1, 6, and 7 are always 0 (reserved for future usage) Variables of this type are used to express if and how a Local Time Base is synchronized to the Global Time Master. The type is a bitfield of individual status bits, although not every combination is possible, i.e. any of the bits TIMEOUT, TIMELEAP_FUTURE, TIMELEAP_PAST and SYNC_TO_GATEWAY can only be set if the GLOBAL_TIME_BASE bit is set.			
Available via	Rte_StbM_Type.h			

] (RS_TS_00009)

8.2.5.3 StbM_TimeStampType

[SWS_StbM_00241] [

Name	StbM_TimeStampType		
Kind	Structure		
Elements	timeBaseStatus	StbM_TimeBaseStatusType	Status of the Time Base
	nanoseconds	uint32	Nanoseconds part of the time
	seconds	uint32	32 bit LSB of the 48 bits Seconds part of the time
	secondsHi	uint16	16 bit MSB of the 48 bits Seconds part of the time
Description	Variables of this type are used for expressing time stamps including relative time and absolute calendar time. The absolute time starts from 1970-01-01. 0 to 281474976710655s == 3257812230d [0xFFFF FFFF FFFF] 0 to 999999999ns [0x3B9A C9FF] invalid value in nanoseconds: [0x3B9A CA00] to [0x3FFF FFFF] Bit 30 and 31 reserved, default: 0		

Variation	--
Available via	Rte_StbM_Type.h

] (RS_TS_00036)

Note: Start of absolute time (1970-01-01) is according to [17], Annex C/C1 (refer to parameter "approximate epoch" for PTP)

8.2.5.4 StbM_TimeStampExtendedType

[SWS_StbM_00242] [

Name	StbM_TimeStampExtendedType		
Kind	Structure		
Elements	timeBaseStatus	StbM_TimeBaseStatusType	Status of the Time Base
	nanoseconds	uint32	Nanoseconds part of the time
	seconds	uint64	48 bit Seconds part of the time
Description	Variables of this type are used for expressing time stamps including relative time and absolute calendar time. The absolute time starts from 1970-01-01.		
Variation	--		
Available via	Rte_StbM_Type.h		

] (RS_TS_00036)

Note: Start of absolute time (1970-01-01) is according to [17], Annex C/C1 (refer to parameter "approximate epoch" for PTP)

8.2.5.5 StbM_TimeDiffType

[SWS_StbM_00300] [

Name	StbM_TimeDiffType		
Kind	Type		
Derived from	sint32		
Description	Variables of this type are used to express time differences / offsets as signed values in in nanoseconds		
Range	-2147483647..2147483647		nanoseconds (-2147483647 .. 2147483647)

Variation	--
Available via	Rte_StbM_Type.h

] (RS_TS_00010)

8.2.5.6 StbM_RateDeviationType

[SWS_StbM_00301] [

Name	StbM_RateDeviationType		
Kind	Type		
Derived from	sint16		
Description	Variables of this type are used to express a rate deviation in ppm.		
Range	-32000..32000		parts per million (-32000..32000)
Variation	--		
Available via	Rte_StbM_Type.h		

] (RS_TS_00017)

8.2.5.7 StbM_UserDataType

[SWS_StbM_00243] [

Name	StbM_UserDataType		
Kind	Structure		
Elements	userDataLength	uint8	User Data Length in bytes
	userByte0	uint8	User Byte 0
	userByte1	uint8	User Byte 1
	userByte2	uint8	User Byte 2
Description	Current user data of the Time Base		
Variation	--		
Available via	Rte_StbM_Type.h		

] (RS_TS_00014, RS_TS_00015)

8.2.5.8 StbM_CustomerIdType

[SWS_StbM_00288] ⌈

Name	StbM_CustomerIdType		
Kind	Type		
Derived from	uint16		
Description	unique identifier of a notification customer		
Range	0..255		(0x00..0xFF)
Variation	--		
Available via	Rte_StbM_Type.h		

⌋ (RS_TS_00035, RS_TS_00016, RS_TS_00017)

8.2.5.9 StbM_TimeBaseNotificationType

[SWS_StbM_00287] ⌈

Name	StbM_TimeBaseNotificationType			
Kind	Bitfield			
Derived from	uint32			
Elements	Kind	Name	Mask	Description
	bit	EV_GLOBAL_TIME	0x01	Bit 0 (LSB): 0: synchronization to global time master not changed 1: GLOBAL_TIME_BASE in StbM_TimeBaseStatusType has changed from 0 to 1
	bit	EV_TIMEOUT_OCCURRED	0x02	Bit 1: 1: TIMEOUT bit in timeBaseStatus has changed from 0 to 1 0: otherwise
	bit	EV_TIMEOUT_REMOVED	0x04	Bit 2 1: TIMEOUT bit in timeBaseStatus has changed from 1 to 0 0: otherwise
	bit	EV_TIMELEAP_FUTURE	0x08	Bit 3 1: TIMELEAP_FUTURE bit in timeBaseStatus has changed from 0 to 1 0: otherwise
	bit	EV_TIMELEAP_FUTURE_REMOVED	0x10	Bit 4

				1: TIMELEAP_FUTURE bit in timeBaseStatus has changed from 1 to 0 0: otherwise
	bit	EV_TIMELEAP_PAST	0x20	Bit 5 1: TIMELEAP_PAST bit in timeBaseStatus has changed from 0 to 1 0: otherwise
	bit	EV_TIMELEAP_PAST_REMOVED	0x40	Bit 6 1: TIMELEAP_PAST bit in timeBaseStatus has changed from 1 to 0 0: otherwise
	bit	EV_SYNC_TO_SUBDOMAIN	0x80	Bit 7 1: SYNC_TO_GATEWAY bit in timeBaseStatus has changed from 0 to 1 0: otherwise
	bit	EV_SYNC_TO_GLOBAL_MASTER	0x100	Bit 8 1: SYNC_TO_GATEWAY bit of Time Domain changes from 1 to 0 0: otherwise
	bit	EV_RESYNC	0x0200	Bit 9: 1: A synchronization of the local time to the valid Global Time value has occured 0: No resynchronization event occured
	bit	EV_RATECORRECTION	0x0400	Bit 10 1: a valid rate correction has been calculated (not beyond limits) 0: No rate correction calculated
Description	The StbM_TimeBaseNotificationType type defines a number of global time related events. The type definition is used for storing the events in the status variable NotificationEvents and for setting the mask variable NotificationMask which defines a subset of events for which an interrupt request shall be raised.			
Available via	Rte_StbM_Type.h			

] (RS_TS_00035, RS_TS_00016)

8.2.5.10 StbM_SyncRecordTableHeadType

[SWS_StbM_00331] ⌈

Name	StbM_SyncRecordTableHeadType		
Kind	Structure		
Elements	SynchronizedTimeDomain	uint8	Time Domain 0..15
	HWfrequency	uint32	HW Frequency in Hz
	HWprescaler	uint32	Prescaler value
Description	Synchronized Time Base Record Table Header		
Variation	--		
Available via	Rte_StbM_Type.h		

] (RS_TS_00034)

8.2.5.11 StbM_SyncRecordTableBlockType

[SWS_StbM_00332] [

Name	StbM_SyncRecordTableBlockType		
Kind	Structure		
Elements	GlbSeconds	uint32	Seconds of the Local Time Base directly after synchronization with the Global Time Base
	GlbNanoSeconds	uint32	Nanoseconds of the Local Time Base directly after synchronization with the Global Time Base
	TimeBaseStatus	StbM_TimeBaseStatusType	Time Base Status of the Local Time Base directly after synchronization with the Global Time Base
	VirtualLocalTimeLow	uint32	Least significant 32 bit of the Virtual Local Time directly after synchronization with the Global Time Base
	RateDeviation	StbM_RateDeviationType	Calculated Rate Deviation directly after rate deviation measurement
	LocSeconds	uint32	Seconds of the Local Time Base directly before synchronization with the Global Time Base
	LocNanoSeconds	uint32	Nanoseconds of the Local Time Base directly before synchronization with the Global Time Base

	PathDelay	uint32	Current propagation delay in nanoseconds
Description	Synchronized Time Base Record Table Block		
Variation	--		
Available via	Rte_StbM_Type.h		

] (RS_TS_00034)

8.2.5.12 StbM_OffsetRecordTableHeadType

[SWS_StbM_00333] [

Name	StbM_OffsetRecordTableHeadType		
Kind	Structure		
Elements	OffsetTimeDomain	uint8	Time Domain 16..31
Description	Offset Time Base Record Table Header		
Variation	--		
Available via	Rte_StbM_Type.h		

] (RS_TS_00034)

8.2.5.13 StbM_OffsetRecordTableBlockType

[SWS_StbM_00334] [

Name	StbM_OffsetRecordTableBlockType		
Kind	Structure		
Elements	GlbSeconds	uint32	Seconds of the Offset Time Base
	GlbNanoSeconds	uint32	Nanoseconds of the Offset Time Base
	TimeBaseStatus	StbM_TimeBaseStatusType	Time Base Status of the Local Time Base directly after synchronization with the Global Time Base
Description	Offset Time Base Record Table Block		
Variation	--		
Available via	Rte_StbM_Type.h		

] (RS_TS_00034)

8.2.5.14 StbM_MasterConfigType

[SWS_StbM_91001] ⌈

Name	StbM_MasterConfigType		
Kind	Type		
Derived from	uint8		
Description	This type indicates if an ECU is configured for a system wide master for a given Time Base is available or not.		
Range	STBM_SYSTEM_WIDE_MASTER_DISABLED	0x00	not configured as System Wide Master
	STBM_SYSTEM_WIDE_MASTER_ENABLED	0x01	configured as System Wide Master
Variation	--		
Available via	Rte_StbM_Type.h		

⌋ (RS_TS_00029)

9 Sequence diagrams

The sequence diagrams in this chapter show the basic operations of the Synchronized Time-Base Manager.

Please note that the sequence diagrams are an extension for illustrational purposes to ease understanding of the specification.

9.1 StbM Initialization

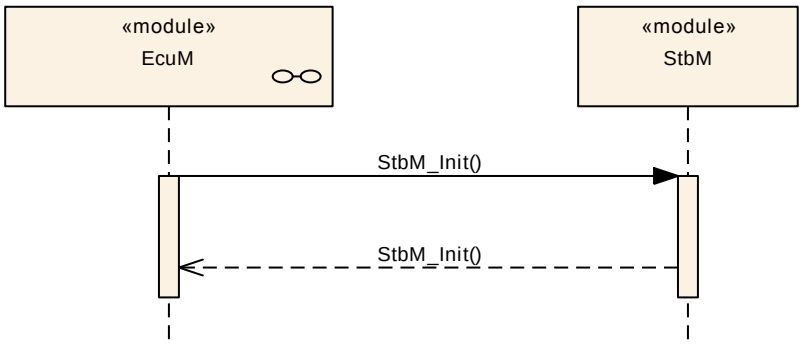


Figure 14: StbM Initialization

9.2 Immediate Time Synchronisation

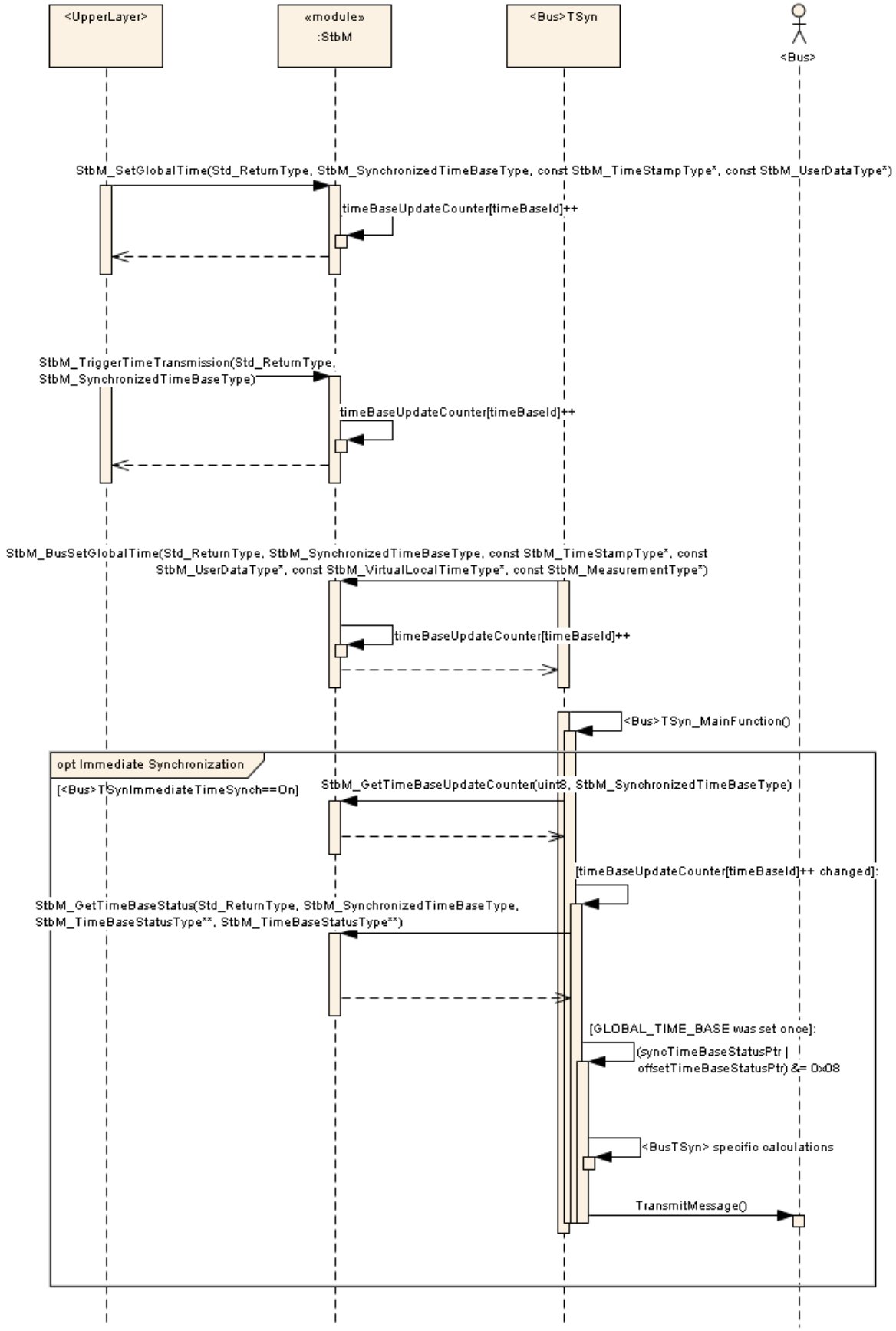


Figure 15: Immediate time synchronization sequence (StbM API)

9.3 Explicit synchronization of OS ScheduleTable

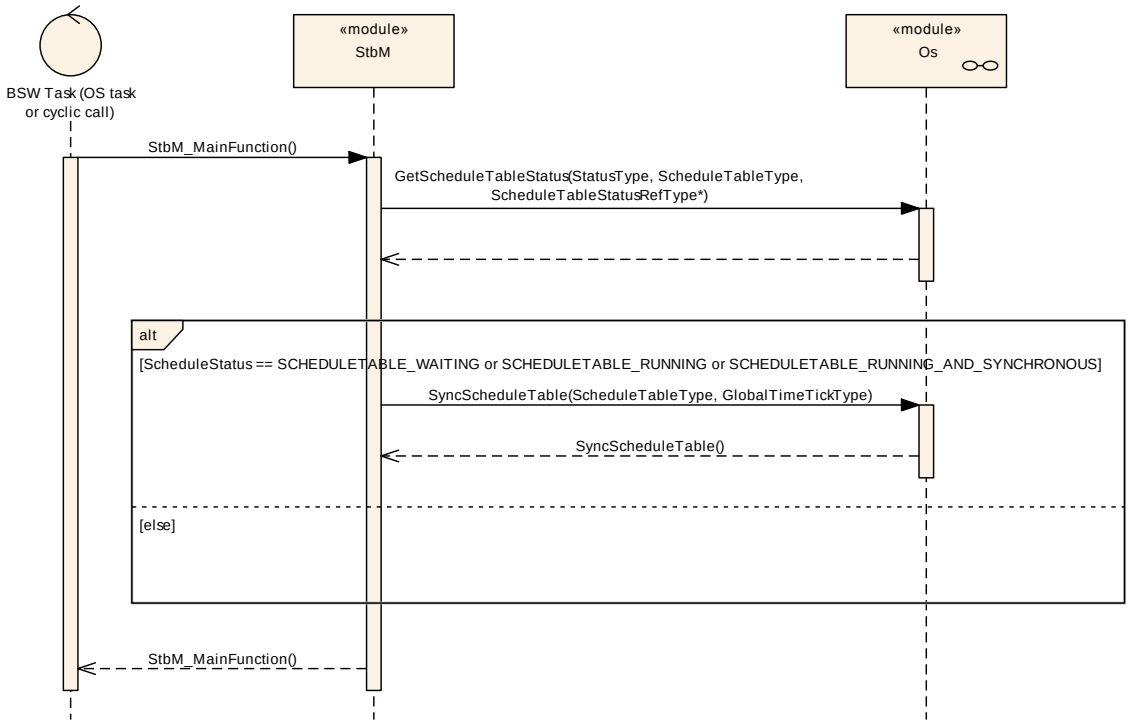


Figure 16: Explicit synchronization of OS Schedule Table

10 Configuration specification

In general, this chapter defines configuration parameters and their clustering into containers. In order to support the specification chapter 10.1 describes fundamentals. It also specifies a template (table) you shall use for the parameter specification. We intend to leave chapter 10.1 in the specification to guarantee comprehension.

Chapter 10.2 specifies the structure (containers) and the parameters of the Synchronized Time-Base Manager. Chapter 10.3 specifies published information of the module Synchronized Time-Base Manager.

10.1 How to read this chapter

For details refer to the chapter 10.1 “Introduction to configuration specification” in *SWS_BSWGeneral.*

10.2 Containers and configuration parameters

The following chapters summarize all configuration parameters. The detailed meanings of the parameters describe Chapters 7 and Chapter 8.

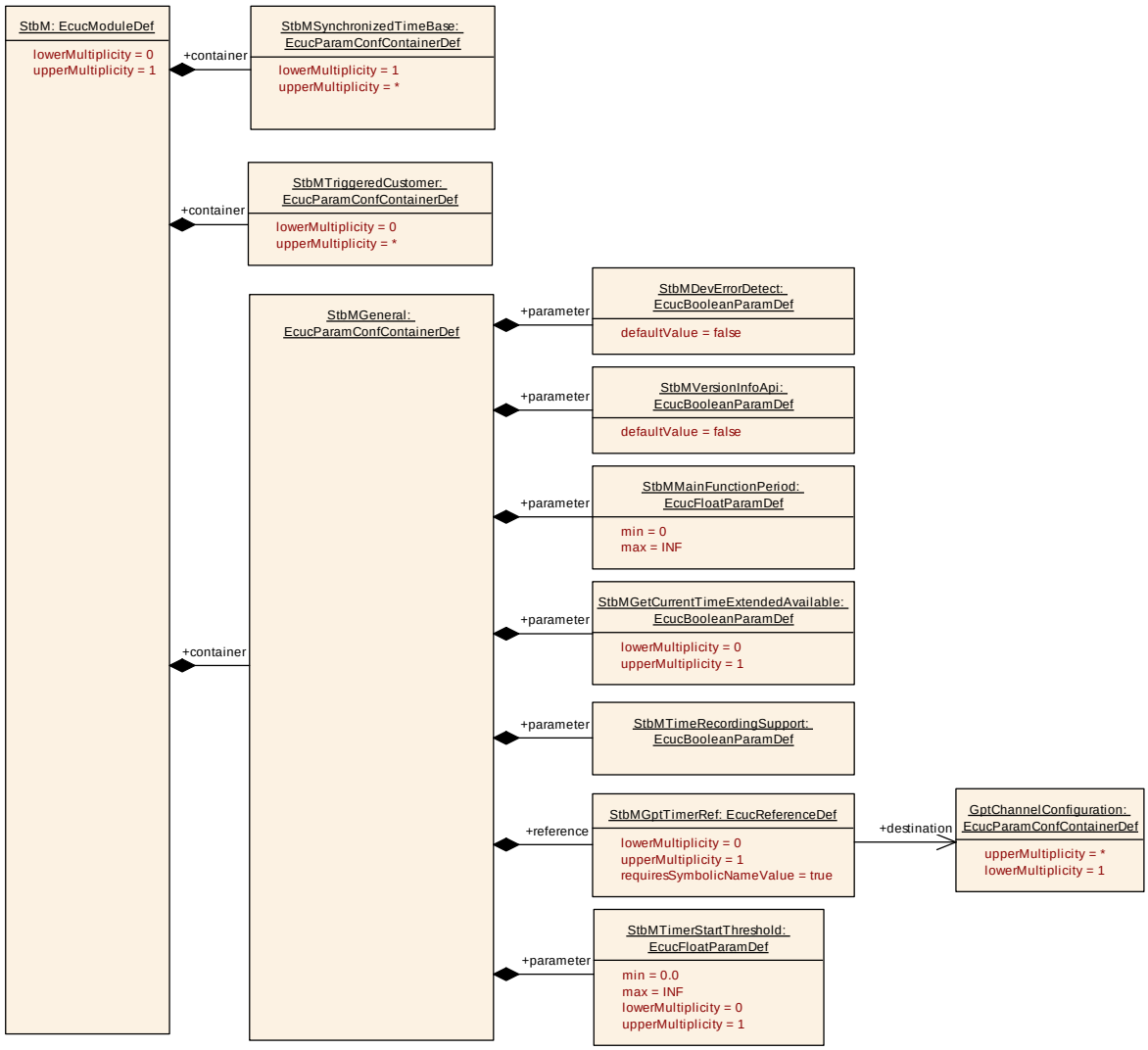
The module supports different post-build variants (previously known as post-build selectable configuration sets), but not post-build loadable configuration.

The configuration tool must check the consistency of the configuration at configuration time.

10.2.1 StbM

SWS Item	**ECUC_StbM_00065 :**
Module Name	*StbM*
Module Description	Configuration of the Synchronized Time-base Manager (StbM) module.
Post-Build Variant Support	true
Supported Config Variants	VARIANT-PRE-COMPILE

Included Containers		
Container Name	***Multiplicity***	***Scope / Dependency***
StbMGeneral	1	This container holds the general parameters of the Synchronized Time-base Manager
StbMSynchronizedTimeBase	1..*	Synchronized time.base collects the information about a specific time-base provider within the system.
StbMTriggeredCustomer	0..*	The triggered customer is directly triggered by the Synchronized Time-base Manager by getting synchronized with the current (global) definition of time and passage of time.



10.2.2 StbMGeneral

SWS Item	**ECUC_StbM_00002 :**
Container Name	StbMGeneral
Description	This container holds the general parameters of the Synchronized Time-base Manager
Configuration Parameters	

SWS Item	**ECUC_StbM_00012 :**
Name	StbMDevErrorDetect
Parent Container	StbMGeneral
Description	Switches the development error detection and notification on or off. • true: detection and notification is enabled. • false: detection and notification is disabled.
Multiplicity	1
Type	EcucBooleanParamDef
Default value	false

Post-Build Variant Value	false		
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00032 :**		
Name	StbMGetCurrentTimeExtendedAvailable		
Parent Container	StbMGeneral		
Description	This allows to define whether an additional variant of the API GetCurrentTime with a 64 bit argument is provided.		
Multiplicity	0..1		
Type	EcucBooleanParamDef		
Default value	--		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00027 :**		
Name	StbMMainFunctionPeriod		
Parent Container	StbMGeneral		
Description	Schedule period of the main function StbM_MainFunction. Unit: [s].		
Multiplicity	1		
Type	EcucFloatParamDef		
Range	]0 .. INF[		
Default value	--		
Post-Build Variant Value	false		
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00038 :**		
Name	StbMTimeRecordingSupport		
Parent Container	StbMGeneral		
Description	Enables/Disables the usage of the recording functionality for Synchronized and Offset timebases for Global Time precision measurement purpose.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
Post-Build Variant Value	false		
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00063 :**
Name	StbMTimerStartThreshold
Parent Container	StbMGeneral

Description	This interval defines, when a GPT Timer shall be started for Time Notification Customers for which the corresponding Customer Timer is running [unit: seconds].		
Multiplicity	0..1		
Type	EcucFloatParamDef		
Range	]0 .. INF[		
Default value	--		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00013 :**		
Name	StbMVersionInfoApi		
Parent Container	StbMGeneral		
Description	Activate/Deactivate the version information API (StbM_GetVersionInfo). True: version information API activated False: version information API deactivated.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	false		
Post-Build Variant Value	false		
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00039 :**		
Name	StbMGptTimerRef		
Parent Container	StbMGeneral		
Description	This represents an optional sub-container in case any Time Notification Customer is configured. The designated GPT timer has to be configured to have a tick duration of one micro second.		
Multiplicity	0..1		
Type	Symbolic name reference to [GptChannelConfiguration]		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

No Included Containers

10.2.3 StbMSynchronizedTimeBase

SWS Item	**ECUC_StbM_00003 :**		
Container Name	StbMSynchronizedTimeBase		
Description	Synchronized time.base collects the information about a specific time-base provider within the system.		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Configuration Parameters			

SWS Item	**ECUC_StbM_00066 :**		
Name	StbMAllowSystemWideGlobalTimeMaster		
Parent Container	StbMSynchronizedTimeBase		
Description	For postbuild variant of the StbM this parameter has to be set to true for a Global Time Master that may act as a system-wide source of time. Otherwise no corresponding service ports/interfaces is provided. The Global Time Master functionality behind the service ports/interfaces has to be enabled/disabled separately via parameter StbMIsSystemWideGlobalTimeMaster.		
Multiplicity	0..1		
Type	EcucBooleanParamDef		
Default value	--		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00037 :**		
Name	StbMClearTimeleapCount		
Parent Container	StbMSynchronizedTimeBase		
Description	This attribute describes the required number of updates to the Time Base where the time difference to the previous value has to remain below StbMTimeLeapPastThreshold/StbMTimeLeapFutureThreshold until the TIMELEAP_PAST/TIMELEAP_FUTURE bit within timeBaseStatus of the Time Base is cleared.		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	1 .. 65535		
Default value	1		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	

	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00036 :**		
Name	StbMIsSystemWideGlobalTimeMaster		
Parent Container	StbMSynchronizedTimeBase		
Description	This parameter shall be set to true for a Global Time Master that acts as a system-wide source of time information with respect to Global Time. It is possible that several Global Time Masters exist that have set this parameter set to true because the Global Time Masters exist once per Global Time Domain and one ECU may own several Global Time Domains on different buses it is connected to.		
Multiplicity	1		
Type	EcucBooleanParamDef		
Default value	--		
Post-Build Variant Value	true		
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00068 :**		
Name	StbMNotificationInterface		
Parent Container	StbMSynchronizedTimeBase		
Description	The parameter defines what type of interface shall be used to notify a customer of a status event.		
Multiplicity	1		
Type	EcucEnumerationParamDef		
Range	CALLBACK	--	
	CALLBACK_AND_SR_INTERFACE	--	
	NO_NOTIFICATION	--	
	SR_INTERFACE	--	
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00046 :**
Name	StbMStatusNotificationCallback
Parent Container	StbMSynchronizedTimeBase
Description	Name of the customer specific status notification callback function, which shall be called, if a non-masked status event occurs.
Multiplicity	0..1
Type	EcucFunctionNameDef
Default value	--
maxLength	--
minLength	--
regularExpression	--

Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local dependency: StbMStatusNotificationCallback shall be available, if and only if StbMNotificationInterface is set to either CALLBACK or CALLBACK_AND_SR_INTERFACE.		

SWS Item	**ECUC_StbM_00045 :**		
Name	StbMStatusNotificationMask		
Parent Container	StbMSynchronizedTimeBase		
Description	The parameter defines the initial value for NotificationMask mask, which defines the events for which the event notification callback function shall be called.		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 4294967295		
Default value	0		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00031 :**		
Name	StbMStoreTimebaseNonVolatile		
Parent Container	StbMSynchronizedTimeBase		
Description	This allows for specifying that the Time Base shall be stored in the NvRam.		
Multiplicity	0..1		
Type	EcucEnumerationParamDef		
Range	NO_STORAGE	--	
	STORAGE_AT_SHUTDOWN	--	
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00021 :**		
Name	StbMSynchronizedTimeBaseIdentifier		
Parent Container	StbMSynchronizedTimeBase		
Description	Identification of a Synchronized TimeBase via a unique identifier. Range: • 0 .. 15: Synchronized Time Bases • 16 .. 31: Offset Time Bases • 32 .. 127: Pure Local Time Bases • 128 .. 65535: Reserved		
Multiplicity	1		
Type	EcucIntegerParamDef (Symbolic Name generated for this parameter)		
Range	0 .. 65535		
Default value	--		
Post-Build Variant Value	false		
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00028 :**		
Name	StbMSyncLossTimeout		
Parent Container	StbMSynchronizedTimeBase		
Description	This attribute describes the timeout for the situation that the time synchronization gets lost in the scope of the time domain. Unit: seconds		
Multiplicity	0..1		
Type	EcucFloatParamDef		
Range	]0 .. INF[		
Default value	--		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00041 :**		
Name	StbMTimeLeapFutureThreshold		
Parent Container	StbMSynchronizedTimeBase		
Description	This represents the maximum allowed positive difference between a newly received Global Time Base value and the current Local Time Base value [unit: seconds].		
Multiplicity	0..1		
Type	EcucFloatParamDef		
Range	[0 .. INF[		
Default value	--		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	

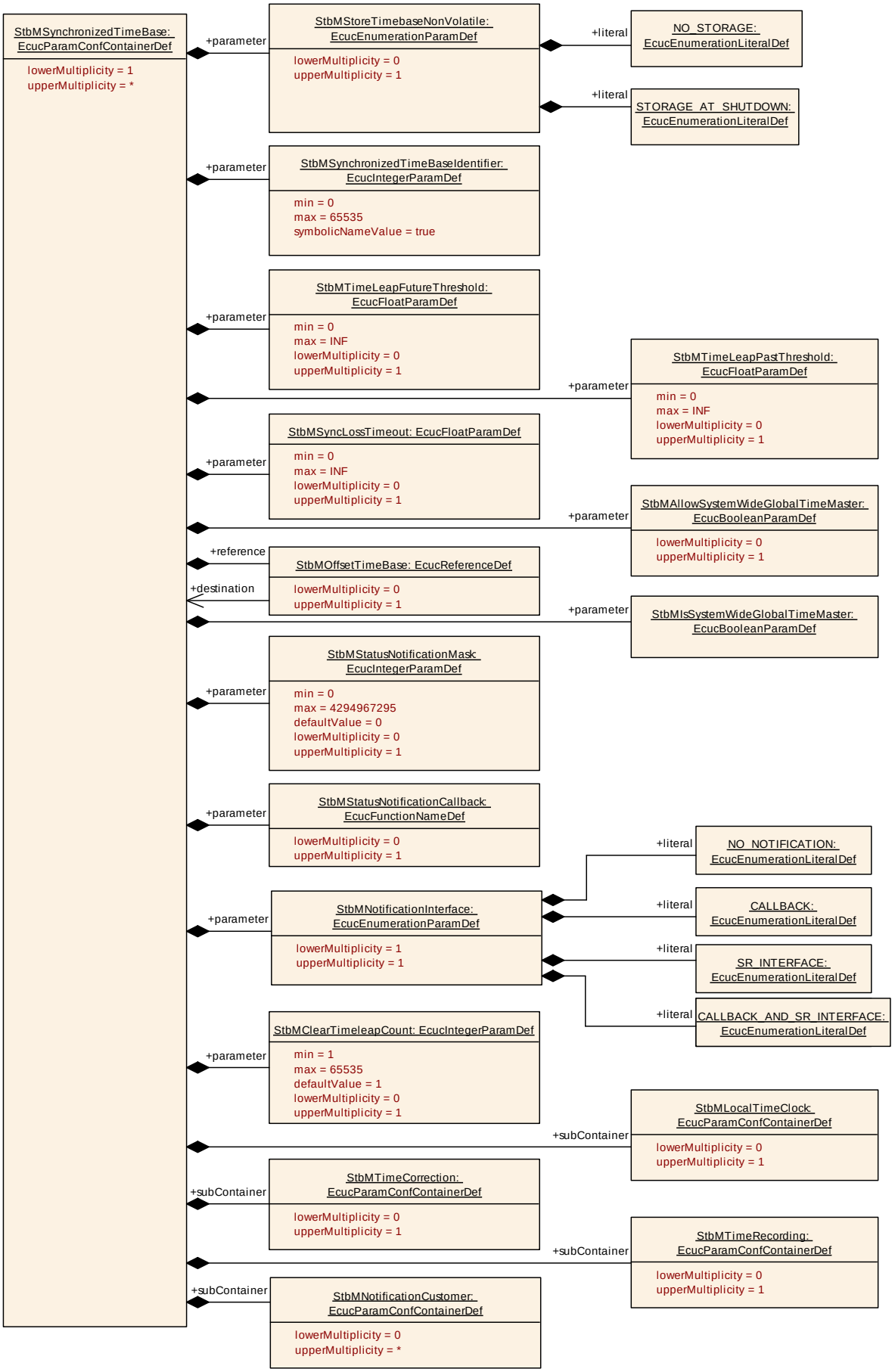
	Post-build time	--	
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00042 :**		
Name	StbMTimeLeapPastThreshold		
Parent Container	StbMSynchronizedTimeBase		
Description	This represents the maximum allowed negative difference between the current Local Time Base value and a newly received Global Time Base value [unit: seconds].		
Multiplicity	0..1		
Type	EcucFloatParamDef		
Range	[0 .. INF[		
Default value	--		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00030 :**		
Name	StbMOffsetTimeBase		
Parent Container	StbMSynchronizedTimeBase		
Description	This is the reference to the Synchronized Time-Base this Offset Time-Base is based on. This reference makes the containing StbMSynchronizedTimeBase an Offset Time-Base.		
Multiplicity	0..1		
Type	Reference to [StbMSynchronizedTimeBase]		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

Included Containers		
Container Name	***Multiplicity***	***Scope / Dependency***
StbMLocalTimeClock	0..1	References the hardware reference clock of this Synchronized Time Base.
StbMNotificationCustomer	0..*	This container holds the configuration of a notification customer, which is notified is informed about the occurance of a Time-base related event.
StbMTimeCorrection	0..1	Collects the information relevant for the rate- and offset correction of a Time Base.
StbMTimeRecording	0..1	Collects the information relevant for configuration of the

		precision measurement of a Time Base.


StbMSynchronizedTimeBase: EcucParamConfContainerDef
lowerMultiplicity = 1
upperMultiplicity = *
+parameter
StbMStoreTimebaseNonVolatile: EcucEnumerationParamDef
lowerMultiplicity = 0
upperMultiplicity = 1
+literal
NO_STORAGE: EcucEnumerationLiteralDef
+literal
STORAGE_AT_SHUTDOWN: EcucEnumerationLiteralDef
+parameter
StbMSynchronizedTimeBaseIdentifier: EcucIntegerParamDef
min = 0
max = 65535
symbolicNameValue = true
+parameter
StbMTimeLeapFutureThreshold: EcucFloatParamDef
min = 0
max = INF
lowerMultiplicity = 0
upperMultiplicity = 1
+parameter
StbMTimeLeapPastThreshold: EcucFloatParamDef
min = 0
max = INF
lowerMultiplicity = 0
upperMultiplicity = 1
+parameter
StbMSyncLossTimeout: EcucFloatParamDef
min = 0
max = INF
lowerMultiplicity = 0
upperMultiplicity = 1
+parameter
StbMAllowSystemWideGlobalTimeMaster: EcucBooleanParamDef
lowerMultiplicity = 0
upperMultiplicity = 1
+reference
+destination
StbMOffsetTimeBase: EcucReferenceDef
lowerMultiplicity = 0
upperMultiplicity = 1
+parameter
StbMIsSystemWideGlobalTimeMaster: EcucBooleanParamDef
+parameter
StbMStatusNotificationMask: EcucIntegerParamDef
min = 0
max = 4294967295
defaultValue = 0
lowerMultiplicity = 0
upperMultiplicity = 1
+parameter
StbMStatusNotificationCallback: EcucFunctionNameDef
lowerMultiplicity = 0
upperMultiplicity = 1
+parameter
StbMNotificationInterface: EcucEnumerationParamDef
lowerMultiplicity = 1
upperMultiplicity = 1
+literal
NO_NOTIFICATION: EcucEnumerationLiteralDef
+literal
CALLBACK: EcucEnumerationLiteralDef
+literal
SR_INTERFACE: EcucEnumerationLiteralDef
+literal
CALLBACK_AND_SR_INTERFACE: EcucEnumerationLiteralDef
+parameter
StbMClearTimeleapCount: EcucIntegerParamDef
min = 1
max = 65535
defaultValue = 1
lowerMultiplicity = 0
upperMultiplicity = 1
+subContainer
StbMLocalTimeClock: EcucParamConfContainerDef
lowerMultiplicity = 0
upperMultiplicity = 1
+subContainer
StbMTimeCorrection: EcucParamConfContainerDef
lowerMultiplicity = 0
upperMultiplicity = 1
+subContainer
StbMTimeRecording: EcucParamConfContainerDef
lowerMultiplicity = 0
upperMultiplicity = 1
+subContainer
StbMNotificationCustomer: EcucParamConfContainerDef
lowerMultiplicity = 0
upperMultiplicity = *

10.2.4 StbMTimeCorrection

SWS Item	**ECUC_StbM_00048 :**		
Container Name	StbMTimeCorrection		
Description	Collects the information relevant for the rate- and offset correction of a Time Base.		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Configuration Parameters			

SWS Item	**ECUC_StbM_00043 :**		
Name	StbMAllowMasterRateCorrection		
Parent Container	StbMTimeCorrection		
Description	This attribute describes whether the rate correction value of a Time Base can be set by StbM_SetRateCorrection(): • false: the rate correction value can not be set by StbM_SetRateCorrection() • true: the rate correction value can be set by StbM_SetRateCorrection()		
Multiplicity	0..1		
Type	EcucBooleanParamDef		
Default value	false		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00044 :**		
Name	StbMMasterRateDeviationMax		
Parent Container	StbMTimeCorrection		
Description	This attribute describes the maximum allowed absolute value of the rate deviation value to be set by StbM_SetRateCorrection() [unit: ppm].		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 32000		
Default value	0		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	

Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00057 :**		
Name	StbMOffsetCorrectionAdaptionInterval		
Parent Container	StbMTimeCorrection		
Description	Defines the interval during which the adaptive rate correction cancels out the rate- and time deviation [unit: seconds].		
Multiplicity	0..1		
Type	EcucFloatParamDef		
Range	]0 .. INF[		
Default value	--		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

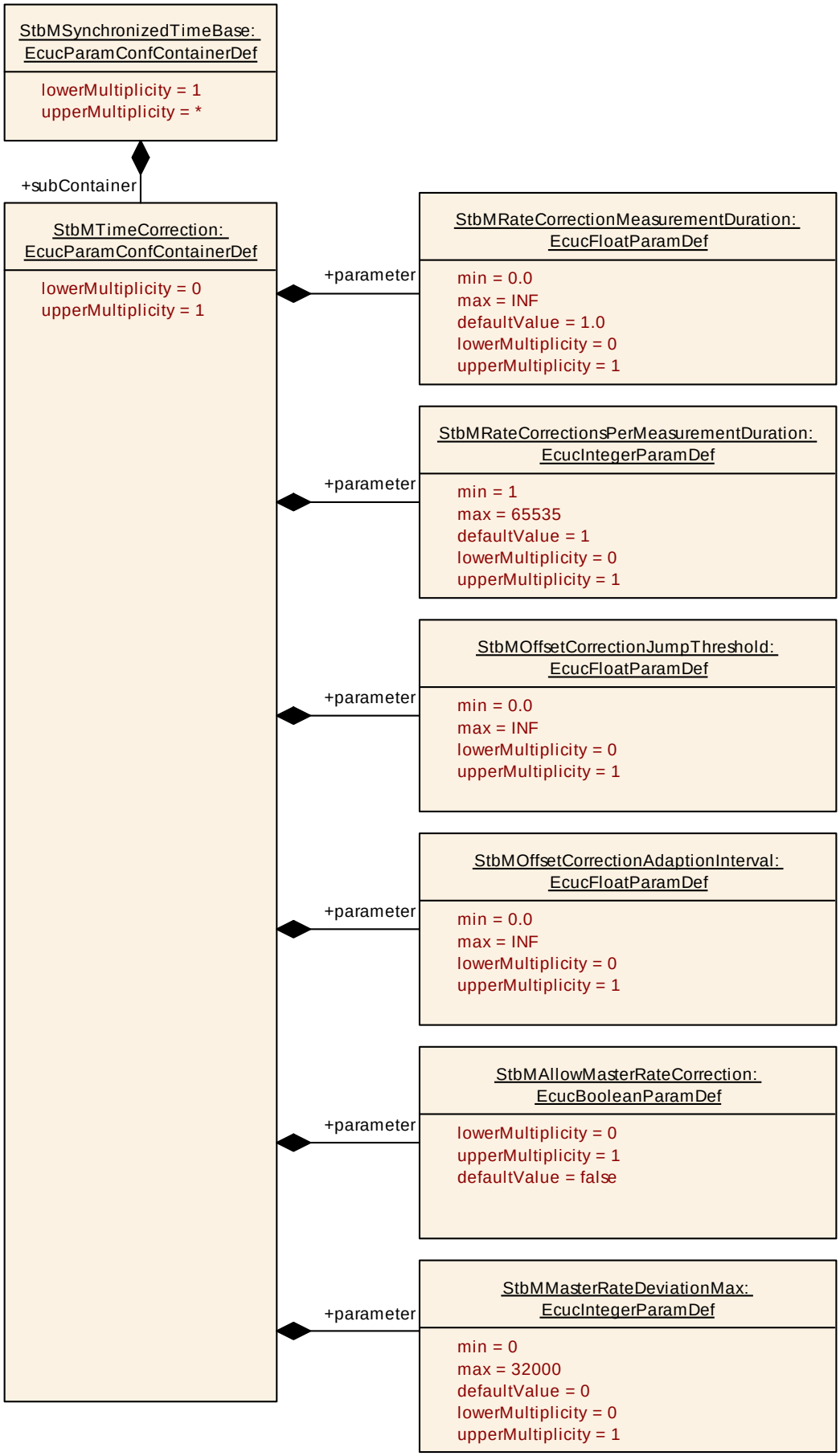
SWS Item	**ECUC_StbM_00056 :**		
Name	StbMOffsetCorrectionJumpThreshold		
Parent Container	StbMTimeCorrection		
Description	Threshold for the correction method. Deviations below this value will be corrected by a linear reduction over a defined timespan. Values equal- and greater than this value will be corrected by immediately setting the correct time- and rate in form of a jump [unit: seconds].		
Multiplicity	0..1		
Type	EcucFloatParamDef		
Range	[0 .. INF[		
Default value	--		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00054 :**		
Name	StbMRateCorrectionMeasurementDuration		
Parent Container	StbMTimeCorrection		
Description	Definition of the time span [s] which is used to calculate the rate deviation.		
Multiplicity	0..1		
Type	EcucFloatParamDef		
Range	[0 .. INF[		
Default value	1		
Post-Build Variant	false		

Multiplicity			
Post-Build Variant Value	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00055 :**		
Name	StbMRateCorrectionsPerMeasurementDuration		
Parent Container	StbMTimeCorrection		
Description	Number of simultaneous rate measurements to determine the current rate deviation.		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	1 .. 65535		
Default value	1		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

No Included Containers


StbMSynchronizedTimeBase:
EcucParamConfContainerDef
lowerMultiplicity = 1
upperMultiplicity = *
+subContainer
StbMTimeCorrection:
EcucParamConfContainerDef
lowerMultiplicity = 0
upperMultiplicity = 1
+parameter
StbMRateCorrectionMeasurementDuration:
EcucFloatParamDef
min = 0.0
max = INF
defaultValue = 1.0
lowerMultiplicity = 0
upperMultiplicity = 1
+parameter
StbMRateCorrectionsPerMeasurementDuration:
EcucIntegerParamDef
min = 1
max = 65535
defaultValue = 1
lowerMultiplicity = 0
upperMultiplicity = 1
+parameter
StbMOffsetCorrectionJumpThreshold:
EcucFloatParamDef
min = 0.0
max = INF
lowerMultiplicity = 0
upperMultiplicity = 1
+parameter
StbMOffsetCorrectionAdaptionInterval:
EcucFloatParamDef
min = 0.0
max = INF
lowerMultiplicity = 0
upperMultiplicity = 1
+parameter
StbMAllowMasterRateCorrection:
EcucBooleanParamDef
lowerMultiplicity = 0
upperMultiplicity = 1
defaultValue = false
+parameter
StbMMasterRateDeviationMax:
EcucIntegerParamDef
min = 0
max = 32000
defaultValue = 0
lowerMultiplicity = 0
upperMultiplicity = 1

10.2.5 StbMLocalTimeClock

SWS Item	**ECUC_StbM_00047 :**		
Container Name	StbMLocalTimeClock		
Description	References the hardware reference clock of this Synchronized Time Base.		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Configuration Parameters			

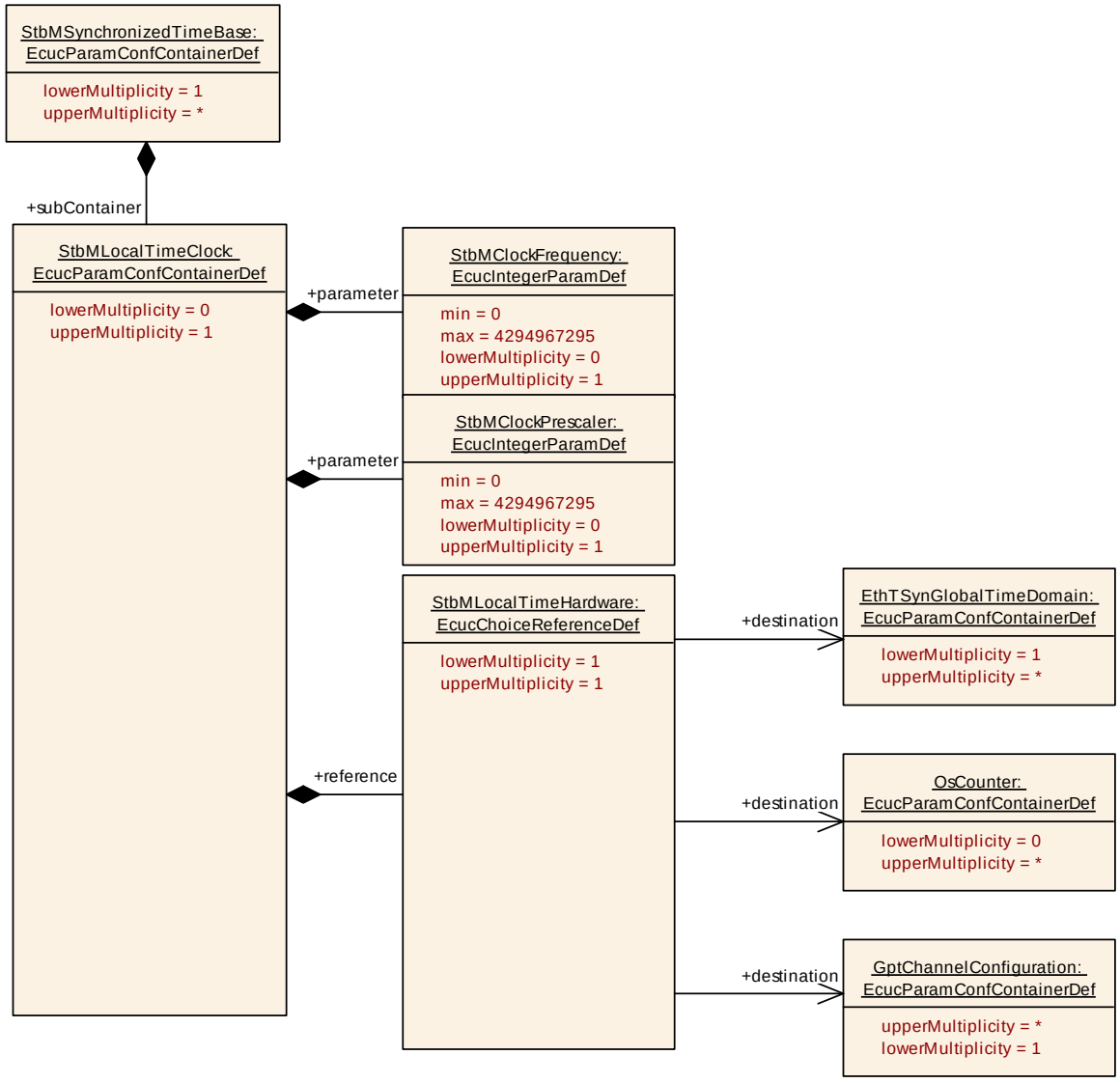
SWS Item	**ECUC_StbM_00051 :**		
Name	StbMClockFrequency		
Parent Container	StbMLocalTimeClock		
Description	Represents the frequency [Hz] of the HW reference clock used by the StbM.		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 4294967295		
Default value	--		
Post-Build Variant Value	false		
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00052 :**		
Name	StbMClockPrescaler		
Parent Container	StbMLocalTimeClock		
Description	Represents the prescaler to calculate the resulting frequency of the HW reference clock used by the StbM.		
Multiplicity	0..1		
Type	EcucIntegerParamDef		
Range	0 .. 4294967295		
Default value	--		
Post-Build Variant Value	false		
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00053 :**		
Name	StbMLocalTimeHardware		
Parent Container	StbMLocalTimeClock		
Description	Reference to the local time hardware.		
Multiplicity	1		
Type	Choice reference to [EthTSynGlobalTimeDomain , GptChannelConfiguration , OsCounter]		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		

Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

No Included Containers



10.2.6 StbMTimeRecording

SWS Item	**ECUC_StbM_00049 :**
Container Name	StbMTimeRecording
Description	Collects the information relevant for configuration of the precision

	measurement of a Time Base.		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Configuration Parameters			

SWS Item	**ECUC_StbM_00061 :**		
Name	StbMOffsetTimeRecordBlockCallback		
Parent Container	StbMTimeRecording		
Description	Name of the customer specific callback function, which shall be called, if a measurement data for a Offset Time Base are available.		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default value	--		
maxLength	--		
minLength	--		
regularExpression	--		
Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

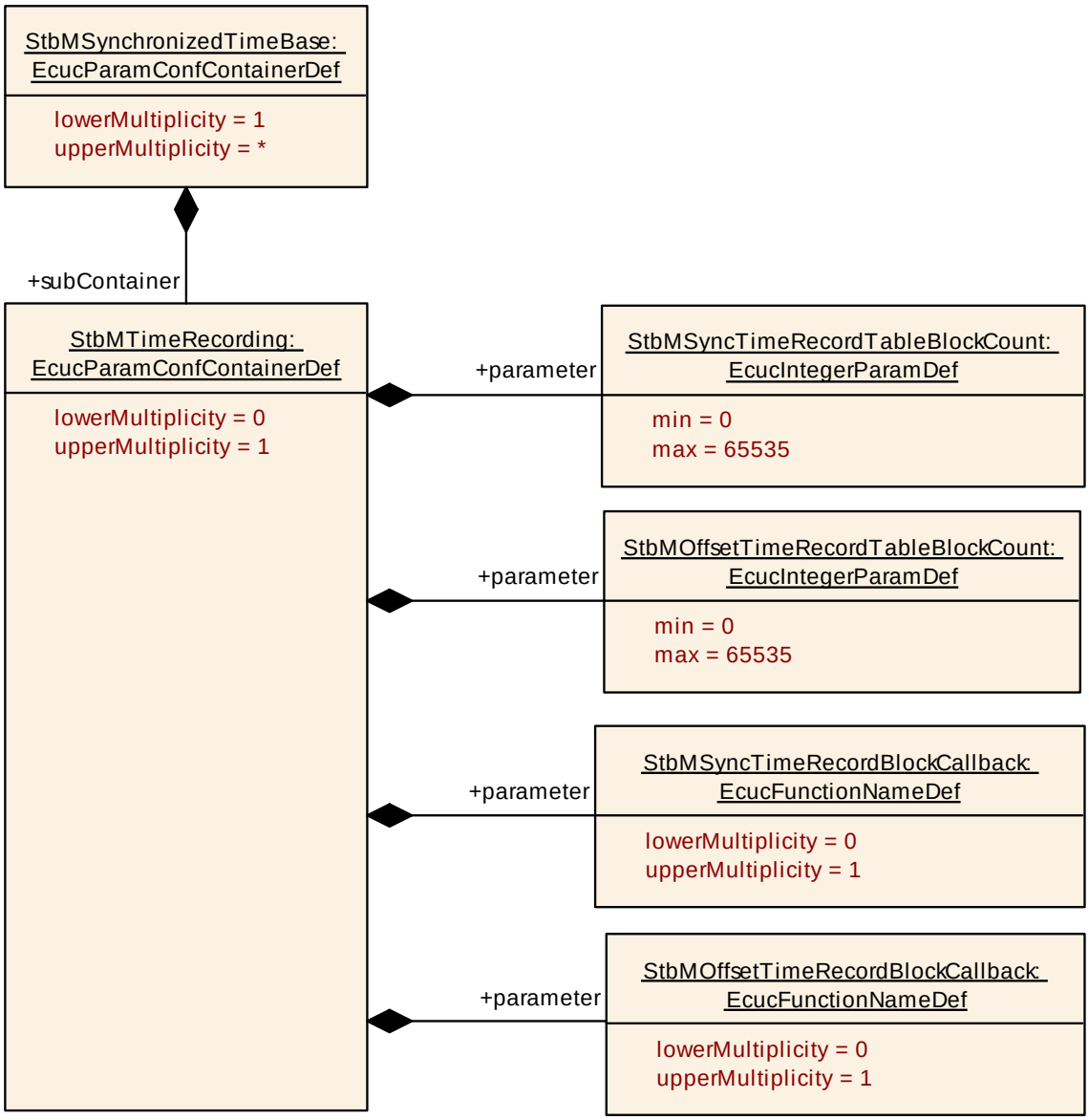
SWS Item	**ECUC_StbM_00059 :**		
Name	StbMOffsetTimeRecordTableBlockCount		
Parent Container	StbMTimeRecording		
Description	Represents the number of Blocks used for queing time measurement events for the Offset Time Base Record Table.		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 65535		
Default value	--		
Post-Build Variant Value	false		
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00060 :**		
Name	StbMSyncTimeRecordBlockCallback		
Parent Container	StbMTimeRecording		
Description	Name of the customer specific callback function, which shall be called, if a measurement data for a Synchronized Time Base are available.		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default value	--		
maxLength	--		
minLength	--		
regularExpression	--		

Post-Build Variant Multiplicity	false		
Post-Build Variant Value	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00058 :**		
Name	StbMSyncTimeRecordTableBlockCount		
Parent Container	StbMTimeRecording		
Description	Represents the number of Blocks used for queing time measurement events for the Synchronized Time Base Record Table.		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 65535		
Default value	--		
Post-Build Variant Value	false		
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

No Included Containers



10.2.7 StbMNotificationCustomer

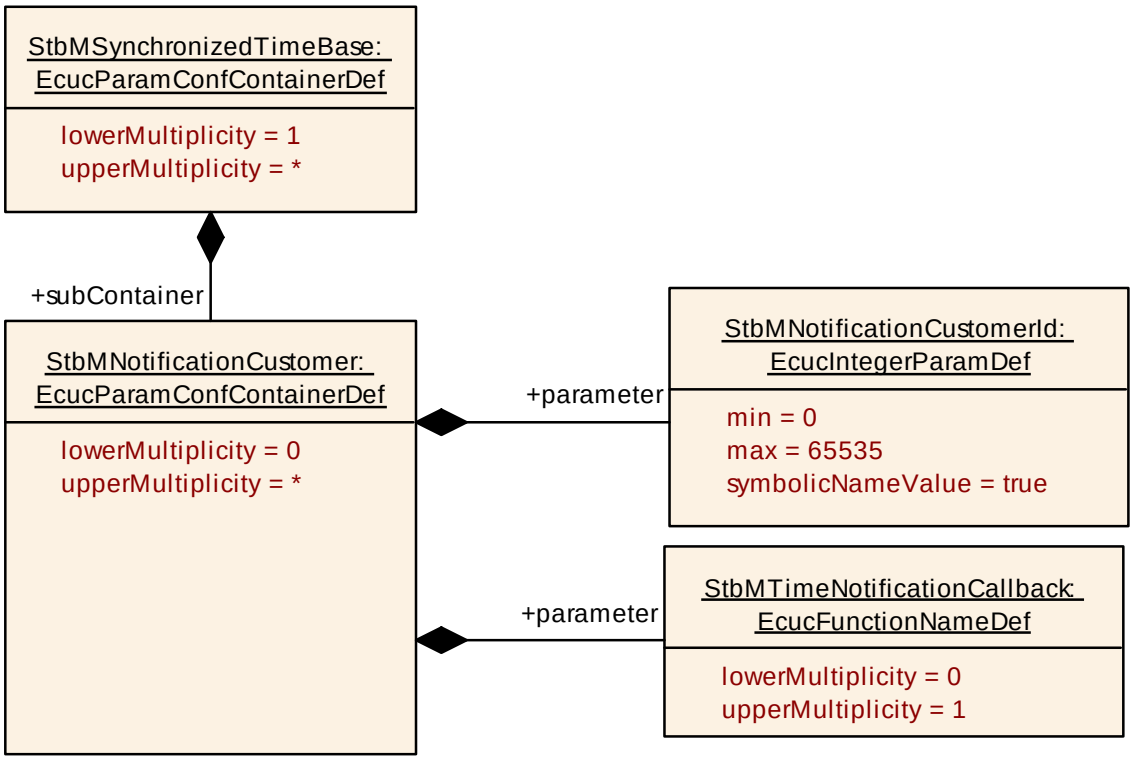
SWS Item	**ECUC_StbM_00050 :**		
Container Name	StbMNotificationCustomer		
Description	This container holds the configuration of a notification customer, which is notified is informed about the occurance of a Time-base related event.		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Configuration Parameters			

SWS Item	**ECUC_StbM_00062 :**
Name	StbMNotificationCustomerId
Parent Container	StbMNotificationCustomer

Description	Identification of a event notification customer.		
Multiplicity	1		
Type	EcucIntegerParamDef (Symbolic Name generated for this parameter)		
Range	0 .. 65535		
Default value	--		
Post-Build Variant Value	false		
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00064 :**		
Name	StbMTimeNotificationCallback		
Parent Container	StbMNotificationCustomer		
Description	Name of the customer specific notification callback function, which shall be called, if the time previously set by the customer is reached.		
Multiplicity	0..1		
Type	EcucFunctionNameDef		
Default value	--		
maxLength	--		
minLength	--		
regularExpression	--		
Post-Build Variant Value	false		
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

No Included Containers



10.2.8 StbMTriggeredCustomer

SWS Item	**ECUC_StbM_00004 :**		
Container Name	StbMTriggeredCustomer		
Description	The triggered customer is directly triggered by the Synchronized Time-base Manager by getting synchronized with the current (global) definition of time and passage of time.		
Post-Build Variant Multiplicity	false		
Multiplicity Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Configuration Parameters			

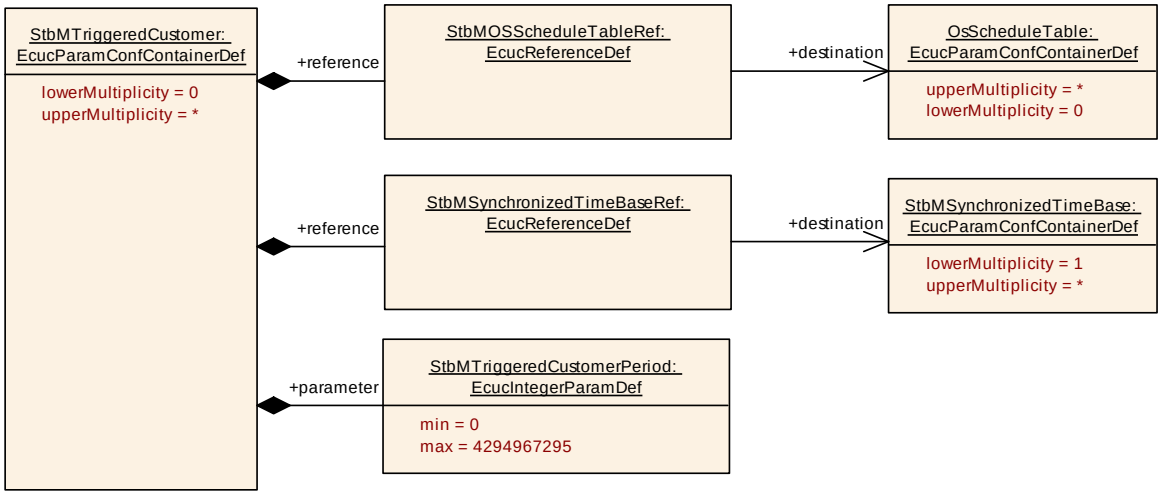
SWS Item	**ECUC_StbM_00020 :**		
Name	StbMTriggeredCustomerPeriod		
Parent Container	StbMTriggeredCustomer		
Description	The triggering period of the triggered customer, called by the StbM_MainFunction. The period is documented in microseconds.		
Multiplicity	1		
Type	EcucIntegerParamDef		
Range	0 .. 4294967295		
Default value	--		
Post-Build Variant Value	false		
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	

Scope / Dependency	scope: local

SWS Item	**ECUC_StbM_00007 :**		
Name	StbMOSScheduleTableRef		
Parent Container	StbMTriggeredCustomer		
Description	Mandatory reference to synchronized OS ScheduleTable, which will be explicitly synchronized by the StbM.		
Multiplicity	1		
Type	Reference to [OsScheduleTable]		
Post-Build Variant Value	false		
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

SWS Item	**ECUC_StbM_00010 :**		
Name	StbMSynchronizedTimeBaseRef		
Parent Container	StbMTriggeredCustomer		
Description	Mandatory reference to the required synchronized time-base.		
Multiplicity	1		
Type	Reference to [StbMSynchronizedTimeBase]		
Post-Build Variant Value	false		
Value Configuration Class	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: local		

No Included Containers



10.3 Constraints

[SWS_StbM_CONSTR_00001]
If variant is `VARIANT-POST-BUILD`, `StbMAllowSystemWideGlobalTimeMaster` shall be mandatory.

[SWS_StbM_CONSTR_00002]
If variant is `VARIANT-POST-BUILD`, `StbMIsSystemWideGlobalTimeMaster` can only be set to `TRUE`, if `StbMAllowSystemWideGlobalTimeMaster` is set to `TRUE`.

10.4 Published Information

For details refer to the chapter 10.3 “Published Information” in *SWS_BSWGeneral.*

11 Not applicable requirements

[SWS_StbM_00140] ⌈These requirements are not applicable to this specification.⌋

(SRS_BSW_00005, SRS_BSW_00006, SRS_BSW_00007, SRS_BSW_00009, SRS_BSW_00010, SRS_BSW_00160, SRS_BSW_00161, SRS_BSW_00162, SRS_BSW_00164, SRS_BSW_00168, SRS_BSW_00170, SRS_BSW_00304, SRS_BSW_00307, SRS_BSW_00308, SRS_BSW_00309, SRS_BSW_00312, SRS_BSW_00314, SRS_BSW_00325, SRS_BSW_00328, SRS_BSW_00334, SRS_BSW_00336, SRS_BSW_00341, SRS_BSW_00342, SRS_BSW_00344, SRS_BSW_00347, SRS_BSW_00353, SRS_BSW_00361, SRS_BSW_00371, SRS_BSW_00375, SRS_BSW_00378, SRS_BSW_00398, SRS_BSW_00399, SRS_BSW_00400, SRS_BSW_00404, SRS_BSW_00405, SRS_BSW_00412, SRS_BSW_00413, SRS_BSW_00415, SRS_BSW_00416,SRS_BSW_00417, SRS_BSW_00422, SRS_BSW_00426, SRS_BSW_00427, SRS_BSW_00428, SRS_BSW_00432, SRS_BSW_00433, SRS_BSW_00437, SRS_BSW_00438, SRS_BSW_00439, SRS_BSW_00440, SRS_BSW_00453)