Document Title	Specification of BSW Scheduler
Document Owner	AUTOSAR GbR
Document Responsibility	AUTOSAR GbR
Document Identification No	210
Document Classification	Standard

Document Version	1.1.1
Document Status	Final
Part of Release	3.1
Revision	0001

Document Change History

Date	Version	Changed by	Change Description
23.06.2008	1.1.1	AUTOSAR Administration	Legal disclaimer revised
10.12.2007	1.1.0	AUTOSAR Administration	• Updates due to advances in BSWMDT (BSW Module Description Template) • Source code file for definition of Exclusive Areas changed • Editorial corrections and improvements • Document meta information extended • Small layout adaptations made
24.01.2007	1.0.1	AUTOSAR Administration	• “Advice for users” revised • “Revision Information” added
01.12.2006	1.0.0	AUTOSAR Administration	Initial release

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1 Introduction and functional overview

This specification specifies the functionality, API and the configuration of the AUTOSAR Basic Software module BSW Scheduler. It does neither specify nor recommend a particular implementation of the BSW Scheduler.

Figure 1 shows the position of the BSW Scheduler within the AUTOSAR Layered Software Architecture (see [2]). The BSW Scheduler is part of the System Services and provides therefore services for all modules of all layers.

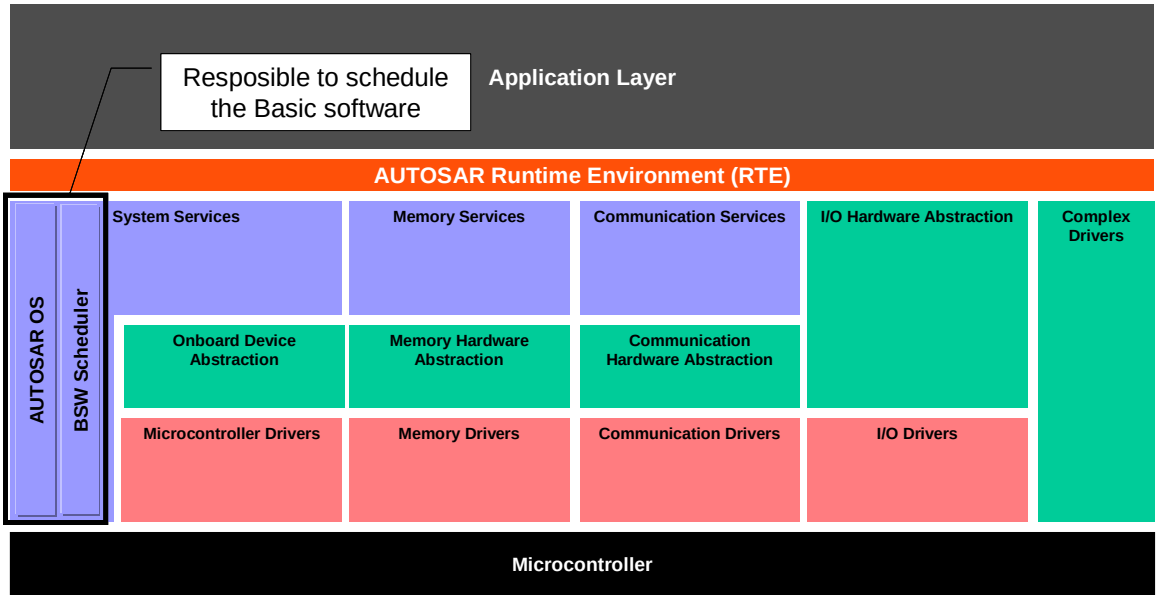


Figure 1: Position of the BSW Scheduler in the AUTOSAR Layered Software Architecture

However, unlike the other BSW modules, the BSW Scheduler offers concepts and services for the *integration*. Hence, this central module provides means to

- embed BSW module implementations into the AUTOSAR OS context
- trigger main processing functions of the BSW modules
- apply data consistency mechanisms for the BSW modules

The integrator's task is to *apply* given means (of the AUTOSAR OS) in order to assemble BSW modules in a well-defined and efficient manner in a project specific context.

This also means that the BSW Scheduler only *uses* the AUTOSAR OS. It is *not* in the least a competing entity for the AUTOSAR OS scheduler.

Example 1.1: The BSW Scheduler uses the concept of the AUTOSAR OS 'Task' to implement the concept 'Triggering of a BSW main processing function'.

Example 1.2: The BSW Scheduler uses the AUTOSAR OS services 'DisableAllInterrupts' and 'EnableAllInterrupts' to implement the BSW Scheduler services for entering and/or exiting a sequence of non-preemptable instructions.

The implementation of the BSW Scheduler is based on

- the BSW Module Description of the BSW modules
- the configuration of the BSW Scheduler

Example 1.3: The BSW Module Description depicts the BSW module `Module` by two main processing functions `<Module>_MainFunction_Transmit` and `<Module>_MainFunction_Receive`, beside others.

Example 1.4: The BSW Scheduler implements the triggering of two main processing functions `<Module1>_MainFunction` and `<Module2>_MainFunction` by calling them in a Task `Task_8ms`. The Task `Task_8ms` calls `<Module1>_MainFunction` before `<Module2>_MainFunction`. The implementation of the BSW Scheduler module activates the Task `Task_8ms` cyclically every eight millisecond. This means, the configuration of the BSW Scheduler mainly determines its implementation.

2 Acronyms and abbreviations

Abbreviation / Acronym:	***Description:***
BSW	Basic Software
RTE	AUTOSAR Runtime Environment
SW-C	AUTOSAR Software Component
OS	Operation System

3 Related documentation

3.1 Input documents

[1] List of Basic Software Modules
https:/svn2.autosar.org/repos2/22_Releases
AUTOSAR_BasicSoftwareModules.pdf

[2] Layered Software Architecture
https:/svn2.autosar.org/repos2/22_Releases
AUTOSAR_LayeredSoftwareArchitecture.pdf

[3] General Requirements on Basic Software Modules
https:/svn2.autosar.org/repos2/22_Releases
AUTOSAR_SRS_General.pdf

[4] Specification of Standard Types
https:/svn2.autosar.org/repos2/22_Releases
AUTOSAR_SWS_StandardTypes.pdf

[5] Specification of Communication Stack Types
https:/svn2.autosar.org/repos2/22_Releases
AUTOSAR_SWS_ComStackTypes.pdf

[6] Specification of ECU Configuration
https:/svn2.autosar.org/repos2/22_Releases
AUTOSAR_ECU_Configuration.pdf

[7] Specification of Operating System
https:/svn2.autosar.org/repos2/22_Releases
AUTOSAR_SWS_OS.pdf

[8] Software Component Template
https:/svn2.autosar.org/repos2/22_Releases
AUTOSAR_SoftwareComponentTemplate.pdf

[9] AUTOSAR Basic Software Module Description Template,
https://svn2.autosar.org/repos2/22_Releases/
AUTOSAR_BSW_Module_Description.pdf

3.2 Related standards and norms

[10] OSEK/VDX Operating System, Version 2.2.2
www.osek-vdx.org

4 Constraints and assumptions

4.1 Limitations

This specification assumes that all modules of the AUTOSAR Basic Software run in the same OS-Application (see [7] for details).

4.2 Applicability to car domains

There are no explicit restrictions for the applicability to car domains.

5 Dependencies to other modules

As explained in the introduction chapter, the BSW Scheduler is the central integration entity. Therefore, the BSW Scheduler has dependencies on all BSW modules; whereas two different dependency types - use dependencies and realize dependencies (as seen from the BSW Scheduler) - are distinguished.

INTEGR004: Use dependencies: The BSW Scheduler *uses* the main processing functions of the BSW modules in the sense that the AUTOSAR OS objects 'Task' call them. The AUTOSAR OS is a particular module because the BSW Scheduler uses its entire functionality.

INTEGR005: Realize dependencies: The BSW Scheduler provides services (APIs) for all other BSW modules, except for the AUTOSAR OS. Hence, the BSW Scheduler *realizes* functionality for those BSW modules (see Chapter 8.3).

From an architectural point of view, there currently exists no relationship between the RTE and the BSW Scheduler. This may be a weakness in the architecture because of the following reasons:

- The RTE provides the infrastructure for Software Components, i.e. the RTE embeds runnable entities in a task context.
- The BSW Scheduler provides the infrastructure for the BSW modules, i.e. the BSW Scheduler embeds main processing function in a task context.

However, with the current architecture, runnable entities and main processing functions cannot be embedded in the same task.

5.1 File structure

5.1.1 Code file structure

In general, this specification shall not restrict implementations in a particular context (of a project). Therefore, this specification does not define the complete code file structure.

INTEGR017: The BSW Scheduler is the sole entity that is responsible to schedule BSW modules (except for AUTOSAR OS and ECU State Manager) in order to ease and simplify the task of their integration.

It is assumed impossible to guarantee a proper integration of the BSW (valid schedule, data consistency, efficiency) if the BSW Scheduler module and therefore the task of integration were split.

INTEGR007: The code-file structure shall include the file `SchM_Cfg.c` in case the implementation of the BSW Scheduler uses generated configuration parameters of

the class ‘pre-compile time’. This file shall contain all generated pre-compile time configuration parameter.

5.1.2 Header file structure

INTEGR071: The include file structure for the BSW Scheduler module `SchM.c` shall be as follows:

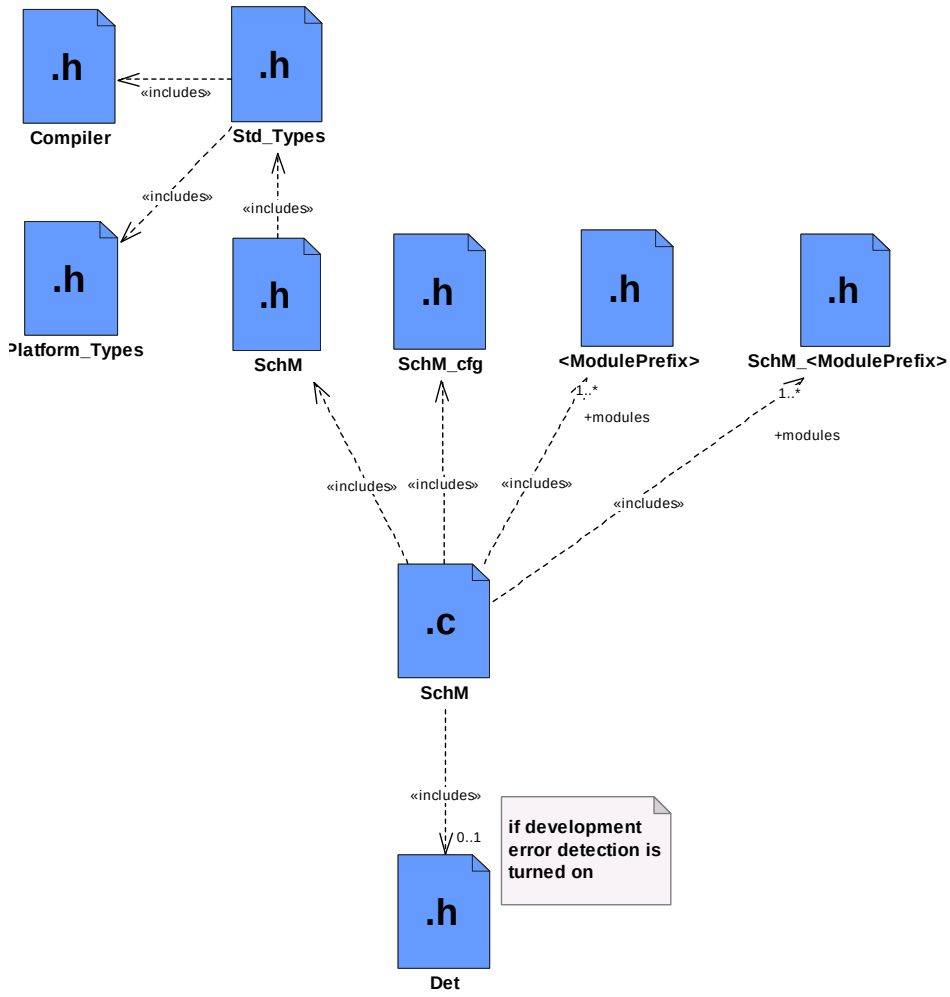


Figure 2: Header file structure of the BSW Scheduler

INTEGR091: The implementation of the BSW Scheduler module `SchM.c` shall include the header file `SchM.h`. `SchM.h` shall include `Std_Types.h` which in turn shall include `Compiler.h` and `Platform_Types.h`.

`SchM.h` exports general services of the BSW Scheduler, i.e. `SchM_Init`, `SchM_Deinit` and `SchM_GetVersionInfo`.

INTEGR072: The implementation of the BSW Scheduler module `SchM.c` shall include all header files `SchM_<ModulePrefix>.h`.

SchM_<ModulePrefix>.h exports specific definitions and services of the BSW Scheduler for a particular module <ModulePrefix>, e.g. definition of “Exclusive Areas”, SchM_Enter_<ModulePrefix>, SchM_Exit_<ModulePrefix>, SchM_ActMainFunction_<ModulePrefix> and SchM_CancelMainFunction_<ModulePrefix>.

If the module <ModulePrefix> is available as source code, the implementer of the BSW Scheduler module (i.e. the integrator) is free to substitute this header file by an optimized version that contains (in the best case) a macro-based implementation of the functionality.

INTEGR010: The implementation of the BSW Scheduler module SchM.c shall include all header files <ModulePrefix>.h of the used BSW modules.

The BSW Scheduler needs to include <ModulePrefix>.h in order to be able to access the main processing functions of the BSW module <ModulePrefix>.

INTEGR073: The implementation of the BSW Scheduler module SchM.c shall include SchM_Cfg.h for pre-compile-time configuration parameter of the BSW Scheduler.

INTEGR074: The implementation of the BSW Scheduler module SchM.c shall include *Det.h* if development error detection is turned on (i.e. SCHM_DEV_ERROR_DETECT = ON).

The include file structures of the BSW modules need to be extended by the respective header files SchM_<ModulePrefix>.h in order to access the module specific functionality provided by the BSW Scheduler.

INTEGR092: Each BSW module implementation <ModulePrefix>.c shall include its respective header file SchM_<ModulePrefix>.h.

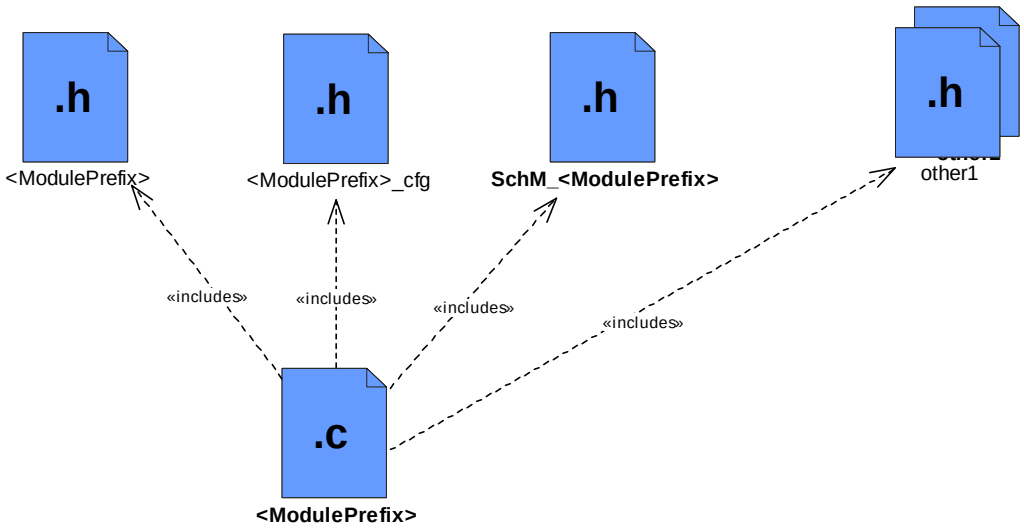


Figure 3: Header file structure of a BSW module <ModulePrefix>.c

5.1.3 Process description (informative)

This section shortly describes the collaboration between the module implementers and the integrator. This collaboration is required to implement the BSW Scheduler. Note that this section is only of informative and informal character and not part of the specification. Furthermore, this description is not exhaustive!

Figure 4 shows the process using the services of AUTOSAR BSW Scheduler from an implementer's point-of-view.

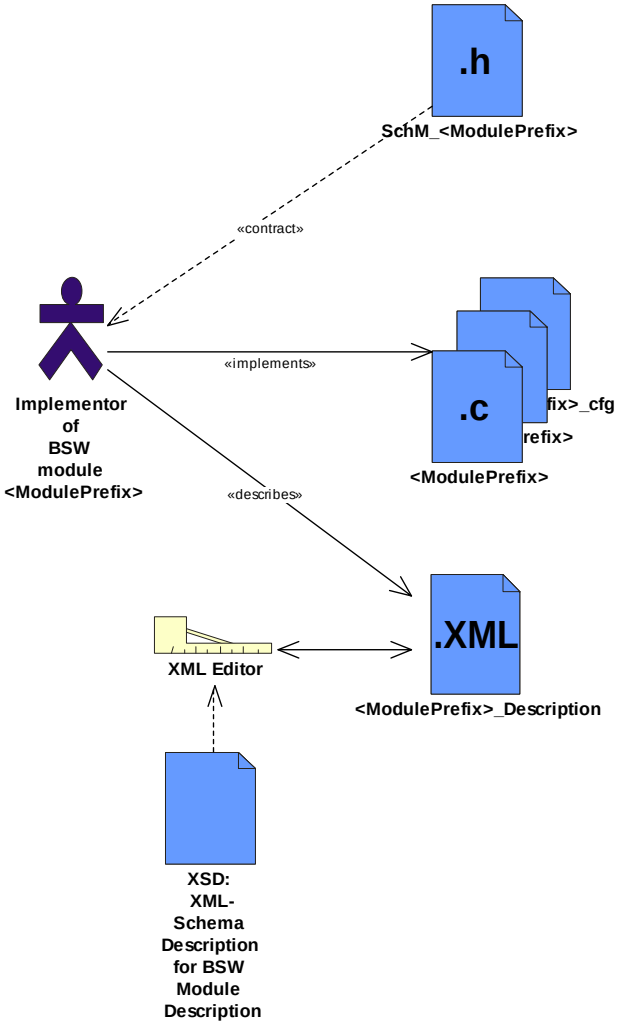


Figure 4: Development process from an implementer's point-of-view

The Header file `SchM_<ModulePrefix>.h` depicts a contract for the implementer because it exports all necessary services for this particular module <ModulePrefix>.
For the BSW module internal testing, a 'stub' implementation of the services in file `SchM_<ModulePrefix>.h` has to be developed. This 'stub software' is not delivered to the Integrator (Implementer of the BSW Scheduler).

Beyond the 'normal' implementation artifacts (source files or object code), the implementer needs to describe its implementation further in the Basic Software Module Description. This description contains specific information about entities, behavior and implementation of the BSW module and serves as an important input for the integrator. E.g., the integrator uses the BSW Module Description to obtain information about which module entities protect critical sections (concept of ExclusiveAreas) or which entities call other module's services and call therefore potentially other module's critical sections.

Since the BSW Module Description Template is an integral part of the AUTOSAR meta-model, deduced module descriptions can be represented and exchanged via XML. This also enables to edit the XML document of a specific module description directly by using an XML editor under the assumption that an XML Schema Description represents the corresponding BSW Module Description Template.

Figure 5 shows the process from an integrator's point-of-view.

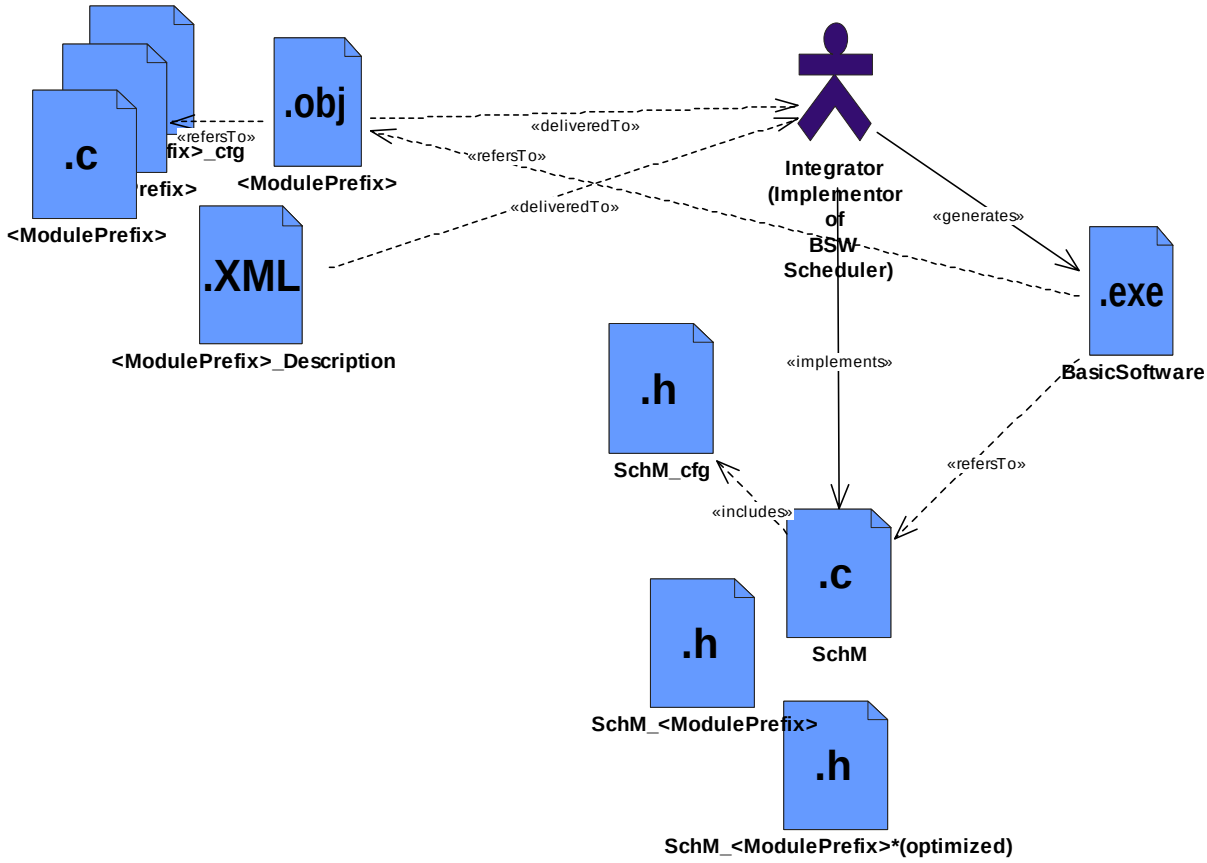


Figure 5: Integration process from an integrators point-of-view

The integrator receives all implementation relevant artifacts - source code, object code and module description - from the module implementers in order to bind them into executable software. As described above, the implementation of the BSW Scheduler is an integral task of this integration work. If a module is available as source code, it may be possible to implement the corresponding BSW Scheduler

functionality as a macro layer. In this case, the integrator is free to substitute the related header file `SchM_<ModulePrefix>.h` by an optimized variant.

The module descriptions delivered by the implementers are important inputs for integration decisions and therefore for the configuration and finally the implementation of the BSW Scheduler.

5.1.4 Basic Software Module Description Template (informative)

As indicated above, the implementation of the BSW Scheduler heavily relies on proper module descriptions that are based on a BSW Module Description Template. Therefore, this section will shortly subsume the main concepts. Unfortunately, this template is currently under development and the specification yet to fix. Therefore, the shown meta-model diagrams serve only as assumption for this specification[1]. Like Section 5.1.3, this description is neither exhaustive nor is it part of this specification.

In general, it is assumed that the modules and their implementations need to be described extensively in order to allow for a correct and easy integration. E.g., the integrator of the Basic Software needs deep knowledge in order to apply a proper protection scheme ensuring data consistency:

- name and list potentially shared resources
- name and list all (internal) entities that access these particular resources
- establish a connection between entities of other modules and the entry points that finally access shared resources
- assumptions on the implementations of critical sections (ExclusiveAreas)
- take ‘possible’ task contexts of the resource access into account
- and other issues

This document assumes that the BSW Module Description will follow the concepts and principles of the AUTOSAR Software Component Template (see [8]).

This means that there are three different layers:

- module/interface level describing the entities of the module
- behavior level describing the triggers of schedulable objects and means for ensuring data consistency (ExclusiveAreas)
- implementation level describing the memory consumption, the timing of a specific implementation etc.

[1] The corresponding meta model can currently be found in the Scratchpad/BswModuleDescription view of the AUTOSAR meta model AR_MetaModel_Master.eap

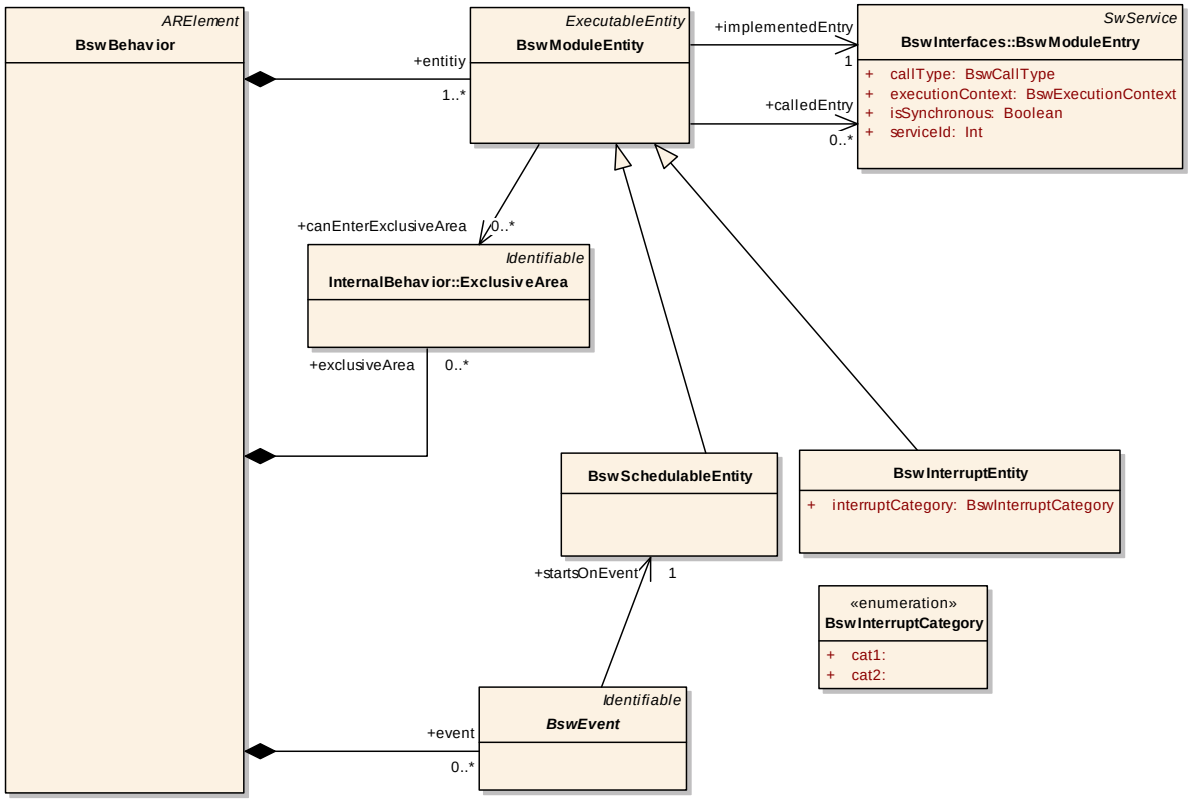


Figure 6: Classification of BSW module entities

Figure 6 shows an excerpt of the BSW Module Description Template covering elements of the first two levels. It shows that there are means to describe modules with their interfaces and behaviors.

The *BswBehavior* is characterized, among others, by its *BswModuleEntities* (see Figure 6) which are assoicated to *BswModuleEntries* either as *ImplementedEntry* or *CalledEntry*. A *BswModuleEntity* can further be a *BswSchedulableEntity* or a *BswInterruptEntity*.

Note that the meta-model elements *BswModuleEntity* and *BswModuleEntry* belong to the first level: the module/interface level.

All other relevant meta-model elements, necessary for the comprehension of this specification (like critical sections / ExclusiveAreas), will be introduced at the point where the corresponding concepts are discussed, i.e. mainly in Chapter 7.

6 Requirements traceability

Document: AUTOSAR General Requirements on Basic Software Modules

Requirement	***Satisfied by***
[BSW00344] Reference to link-time configuration	INTEGR083
[BSW00404] Reference to post build time configuration [approved]	Not applicable (only #define's as pre-compile time parameters)
[BSW00405] Reference to multiple configuration sets	Not applicable (only #define's as pre-compile time parameters)
[BSW00345] Pre-compile-time configuration	INTEGR007, INTEGR073
[BSW159] Tool-based configuration	Not applicable (requirement on implementation, not on specification)
[BSW167] Static configuration checking	Not applicable (requirement on implementation, not on specification)
[BSW171] Configurability of optional functionality	Chapter 8 and Chapter 10
[BSW170] Data for reconfiguration of AUTOSAR SW-Components	Not applicable (this module does not provide an AUTOSAR interface)
[BSW00380] Separate C-Files for configuration parameters	INTEGR007
[BSW00419] Separate C-Files for pre-compile time configuration parameters	INTEGR007
[BSW00381] Separate configuration header file for pre-compile time parameters	INTEGR073
[BSW00412] Separate H-File for configuration parameters	Not applicable (implementation related requirement)
[BSW00383] List dependencies of configuration files	Chapter 10
[BSW00384] List dependencies to other modules	Chapter 5, INTEGR004, INTEGR005, INTEGR006, INTEGR017, INTEGR007, INTEGR071, INTEGR091, INTEGR072, INTEGR010, INTEGR073, INTEGR074, INTEGR092
[BSW00387] Specify the configuration class of callback function	Not applicable (this module does not provide any callback functions)
[BSW00388] Introduce containers	Chapter 10
[BSW00389] Containers shall have names	Chapter 10
[BSW00390] Parameter content shall be unique within the module	Chapter 10
[BSW00391] Parameter shall have unique names	Chapter 10
[BSW00392] Parameters shall have a type	Chapter 10
[BSW00393] Parameters shall have a range	Chapter 10
[BSW00394] Specify the scope of the parameters	Chapter 10
[BSW00395] List the required parameters (per parameter)	Chapter 10
[BSW00396] Configuration classes	Chapter 10
[BSW00397] Pre-compile-time parameters	Chapter 10; However, this specification does not specify a particular implementation or a set of implementations of the BSW Scheduler. Therefore, Chapter 10 does not list implementation specific parameters: There might be additional implementation

	relevant pre-compile-time parameters, then listed in Chapter 10.
[BSW00398] Link-time parameters	Not applicable (only #define's as pre-compile time parameters)
[BSW00399] Loadable Post-build time parameters	Not applicable (only #define's as pre-compile time parameters)
[BSW00400] Selectable Post-build time parameters	Not applicable (only #define's as pre-compile time parameters)
[BSW00402] Published information	INTEGR045
[BSW00375] Notification of wake-up reason	Not applicable (this module does not provide any wake-up reason)
[BSW101] Initialization interface	INTEGR023,
[BSW00416] Sequence of Initialization	Not applicable (this module does not handle initialization)
[BSW00406] Check module initialization	Not applicable (requirement on implementation, not on specification)
[BSW168] Diagnostic Interface of SW components	Not applicable (this module does not provide an AUTOSAR interface)
[BSW00407] Function to read out published parameters	INTEGR030
[BSW00423] Usage of SW-C template to describe BSW modules with AUTOSAR Interfaces	Not applicable (this module does not provide an AUTOSAR interface)
[BSW00429] Restricted BSW OS functionality access	Chapter 1 and Chapter 7
[BSW00432] Modules should have separate main processing functions for read/receive and write/transmit data path	Not applicable (this module does not provide any schedulable objects)
[BSW00336] Shutdown interface	INTEGR027
[BSW00337] Classification of errors	Chapter 7.3
[BSW00338] Detection and Reporting of development errors	INTEGR080, INTEGR077, INTEGR078, INTEGR085, INTEGR076
[BSW00369] Do not return development error codes via API	API specified in Chapter 8
[BSW00339] Reporting of production relevant error status	Not applicable (this module does not raise production relevant errors)
[BSW00417] Reporting of Error Events by Non-Basic Software	Not applicable (this module is not part of the Non-Basic Software)
[BSW00323] API parameter checking	INTEGR076, Chapter 7.3.3.2
[BSW004] Version check	INTEGR045
[BSW00409] Header files for production code error IDs	Not applicable (this module does not raise production relevant errors)
[BSW00385] List possible error notifications	Chapter 7.3.3.2
[BSW00386] Configuration for detecting an error	Chapter 7.3
[BSW161] Microcontroller abstraction	Not applicable (requirement on system design, not on a single module)
[BSW162] ECU layout abstraction	Not applicable (requirement on system design, not on a single module)
[BSW005] No hard coded horizontal interfaces within MCAL	Not applicable (requirement on system design, not on a single module)

[BSW00415] User dependent include files [approved]	INTEGR072
[BSW164] Implementation of interrupt service routines	Not applicable (requirement on implementation, not on specification)
[BSW00325] Runtime of interrupt service routines	Not applicable (requirement on implementation, not on specification)
[BSW00326] Transition from ISRs to OS tasks	Chapter 7.1.2.3.1, Chapter 7.2.3.1
[BSW00342] Usage of source code and object code	Chapter 7
[BSW00343] Specification and configuration of time	INTEGR069
[BSW160] Human-readable configuration data	Chapter 10
[BSW007] HIS MISRA C	Not applicable (requirement on implementation, not on specification)
[BSW00300] Module naming convention	API specifications in Chapter 8
[BSW00413] Accessing instances of BSW modules	API specifications in Chapter 8
[BSW00347] Naming separation of different instances of BSW drivers	Not applicable (this module does not specify a BSW driver)
[BSW00305] Self-defined data types naming convention	Type specification in Chapter 8
[BSW00307] Global variables naming convention	Not applicable (requirement on implementation, not on specification)
[BSW00310] API naming convention	API specification of Chapter 8
[BSW00373] Main processing function naming convention	Not applicable (this module does not provide any schedulable objects)
[BSW00327] Error values naming convention	INTEGR070
[BSW00335] Status values naming convention	INTEGR070
[BSW00350] Development error detection keyword	INTEGR067
[BSW00408] Configuration parameter naming convention	Chapter 10
[BSW00410] Compiler switches shall have defined values	Chapter 10, INTEGR067
[BSW00411] Get version info keyword	INTEGR031
[BSW00346] Basic set of module files	Chapter 5.1
[BSW158] Separation of configuration from implementation	Chapter5, INTEGR071
[BSW00314] Separation of interrupt frames and service routines	Not applicable (requirement on AUTOSAR architecture, not a single module)
[BSW00370] Separation of callback interface from API	Not applicable (requirement on AUTOSAR architecture, not a single module)
[BSW00348] Standard type header	Not applicable (requirement on AUTOSAR architecture, not a single module)
[BSW00353] Platform specific type header	Not applicable (requirement on AUTOSAR architecture, not a single module)
[BSW00361] Compiler specific language extension header	Not applicable (requirement on AUTOSAR architecture, not a single module)
[BSW00301] Limit imported information	INTEGR071

[BSW00302] Limit exported information	INTEGR071
[BSW00328] Avoid duplication of code	Not applicable (requirement on implementation, not on specification)
[BSW00312] Shared code shall be reentrant	Not applicable (requirement on implementation, not on specification)
[BSW006] Platform independency	Not applicable (requirement on implementation, not on specification)
[BSW00357] Standard API return type	API specification of Chapter 8
[BSW00377] Module specific API return types	API specification of Chapter 8.2, INTEGR070
[BSW00304] AUTOSAR integer data types	API specification of Chapter 8
[BSW00355] Do not redefine AUTOSAR integer data types	API specification of Chapter 8
[BSW00378] AUTOSAR boolean type	Not applicable (requirement on AUTOSAR architecture, not a single module)
[BSW00306] Avoid direct use of compiler and platform specific keywords	Not applicable (requirement on implementation, not on specification)
[BSW00308] Definition of global data	Not applicable (requirement on implementation, not on specification)
[BSW00309] Global data with read-only constraint	Not applicable (requirement on implementation, not on specification)
[BSW00371] Do not pass function pointers via API	API specification of Chapter 8
[BSW00358] Return type of `init()` functions	INTEGR023
[BSW00414] Parameter of init function	INTEGR023
[BSW00376] Return type and parameters of main processing functions	Not applicable (this module does not provide any schedulable objects)
[BSW00359] Return type of callback functions	Not applicable (this module does not provide any callback functions)
[BSW00360] Parameters of callback functions	Not applicable (this module does not provide any callback functions)
[BSW00329] Avoidance of generic interfaces	No generic interface specified.
[BSW00330] Usage of macros / inline functions instead of functions	Not applicable (requirement on implementation, not on specification, but examples of Chapter 7 point in this direction)
[BSW00331] Separation of error and status values	Chapter 8.1 vs Chapter 8.2.1
[BSW009] Module User Documentation	Not applicable (requirement on documentation, not on specification)
[BSW00401] Documentation of multiple instances of configuration parameters	Not applicable (requirement on documentation, not on specification)
[BSW172] Compatibility and documentation of scheduling strategy	Not applicable (requirement on documentation, not on specification)
[BSW010] Memory resource documentation	Not applicable (requirement on documentation, not on specification)
[BSW00333] Documentation of callback function context	Not applicable (requirement on documentation, not on specifica-

	tion)
[BSW00374] Module vendor identification	INTEGR045
[BSW00379] Module identification	INTEGR045
[BSW003] Version identification	INTEGR045
[BSW00318] Format of module version numbers	INTEGR045
[BSW00321] Enumeration of module version numbers	Not applicable (requirement on documentation, not on specification)
[BSW00341] Microcontroller compatibility documentation	Not applicable (requirement on documentation, not on specification)
[BSW00334] Provision of XML file	XML is only one representation of input or configuration information for the BSW Scheduler. Configuration and module description (templates) are handled in Chapter 10.

Document: AUTOSAR General requirements on Basic Software Modules, BSW Scheduler

Requirement	***Satisfied by***
[BSW00424] BSW main processing function task allocation	INTEGR068
[BSW00425] Trigger conditions for schedulable objects	Chapter 7.1.2, INTEGR064, INTEGR044, INTEGR063
[BSW00426] Exclusive areas in BSW modules	Chapter 7.2, INTEGR047, INTEGR093, INTEGR094
[BSW00427] ISR description for BSW modules	Not applicable (requirement on documentation, not on specification)
[BSW00428] Execution order dependencies of main processing functions	INTEGR068
[BSW00431] The BSW Scheduler module implements task bodies	INTEGR015
[BSW00433] Calling of main processing functions	INTEGR012, INTEGR013
[BSW00434] The Schedule Module shall provide an API for exclusive areas	INTEGR032 (Enter), INTEGR035 (Exit)

7 Functional specification

The software specifications of the BSW modules specify services and main processing functions. However, module specification as well as the implementation are decoupled from a certain infrastructure (mainly determined by the OS). Integration in this context signifies mapping: the BSW Scheduler maps the implementation onto the given infrastructure, regardless of whether the implementation is available as source code or as object code.

In this sense, this chapter continues the discussion started in Chapter 1. There, we already formulated main requirements on the BSW Scheduler. In detail, the BSW Scheduler shall provide means to

- embed the implementation of BSW modules into the AUTOSAR OS context,
- trigger main processing functions of the BSW modules,
- apply data consistency mechanisms for the BSW modules.

Altogether, these requirements shall ensure that particular implementations of modules can be properly integrated into the Basic Software.

7.1 Embedding main processing functions into the AUTOSAR OS context

7.1.1 General considerations

INTEGR012: The BSW Scheduler shall be the only instance that embeds BSW main processing functions into the AUTOSAR OS infrastructure.

Practically, INTEGR012 means that the BSW Scheduler shall

- set up AUTOSAR OS Task bodies,
- arrange the calls of the main processing functions within the OS Task bodies.

In this sense, the BSW Scheduler implementation bases deeply on its configuration (see Chapter 10.2 for details). Because in order to satisfy INTEGR012, the BSW Scheduler configuration needs to refer to OS Tasks, to specify the assignments of the main processing functions to given OS Tasks and finally, it needs to specify the execution order of the main processing functions within a particular OS Task.

INTEGR015: The BSW Scheduler shall implement the AUTOSAR OS Task bodies of the BSW Layer based on its configuration.

INTEGR096: The BSW Scheduler shall implement the calls to the main processing functions within the AUTOSAR OS Task bodies based on its configuration.

INTEGR097: When implementing the calls to the main processing functions, the BSW Scheduler shall respect the configured (unambiguous) execution order of main processing functions within a single AUTOSAR OS Task context.

AUTOSAR OS classifies two types of tasks: basic tasks and extended tasks. The configuration of the BSW Scheduler allows mapping of main processing functions to both types; basic tasks and extended tasks.

However, note that the main processing functions themselves must not enter a wait state.

INTEGR014: The BSW Scheduler (generator/implementer) shall reject configurations where main processing functions can enter wait states.

Example 7.1:

Implementation of the BSW Scheduler module:

Schm.c:

```
TASK (Task_7ms) {
   ...
   Com_MainFunction_Receive ();
   Com_MainFunction_Transmit ();
   ...
}
```

7.1.2 Triggering main processing functions

7.1.2.1 General concepts

Although Chapter 7.1.1 discusses main approaches, it does not consider aspects of triggering main processing functions for the integration into an OS context.

In general, main processing functions, as schedulable objects, shall react on specific trigger conditions. The BSW Module Description (Template) models trigger conditions as so-called *BswEvents*. Currently, the concept of BswEvents distinguishes two different types (see Figure 7):

- *BswSporadicEvents* - comprising triggers that appear occasionally
- *BswCyclicEvents* - comprising triggers that recur cyclically

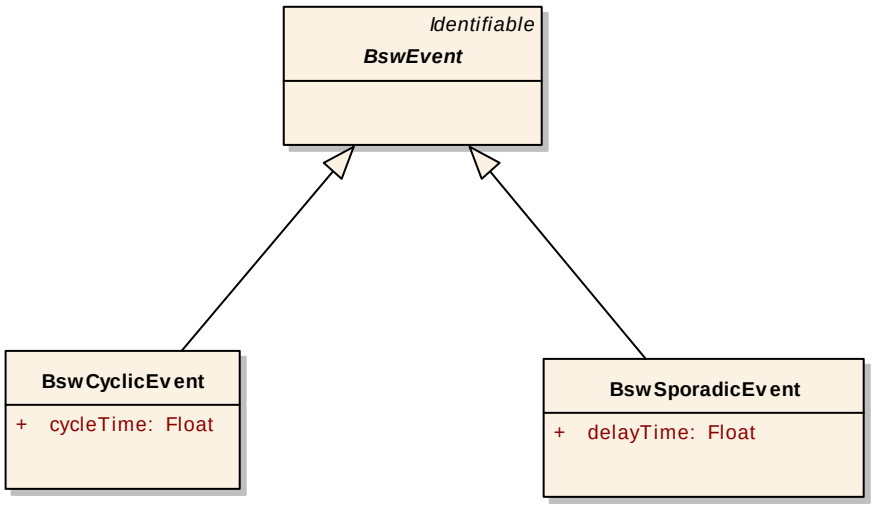


Figure 7: Types of BswEvents

Furthermore, Figure 8 shows the general connection between *BswEvents* and the reaction of schedulable entities (main processing functions). The occurrence of a specific BswEvent can activate (start) a schedulable function (main processing function). However, unlike the meta-model of the Software Component Template, schedulable objects (main processing functions) must not enter a wait state.

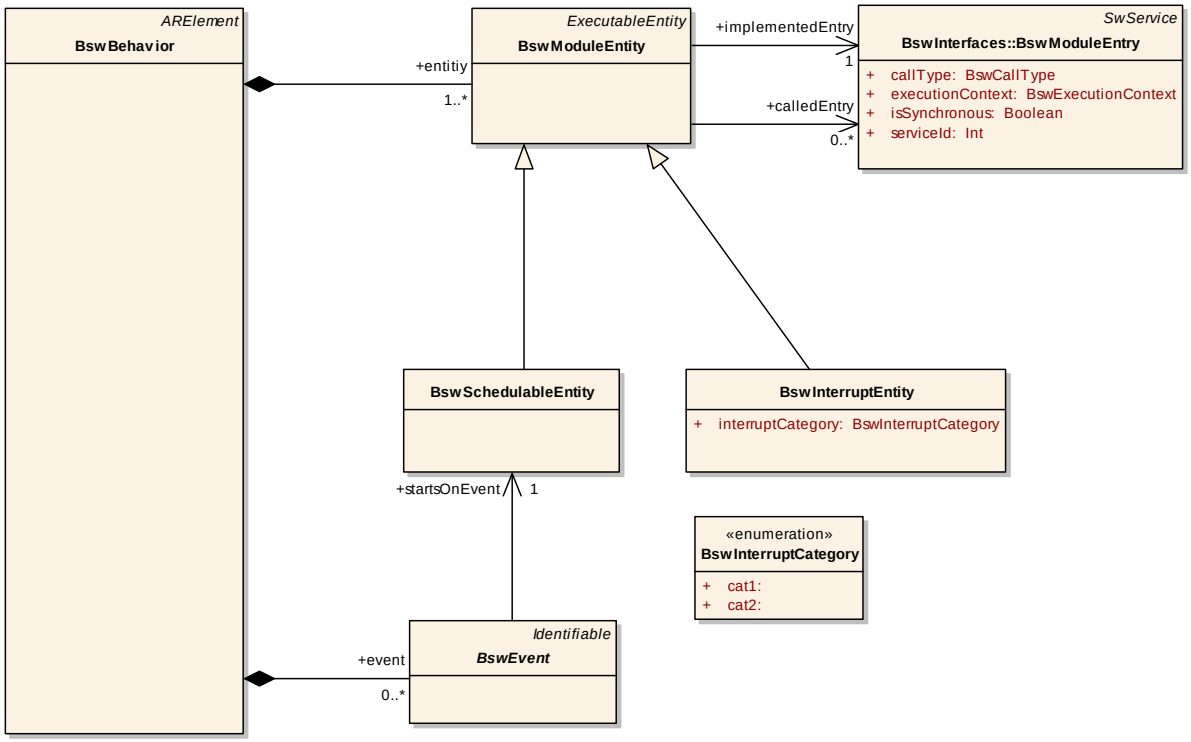


Figure 8: Interactions of BswEvents and BswSchedulableEntities

Note again, that the aforementioned concept *only* denotes the context of main processing functions. It does *not* describe the implementation with respect to an AUTOSAR OS context. The BSW Module Description serves only as an input to the BSW Scheduler and therefore sets the conditions (requirements) for a 'proper' implementation of the BSW Scheduler.

Example 7.2: The cyclical occurrence of the *BswCyclicEvent TE7MS* activates a main processing function every seven millisecond.

7.1.2.2 BswCyclicEvents

7.1.2.2.1 Background

The concept of *BswCyclicEvent*s depicts the ability to process recurring events. The following classes of *BswCyclicEvents* are possible:

- fixed or variable cyclic recurring events where the type of trigger condition is Time[2] - in the document referred to as timed *BswCyclicEvents*,
- recurring events where the type of trigger condition only indirectly relates to Time (e.g. angle of a crankshaft)

7.1.2.2.2 Fixed cyclic BswCyclicEvents based on Time

The term 'fixed cyclic' means that a specific configured cycle time shall not change during runtime.

Thus, a most likely implementation uses AUTOSAR OS 'Tasks' activated by AUTOSAR OS 'Alarms' for these time-based *BswCyclicEvents* with fixed cycle times. The same task can call (implement) different main processing functions if they have the same attribute 'cycle time'.

However, note that different objects 'Alarm' can base on different objects 'Counter'. The system counter is not the only counter in the system. Be aware of the fact that this might lead to different implementation with different behaviors.

E.g., two main processing functions triggered by different *BswCyclicEvents* but identical attributes might be implemented by two different tasks triggered by two different alarms. Alternatively, only one task will implement (call) them. The implementation of the BSW Scheduler will behave differently.

However, the same task will most likely trigger different main processing functions in case the same *BswCyclicEvent* triggers them.

The BSW Scheduler is not responsible for the lifecycle management. The AUTOSAR OS scheduler manages and schedules the AUTOSAR OS objects 'Task'.

[2] This type of event is called TimingEvent in the Software Component Template

Example 7.3: Two main processing functions `Com_MainFunction_Receive ()` and `Com_MainFunction_Transmit ()` shall process every seven millisecond.

The BSW Scheduler module implements this by using the AUTOSAR OS objects ‘Task’ and ‘Alarm’.

Implementation of the BSW Scheduler module:

AUTOSAR OS configuration:

```
COUNTER SYSTEM_COUNTER {
   /* 1MS system counter */
   MAXALLOWEDVALUE = 65535;
   TICKSPERBASE = 1000000;
   MINCYCLE = 1;
};

ALARM TASK_7MS {
    COUNTER = SYSTEM_COUNTER;
    ACTION = ACTIVATETASK {
        TASK = Task_7ms;
    };
};
```

SchM_cfg.h:

```
#define START_TIME_7MS            0
#define CYCLE_TIME_7MS            7
```

SchM.c:

```
void
SchM_Init () {
    SetRelAlarm (TASK_7MS, START_TIME_7MS, CYCLE_TIME_7MS);
}


TASK (Task_7ms) {
   ...
   Com_MainFunction_Receive ();
   Com_MainFunction_Transmit ();
   ...
}
```

7.1.2.2.3 Variable cyclic BswCyclicEvents based on Time

Variable cyclic here means that the cycle time might be mode dependent and might vary during runtime.

Thus, the AUTOSAR OS object ‘ScheduleTable’ likely implements *BswCyclicEvents* with variable cycles.

7.1.2.2.4 BswCyclicEvents not directly based on Time

Since there are various use cases and therefore implementations possible, the implementation of this type of BswCyclicEvents is neither specified nor documented.

7.1.2.3 BswSporadicEvents

7.1.2.3.1 Concept

The concept of *BswSporadicEvents* expresses the ability to synchronize module entities. This comprises the decoupling of interrupt and task context as well as the starting of timeouts and connected actions.

Figure 9 shows the relation of *ModuleEntities* (code), *ActivationPoints*, *CancellationPoints* and *BswSporadicEvents*, Figure 8 the correlation of BswEvents and schedulable entities (main processing function).

The class *BswSporadicEvents* shall contain an attribute denoting the minimum delay time (given in time units, tick, etc.) until a main processing function is started. Since the least possible delay is zero, *BswSporadicEvents* can express an immediate trigger which in turn could start a corresponding main processing function immediately. The case where the value of the ‘delay attribute’ is greater than zero denotes a delayed trigger. Likewise, the trigger activates the corresponding main processing function with a delay.

ActivationPoints are the means to refer to *BswSporadicEvents* within the code of a BSW module entity, whereas each *ActivationPoint* points exactly to one *BswSporadicEvent*. It is also possible that more than one *ActivationPoint* references a particular *BswSporadicEvent*.

Thus, the shown concept allows for hosting different timeout timers at different points during execution but activating the very same main processing function after their expiration.

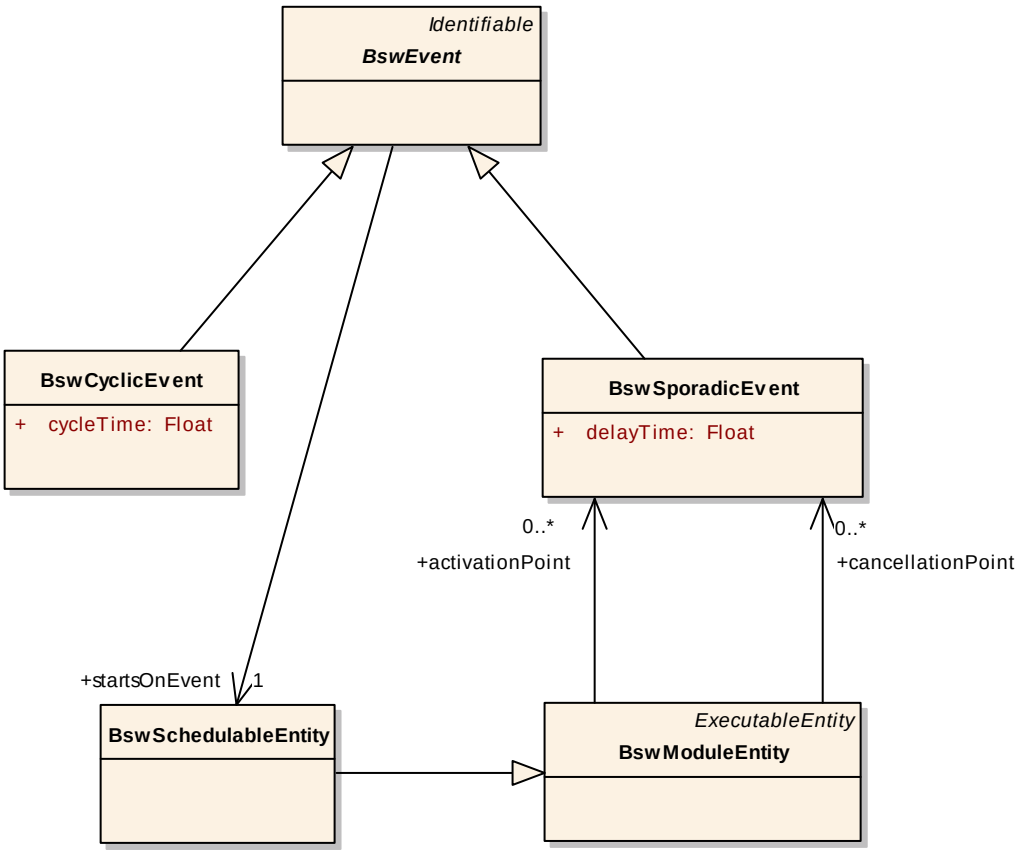


Figure 9: *ActivationPoint*s and *CancellationPoint*s in the context of *BswSporadicEvents*

CancellationPoints are the counterparts of the *ActivationPoints*. Like ActivationPoints, each *CancellationPoint* points exactly to one *BswSporadicEvent*. In case the corresponding Bsw*SporadicEvent* is not yet fired, it will be cancelled.

7.1.2.3.2 Implementation

The implementation of *BswSporadicEvents, ActivationPoints* and *CancellationPoints* reflects their description: The service `SchM_ActMainFunction` corresponds to *ActivationPoints* (see INTEGR039). The service `SchM_CancelMainFunction` corresponds to *CancellationPoints* (see INTEGR044).

The implementation of the real *BswSporadicEvents* can vary depending on the desired semantic. This document does not specify particular solutions. Proper means to realize the activation of main processing functions might be the AUTOSAR OS services `ActivateTask` for immediate and `SetRelAlarm` or `SetAbsAlarm` for delayed activation. However, there might be other solutions which use the AUTOSAR OS services differently.

Example 7.4: A main processing function of a BSW module shall explicitly be activated. The implementation of the calling BSW module exists as source code.

Implementation of the BSW module <ModulePrefix>:

<ModulePrefix>_cfg.h:

```
#define TIMEOUT_EVENT_100MS    (1)

#define ACTIVATION_POINT_1     TIMEOUT_EVENT_100MS
```

<ModulePrefix>.c:

```
#include "<ModulePrefix>.h"
#include "<ModulePrefix>_cfg.h"
#include "SchM_<ModulePrefix>.h"

void
<ModulePrefix>_foo () {
    ...
    SchM_ActMainFunction_<ModulePrefix> (ACTIVATION_POINT_1);
    ...
}
```

Implementation alternative 1 of the BSW Scheduler module:

SchM_<ModulePrefix>.h:

```
#define SchM_ActMainFunction_<ModulePrefix> (ActivationPoint) \
    ActMainFunction_<ModulePrefix>_ ## ActivationPoint

#define ActMainFunction_<ModulePrefix>_1 \
    ActivateTask (<ModulePrefix>_MainFunction_<Name>Task)
```

SchM.c:

```
#include "<ModulePrefix>.h"
#include "SchM.h"
#include "SchM_<ModulePrefix>.h"

TASK (<ModulePrefix>_MainFunction_<Name>Task) {
    <ModulePrefix>_MainFunction_<Name> ();
    TerminateTask ();
}
```

Implementation alternative 2 of the BSW Scheduler module:

SchM_<ModulePrefix>.h:

```
extern boolean Flag_1;


#define SchM_ActMainFunction_<ModulePrefix> (ActivationPoint) \
    ActMainFunction_<ModulePrefix>_ ## ActivationPoint

#define ActMainFunction_<ModulePrefix>_1 \
    (Flag_1 = (TRUE), SCHM_E_OK)
```

SchM.c:

```
#include “<ModulePrefix>.h”
#include “SchM.h”
#include “SchM_<ModulePrefix>.h”

    boolean Flag_1;

SchM_Init () {
    Flag_1 = FALSE;
}

TASK (Task_Cycle10ms) {
    ...
    if (Flag_1) {
        <ModulePrefix>_MainFunction_<Name> ();
        Flag_1 = FALSE;
    }
    ...
    TerminateTask ();
}
```

Example 7.5: A main processing function shall be activated after a timeout has been expired. The implementation of the calling BSW module exists as object code.

Implementation of the BSW module <ModulePrefix>:

<ModulePrefix>_cfg.h:

```
#define TIMEOUT_EVENT_10MS     ((uint8)0)
#define TIMEOUT_EVENT_20MS     ((uint8)1)

#define ACTIVATION_POINT_0     TIMEOUT_EVENT_10MS
#define ACTIVATION_POINT_1     TIMEOUT_EVENT_20MS

#define CANCELATION_POINT_0    TIMEOUT_EVENT_10MS
#define CANCELATION_POINT_1    TIMEOUT_EVENT_20MS
```

<ModulePrefix>.c

```
#include “<ModulePrefix>.h”
#include “<ModulePrefix>_cfg.h
#include “SchM_<ModulePrefix>.h”

void
<ModulePrefix>_foo () {
    SchM_ReturnType status;

    ...
    status = SchM_ActMainFunction_<ModulePrefix> (ACTIVATION_POINT_0);
    ...
```

```
    status =
    SchM_CancelMainFunction_<ModulePrefix> (CANCELATION_POINT_0);
    ...
    /* error case, because not activated before */
    status =
     SchM_CancelMainFunction_<ModulePrefix> (CANCELATION_POINT_1);
    ...
}
```

Implementation of the BSW Scheduler module:

AUTOSAR OS configuration:

```
COUNTER SYSTEM_COUNTER {
   /* 1MS system counter */
   MAXALLOWEDVALUE = 65535;
   TICKSPERBASE = 1000000;
   MINCYCLE = 1;
};

ALARM ALARM_0 {
    COUNTER = SYSTEM_COUNTER;
    ACTION = ACTIVATETASK {
        TASK = <ModulePrefix>_MainFunction_<Name>Task;
    };
};

ALARM ALARM_1 {
    COUNTER = SYSTEM_COUNTER;
    ACTION = ACTIVATETASK {
       TASK = <ModulePrefix>_MainFunction_<Name>Task;
    };
};
```

SchM_cfg.h:

```
#define TIMEOUT_10MS          10
#define TIMEOUT_20MS          20
```

SchM_<ModulePrefix>.h:

```
SchM_ReturnType
SchM_ActMainFunction_<ModulePrefix> (uint8 ActivationPoint);

SchM_ReturnType
SchM_CancelMainFunction_<ModulePrefix> (uint8 CancellationPoint);

struct SchM_<ModulePrefix>_Activation {
    ALARM alarm;
    TickType tick;
};
```

SchM.c:

```
#include “<ModulePrefix>.h”
#include “SchM_cfg.h”
#include “SchM_<ModulePrefix>.h”

const struct SchM_<ModulePrefix>_Activation
    <ModulePrefix>_Activation[] =
```

```
{
    {ALARM_0, TIMEOUT_10MS},
    {ALARM_1, TIMEOUT_20MS}
};

SchM_ReturnType
SchM_ActMainFunction_<ModulePrefix> (uint8 ActivationPoint) {
  return SetRelAlarm (
    <ModulePrefix>_Activation [ActivationPoint].alarm,
    <ModulePrefix>_Activation [ActivationPoint].tick
  );
}

SchM_ReturnType
SchM_CancelMainFunction_<ModulePrefix> (uint8 CancellationPoint) {
    return CancelAlarm (
      <ModulePrefix>_Activation [CancellationPoint].alarm
    );
}
```

7.1.2.4 Main processing functions triggered by BswCyclicEvents and BswSporadicEvents

BswCyclicEvents and *BswSporadicEvents* might trigger the same main processing function.

In general, it has to be made sure that no side effects can occur. Therefore, the most likely implementation is a task containing only the call to this main processing function. The task may then be activated cyclically (based on Time) or by a sporadic call of 'ActivateTask'.

BswCyclicEvents, which are not directly time based, are supported as long as the event is captured via an OS counter. For all other cases, the implementation of this type of *BswCyclicEvents* is neither specified nor documented.

Example 7.6: A main processing function shall be activated by a time-based fixed cyclic *BswCyclicEvent* and a *BswSporadicEvent*. The implementation of the BSW module exists as source code.

Implementation of the BSW module <ModulePrefix>:

<ModulePrefix>_cfg.h:

```
#define IMMEDIATE_TRIGGER_EVENT    ((uint8)0)

#define ACTIVATION_POINT_0         IMMEDIATE_TRIGGER_EVENT
```

<ModulePrefix>.c:

```
#include "<ModulePrefix>_cfg.h"
#include "SchM_<ModulePrefix>.h"

void
<ModulePrefix>_foo () {
```

```
    ...
    SchM_ActMainFunction_<ModulePrefix> (ACTIVATION_POINT_1);
    ...
}
```

Implementation of the BSW Scheduler module:

AUTOSAR OS configuration:

```
COUNTER SYSTEM_COUNTER {
   /* 1MS system counter */
   MAXALLOWEDVALUE = 65535;
   TICKSPERBASE = 1000000;
   MINCYCLE = 1;
};



ALARM <MODULEPREFIX>_TRANSMIT_ALARM {
    COUNTER = SYSTEM_COUNTER;
    ACTION = ACTIVATETASK {
        TASK = <ModulePrefix>_MainFunction_TransmitTask;
    };
};
```

SchM_cfg.h:

```
#define START_TIME_10MS           0
#define CYCLE_TIME_10MS           10
```

SchM_<ModulePrefix>.h:

```
#define SchM_ActMainFunction_<ModulePrefix> (ActivationPoint) \
    ActMainFunction_<ModulePrefix>_ ## ActivationPoint

#define SchM_ActMainFunction_<ModulePrefix>_0 \
    ActivateTask (<ModulePrefix>_MainFunction_TransmitTask)
```

SchM.c:

```
#include “<ModulePrefix>.h”
#include “SchM.h”
#include “SchM_cfg.h”
#include “SchM_<ModulePrefix>.h”

void
SchM_Init () {
  SetRelAlarm (<MODULEPREFIX>_TRANSMIT_ALARM,
               START_TIME_10MS,
               CYCLE_TIME_10MS);
}

TASK (<ModulePrefix>_MainFunction_TransmitTask) {
   <ModulePrefix>_MainFunction_Transmit ();
```

```
    TerminateTask ();
}
```

7.2 Data consistency

7.2.1 Background

The access to shared data from concurrent threads of code execution can potentially cause data inconsistencies. One of these phenomenons is known as ‘lost update problem’.

As explained above, the specifications of the BSW modules do not define the ultimate execution context, but potentially concurrent threads of executions: main processing functions. Functions called from a main processing function run in the context of the main processing function. That means further that a service of a module likely runs in the context of another module’s main processing function, too.

Since BSW modules are potentially implemented by different vendors, only the integrator of the entire BSW has the information to map the threads of execution (main processing functions) onto the execution context (OS object ‘Tasks’). Thus, only the integrator of the BSW has the proper information to handle data consistency problems, correctly.

Although the implementer of a BSW module has a limited view on the problem, an implementation shall consider potential data consistency problems: by the used module interaction scheme, by the BSW Module Description and by the concept of ExclusiveAreas described below (see also Section 5.1.4).

In general, there are two types of shared resources possible: resources accessed *globally* and resources that are accessed *locally*. The AUTOSAR BSW uses both types.

In case of *locally accessible* resources, external BSW module can only access the shared resources via an entry point of the module, i.e. APIs or callback functions. Thus, the BSW module encapsulates the resources. Although, the entry points of the module are accessible from the outside (from unknown execution contexts), the module implementer knows all entities (access points) that access the module internal shared resources. However, even in this case, the module implementer cannot reason about a ‘proper’ locking scheme because of the problems explained above.

In case of *globally accessible* resources, any code entity (of any BSW module) can access a resource directly via a pointer rather then via an entry point of a module. Thus, the BSW module that ‘owns’ the resource cannot apply *any* locking scheme to provide data consistency.

AUTOSAR handles both types in different ways.

7.2.2 Built-in data consistency

For *globally accessible* resources, only the design of the possible interaction between BSW modules can ensure data consistency. Modules that access a shared resource shall run in the execution context of the ‘owner’.

INTEGR047: For *globally accessible* resources, only the design of the possible interaction between BSW modules can ensure data consistency. Thus, modules that access a shared resource shall run in the execution context of the 'owner'.

7.2.3 ExclusiveAreas

7.2.3.1 Concept

For *locally accessible* resources, this document introduces the concept of *ExclusiveAreas*[3]. It expresses the (abstract) means to protect the concurrent access to module internal but shared resources by different module entities.

INTEGR093: Implementation of BSW modules shall use the concept of *ExclusiveAreas* to protect locally accessible (shared) resources.

To address the problem correctly, this document distinguishes between the description of an *ExclusiveArea* as part of the BSW Module Description and its corresponding implementation.

See first the UML diagram of Figure 10: it shows the meta-model of the *ExclusiveArea* concept.

An *ExclusiveArea* is part of the internal behavior of a BSW module and has a name for identification. There might be several shared resources per BSW module and so there are a number of differently named *ExclusiveAreas* (per module).

In addition, there are module entries (APIs, callbacks). They can be accessed from other modules and might need to access locally shared resources as well. The latter link is achieved via the meta-model association *CanEnterExclusiveArea* referencing to a particular and named *ExlusiveArea*. In this case, the BSW module implementation is required to call a particular service `SchM_Enter` (see INTEGR032) for entering the protection scheme and `SchM_Exit` (see INTEGR035) for exiting the protection scheme. Note that both services distinguish the access to differently named *ExclusiveAreas* via a parameter.

[3] The term 'ExclusiveArea' has been adopted from the Software Component Template. In general, this concept is known by the term 'critical region'. The meta-model of the ExclusiveArea has been adopted from the Software Component Template, too.

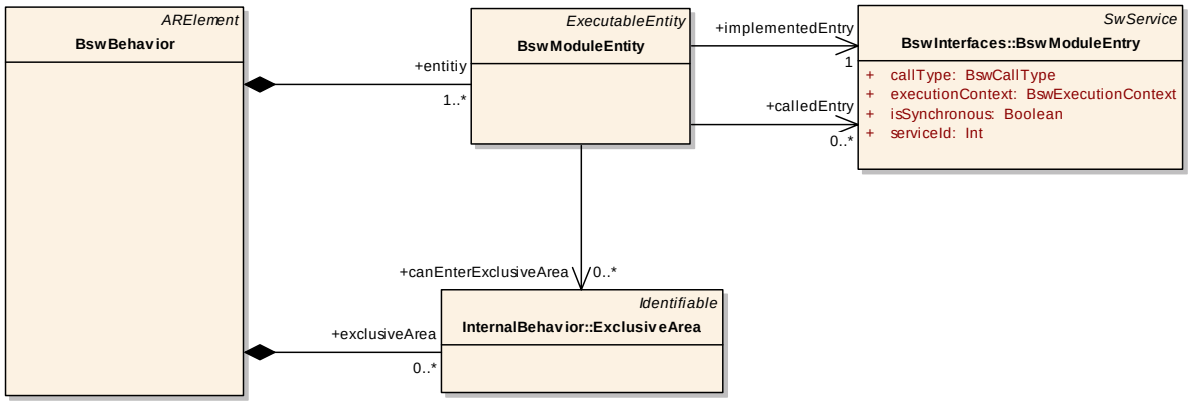


Figure 10: BSW module description template extract concerning *ExclusiveArea*s

7.2.3.2 Implementation

INTEGR094: The integrator shall implement the particular services `SchM_Enter` and `SchM_Exit`.

The implementation of the services `SchM_Enter` or `SchM_Exit` may differ depending on the context of the project, the implementation of the module or a particular shared resource. Therefore, this document will not specify or favor any solution. Possible implementations comprise

- the use of interrupt locking schemes provided by the AUTOSAR OS services like `DisableAllInterrupts`, `EnableAllInterrupts`,
- the use of specific interrupt locking schemes provided by the BSW modules like `Can_DisableControllerInterrupts`, `Can_EnableControllerInterrupts`,
- the use of AUTOSAR OS ‘Resources’ preventing priority inversion and deadlocks,
- the dedicated sequential invocation of code entities that access the shared resources.

There may be other implementations.

Example 7.7: The BSW module <ModulePrefix> shall assure data consistency for three different internal resources (buffer). The implementation of the BSW module <ModulePrefix> exists as source code.

Implementation of the BSW module <ModulePrefix>:

<ModulePrefix>_cfg.c:

```
#define CAN_CONTROLLER_0    ((uint8)0)
```

<ModulePrefix>.c:

```
#include “SchM_<ModulePrefix>.h”
```

```
SchM_Enter_<ModulePrefix> (EXCLUSIVE_AREA_0);
<Access to buffer 0>
SchM_Exit_<ModulePrefix> (EXCLUSIVE_AREA_0);
...
...
SchM_Enter_<ModulePrefix> (EXCLUSIVE_AREA_1);
<Access to buffer 1>
SchM_Exit_<ModulePrefix> (EXCLUSIVE_AREA_1);
...
...
SchM_Enter_<ModulePrefix> (EXCLUSIVE_AREA_2);
<Access to buffer 2>
SchM_Exit_<ModulePrefix> (EXCLUSIVE_AREA_2);
...
```

Implementation of the BSW Scheduler module:

AUTOSAR OS configuration:

```
RESOURCE RESOURCE_2 {
}
```

SchM_<ModulePrefix>.h:

```
#define EXCLUSIVE_AREA_0    ((uint8)0)
#define EXCLUSIVE_AREA_1    ((uint8)1)
#define EXCLUSIVE_AREA_2    ((uint8)2)

#define SchM_Enter_<ModulePrefix> (ExclusiveArea) \
    SchM_Enter_<ModulePrefix>_ ## ExclusiveArea

#define SchM_Exit_<ModulePrefix> (ExclusiveArea) \
    Schm_Exit_<ModulePrefix>_ ## ExclusiveArea

#define SchM_Enter_<ModulePrefix>_0    DisableAllInterrupts
#define SchM_Exit_<ModulePrefix>_0     EnableAllInterrupts

#define SchM_Enter_<ModulePrefix>_1 \
    Can_DisableControllerInterrupts (CAN_CONTROLLER_0)
#define SchM_Exit_<ModulePrefix>_1 \
    Can_EnableControllerInterrupts (CAN_CONTROLLER_0)

#define SchM_Enter_<ModulePrefix>_2   GetResource (RESOURCE_2)
#define SchM_Exit_<ModulePrefix>_2  ReleaseResource (RESOURCE_2)
```

7.3 Error handling concept

7.3.1 Background

In general, the AUTOSAR Basic Software distinguishes between production errors and development errors (see [2]).

As explained above, the BSW Scheduler deals more with the integration of the AUTOSAR Basic Software than with being a 'real' BSW module. In this sense, the BSW Scheduler acts like a "façade" by hiding the embedding of BSW modules into a particular infrastructure. Therefore, the BSW Scheduler cannot report production errors but only development errors. Of course, the BSW modules integrated by the BSW Scheduler can report both production and development errors.

7.3.2 Error handling in the context of AUTOSAR OS/OSEK

Since the AUTOSAR OS (based on OSEK) is likely to provide the main infrastructure for the AUTOSAR Basic Software, its error-handling concept shall also serve for the following considerations. Unfortunately, the standard does not cleanly differentiate between production and development errors, but defines the subsequent types:

- fatal errors (of OSEK)
- protection errors (of AUTOSAR OS)
- application errors

7.3.2.1 Fatal errors

In case of fatal errors, the AUTOSAR/OSEK OS can no longer assume the correctness of its internal data and calls the centralized system shutdown via `ShutdownOS (StatusType error)`. `ShutdownOS` then calls the hook routine `ShutdownHook`, if configured, and the integrator is responsible to implement a 'proper' `ShutdownHook` (see [10] for further information)[4] for handling the errors.

Fatal errors are assumed production errors of the AUTOSAR OS.

7.3.2.2 Protection errors

In case of protection errors (timing or memory), the AUTOSAR OS provides the ability to react by the means of a `ProtectionHook`. The integrator needs to implement a 'proper' `ProtectionHook`.

Protection errors are assumed production errors by the OS.

[4] Please note that this is not a specification item for this specification because it refers to a likely but particular implementation of the BSW Scheduler.

7.3.2.3 Application errors

In case of application errors, the AUTOSAR/OSEK OS cannot execute the requested service correctly but assumes the correctness of its internal data.

In general, OSEK OS signals erroneous states by return values, whereas the standard defines standard and extended mode values. OSEK refers to the standard mode values as 'warnings' because they are no real signal errors. However, they signal the (potentially transient) status of an API request. AUTOSAR refers to this type of errors as *infrastructure errors*. In general, the 'extended mode values' correspond to development errors.

7.3.2.3.1 Development phase

OSEK supports the development process by means of hooks: `ErrorHook`, `PreTaskHook` and `PostTaskHook`. The integrator is responsible for the implementation of the hooks if configured. `PreTaskHook` and `PostTaskHook` are not integral part of production code.

7.3.2.3.2 Production phase

During the production phase, the BSW Scheduler only forwards *infrastructure errors* to the respective BSW modules via return values of type `SchM_ReturnType` (see INTEGR070). The BSW Scheduler does not cause production errors by itself.
If configured, `ErrorHook` is an integral part of the production code.

7.3.3 Error handling of the BSW Scheduler

7.3.3.1 Production errors

There are no production errors for the BSW Scheduler specified.

7.3.3.2 Development errors

INTEGR076: Development error values are of type uint8.

Type or error	*Relevance*	*Related error code*	*Value [hex]*
API service called with wrong parameter	Development	`SCHM_E_PARAM_CONFIG`	`0x01`

INTEGR085: A particular implementation of BSW Scheduler module may specify additional (implementation specific) development errors.

INTEGR077: The detection of development errors is configurable (*ON*/*OFF*) at precompile time.

The switch *SCHM_DEV_ERROR_DETECT* (see Chapter 10) shall activate or deactivate the detection of all development errors.

INTEGR080: The BSW Scheduler shall report detected development errors to the *Det_ReportError* service of the Development Error Tracer (DET).

INTEGR078: The switch *SCHM_DEV_ERROR_DETECT* shall also activate (ON) or deactivate (OFF) API parameter checking. Specification item INTEGR076 and Chapter 8 specify details.

8 API specification

8.1 Imported types

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

INTEGR098:

Header file	*Imported Type*
Std_Types.h	Std_VersionInfoType

8.2 Type definitions

8.2.1 SchM_ReturnType

INTEGR070:

Name:	SchM_ReturnType		
Type:	uint8		
Range:	SCHM_E_NOFUNC	0x05	Requested service has not the desired effect.
	SCHM_E_STATE	0x07	Requested service is already in use.
	SCHM_E_OK	0x00	No error occurred.
	SCHM_E_LIMIT	0x04	An internal limit has been exceeded.
Description:	The values of this BSW Scheduler specific status type are aligned to the values of the AUTOSAR OS status types.		

8.2.2 SchM_ConfigType

INTEGR083:

Name:	SchM_ConfigType	
Type:	Structure	
Range:	Implementation specific structure	Structure to hold the module's configuration set. The contents of this data structure are implementation specific.
Description:	Structure for the purpose of configuration.	

8.3 Function definitions

8.3.1 SchM_Init

INTEGR099:

Service name:	SchM_Init
Syntax:	void SchM_Init( )

Service ID[hex]:	0x00
Sync/Async:	Synchronous
Reentrancy:	Non Reentrant
Parameters (in):	None
Parameters (in-out):	None
Parameters (out):	None
Return value:	None
Description:	Function for initialization of the SchM module.

INTEGR023: The `SchM_Init` function shall allocate and initialize the resources to be used by the Scheduler Module. This function can also call OS services to trigger AUTOSAR OS 'Tasks'.

8.3.2 SchM_Deinit

INTEGR100:

Service name:	SchM_Deinit

Syntax:	`void SchM_Deinit(`
	
	`)`

Service ID[hex]:	0x01
Sync/Async:	Synchronous
Reentrancy:	Non Reentrant
Parameters (in):	None
Parameters (in-out):	None
Parameters (out):	None
Return value:	None
Description:	Function for de-initialization of the SchM module.

INTEGR027: The `SchM_Deinit` function shall finalize and free the resources used by the Scheduler Module.

8.3.3 SchM_GetVersionInfo

INTEGR101:

Service name:	SchM_GetVersionInfo	

Syntax:	`void SchM_GetVersionInfo(`
	`  Std_VersionInfoType* versioninfo`
	`)`	

Service ID[hex]:	0x02	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	None	
Parameters (in-out):	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.	

INTEGR030: The `SchM_GetVersionInfo` function shall return the version information of this module. The version information includes:

- Module Id
- Vendor Id
- Vendor specific version numbers (BSW00407).

INTEGR037: The parameter `versionInfo` of the `SchM_GetVersionInfo` function shall point to the memory location holding the version information of the module.

INTEGR031: The `SchM_GetVersionInfo` function shall be pre-compile time configurable `On/Off` by the configuration parameter `SCHM_VERSION_INFO_API`

Hint:
If source code for caller and callee of this function is available, this function should be realized as a macro. The macro should be defined in the modules header file.

8.3.4 SchM_Enter

INTEGR102:

Service name:	SchM_Enter_<ModulePrefix>	

Syntax:	`void SchM_Enter_<ModulePrefix>(`
	`  uint8 Instance,`
	`  uint8 ExclusiveArea`
	`)`	

Service ID[hex]:	0x03	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	Instance	Parameter for identifying a unique instance of the calling BSW module
	ExclusiveArea	Parameter for identify a unique internal resource of the BSW Module <ModulePrefix>
Parameters (in-out):	None	
Parameters (out):	None	
Return value:	None	
Description:	Invokes the SchM_Enter function to enter a module local exclusive area.	

INTEGR032: A BSW module <ModulePrefix> shall invoke the `SchM_Enter` function to enter a module local exclusive area (also known as critical section).

INTEGR033: The `SchM_Enter` function shall expect a valid configuration of system resources in terms of OS objects. The BSW Scheduler shall use the AUTOSAR OS by default.

INTEGR051: The parameter `Instance` of the function `SchM_Enter_<ModulePrefix>` shall identify a unique instance of the calling BSW module <ModulePrefix>.

INTEGR052: When calling the function `SchM_Enter_<ModulePrefix>`, a BSW module <ModulePrefix> can omit the parameter `Instance` in case there is only one instance of the BSW module <ModulePrefix> possible.

INTEGR053: The parameter `ExclusiveArea` of the function `SchM_Enter_<ModulePrefix>` shall identify a unique internal resource of the BSW Module <ModulePrefix>.

Note:
The configuration of the service `SchM_Enter` depends on the implementation of the BSW Scheduler Module. Because the implementation of the BSW Scheduler module belongs to the ECU integrators tasks, the implementation is mainly project specific.

8.3.5 SchM_Exit

INTEGR103:

Service name:	SchM_Exit_<ModulePrefix>	

Syntax:	`void SchM_Exit_<ModulePrefix>(`
	`  uint8 Instance,`
	`  uint8 ExclusiveArea`
	`)`	

Service ID[hex]:	0x04	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	Instance	Parameter for identifying a unique instance of the calling BSW module
	ExclusiveArea	Parameter for identifying a unique internal resource of the BSW Module to be protected
Parameters (in-out):	None	
Parameters (out):	None	
Return value:	None	
Description:	Invokes the SchM_Exit function to exit an exclusive area.	

INTEGR035: A BSW module shall invoke the `SchM_Exit` function to exit an exclusive area (also known as critical section).

INTEGR036: The `SchM_Exit` function shall expect a valid configuration of system resources in terms of OS objects. The BSW Scheduler shall use the AUTOSAR OS by default.

INTEGR054: The parameter `Instance` of the `SchM_Exit_<ModulePrefix>` function shall identify a unique instance of the calling BSW module <ModulePrefix>.

INTEGR056: When calling the function `SchM_Exit_<ModulePrefix>`, a BSW module <ModulePrefix> can omit the parameter `Instance` in case there is only one instance of the BSW module <ModulePrefix> possible.

INTEGR055: The parameter `ExclusiveArea` of the `SchM_Exit_<ModulePrefix>` function shall identify a unique internal resource of the BSW Module <ModulePrefix> to be protected.

Note:
The configuration of the function `SchM_Exit` depends on the implementation of the BSW Scheduler Module. Because the implementation of the BSW Scheduler module belongs to the ECU integrators tasks, the implementation is mainly project specific.

8.3.6 SchM_ActMainFunction

INTEGR104:

Service name:	SchM_ActMainFunction_<ModulePrefix>	
Syntax:	`SchM_ReturnType SchM_ActMainFunction_<ModulePrefix>( uint8 Instance, uint8 ActivationPoint )`	
Service ID[hex]:	0x05	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	Instance	Parameter for identifying a unique instance of the calling BSW module
	ActivationPoint	Parameter for identifying the unique execution point which invokes SchM_ActMainFunction_<ModulePrefix>
Parameters (inout):	None	
Parameters (out):	None	
Return value:	SchM_ReturnType	SCHM_E_OK: No error occurred. SCHM_E_LIMIT: To many task activation (of the task context of the main processing function) SCHM_E_STATE: ActivationPoint is already in use.
Description:	Invokes the SchM_ActMainFunction function to trigger the activation of a corresponding main processing function.	

INTEGR039: A BSW module implementation shall invoke the `SchM_ActMainFunction` function to trigger the activation of a corresponding main processing function.

INTEGR064: The `SchM_ActMainFunction` function shall expect a valid configuration of system resources in terms of OS objects. The BSW Scheduler shall use the AUTOSAR OS by default.

INTEGR057: The parameter `Instance` of the `SchM_ActMainFunction_<ModulePrefix>` function shall identify a unique instance of the calling BSW module <ModulePrefix>.

INTEGR058: When calling the function `SchM_ActMainFunction_<ModulePrefix>`, a BSW module can omit the parameter `Instance` in case there is only one instance of the BSW module <ModulePrefix> possible.

INTEGR061: The parameter `ActivationPoint` of the function `SchM_ActMainFunction_<ModulePrefix>` shall identify the unique execution point which invokes `SchM_ActMainFunction_<ModulePrefix>`.

The BSW Module Description shall bind the `ActivationPoint` to a *BswSporadicEvent* containing the attribute:

- the minimum delay time (given in time units, ticks …) until activation of a main processing function

A *BswSporadicEvent* is then able to activate a main processing function.

Note:
The configuration of the service `SchM_ActMainFunction` depends on the implementation of the BSW Scheduler Module. Because the implementation of the BSW Scheduler module belongs to the ECU integrators tasks, the implementation is mainly project specific.

8.3.7 SchM_CancelMainFunction

INTEGR105:

Service name:	SchM_CancelMainFunction_<ModulePrefix>	

Syntax:	`SchM_ReturnType SchM_CancelMainFunction_<ModulePrefix>(`
	`  uint8 Instance,`
	`  uint8 ActivationPoint`
	`)`	

Service ID[hex]:	0x06	
Sync/Async:	Synchronous	
Reentrancy:	Non Reentrant	
Parameters (in):	Instance	Parameter for identifying a unique instance of the calling BSW module
	ActivationPoint	Parameter refering to the corresponding ActivationPoint of SchM_ActMainFunction_<ModulePrefix> to be canceled
Parameters (in-out):	None	
Parameters (out):	None	
Return value:	SchM_ReturnType	SCHM_E_OK: No error occurred. SCHM_E_NOFUNC : Currently, there is no activation of a main processing function for the given ActivationPoint pending.
Description:	Invokes the SchM_CancelMainFunction function to trigger the cancellation of the requested activation of a corresponding main processing function.	

INTEGR044: A BSW module shall invoke the `SchM_CancelMainFunction` function to trigger the cancellation of the requested activation of a corresponding main processing function.

INTEGR063: The `SchM_CancelMainFunction` function shall have no effect on an ActivationPoint where the content of the 'delay attribute' is zero (0 time units, ticks …), at all. In this case, the service shall return with value `SCHM_E_NOFUNC`.

INTEGR066: The `SchM_CancelMainFunction` function shall expect a valid configuration of system resources in terms of OS objects. The BSW Scheduler shall use the AUTOSAR OS by default.

INTEGR059: The parameter `Instance` of the function `SchM_CancelMainFunction_<ModulePrefix>` shall identify a unique instance of the calling BSW module <ModulePrefix>.

INTEGR060: When calling the function `SchM_CancelMainFunction_<ModulePrefix>`, a BSW module can omit the parameter `Instance` in case there is only one instance of the BSW module <ModulePrefix> possible.

INTEGR062: The parameter `ActivationPoint` of the function `SchM_CancelMainFunction_<ModulePrefix>` shall refer to the corresponding `ActivationPoint` of `SchM_ActMainFunction_<ModulePrefix>` to be canceled.

Note:
The configuration of the service `SchM_CancelMainFunction` depends on the implementation of the BSW Scheduler Module. Because the implementation of the BSW Scheduler module belongs to the ECU integrators tasks, the implementation is mainly project specific.

8.4 Call-back notifications

Not applicable

8.5 Scheduled functions

Not applicable

8.6 Expected Interfaces

This chapter lists all interfaces required from other modules.

8.6.1 Mandatory Interfaces

This chapter defines all interfaces which are required to fulfill the core functionality of the module.

INTEGR106:

API function	*Module*	*Description*
<ModulePrefix>_MainFunction_<…>	all	The BSW Scheduler Module needs to access all main processing functions of all modules. The BSW Scheduler Module implements or triggers their invocation.

8.6.2 Optional Interfaces

This chapter defines all interfaces which are required to fulfill an optional functionality of the module.

INTEGR107:

API function	*Description*
Det_ReportError	Service to report development errors.

8.6.3 Configurable interfaces

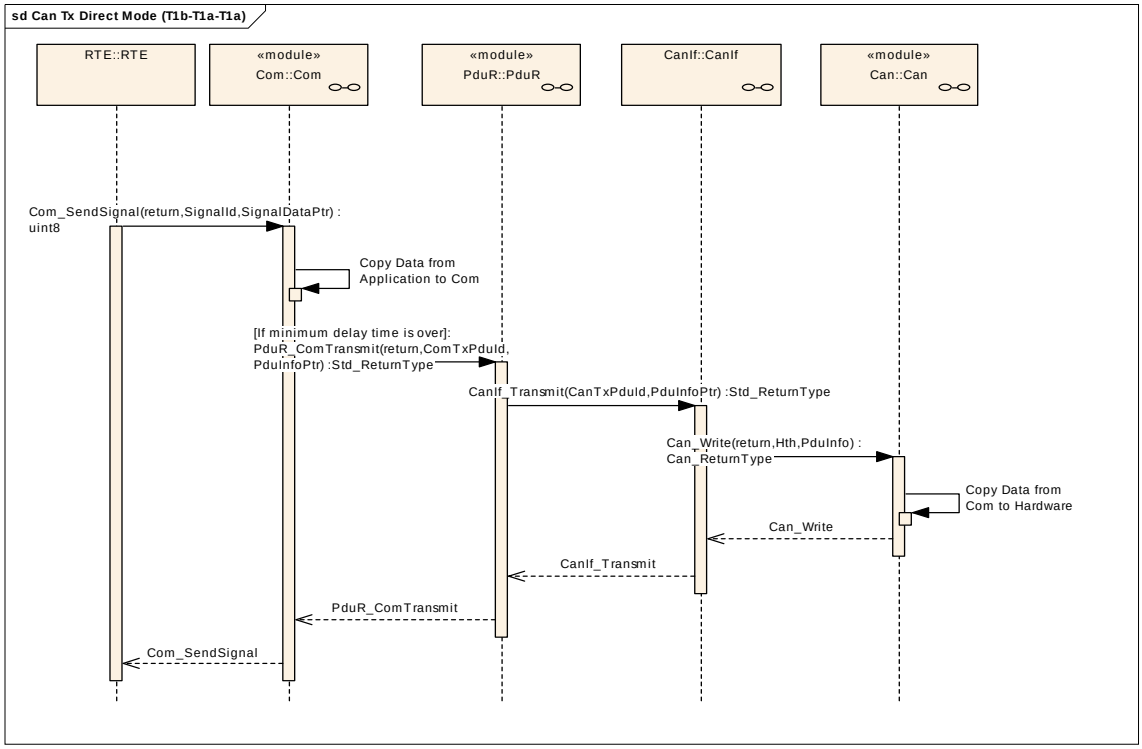
This chapter lists all interfaces, which are potentially configurable. This is usually a callback function whereas the name is configurable.

Not applicable

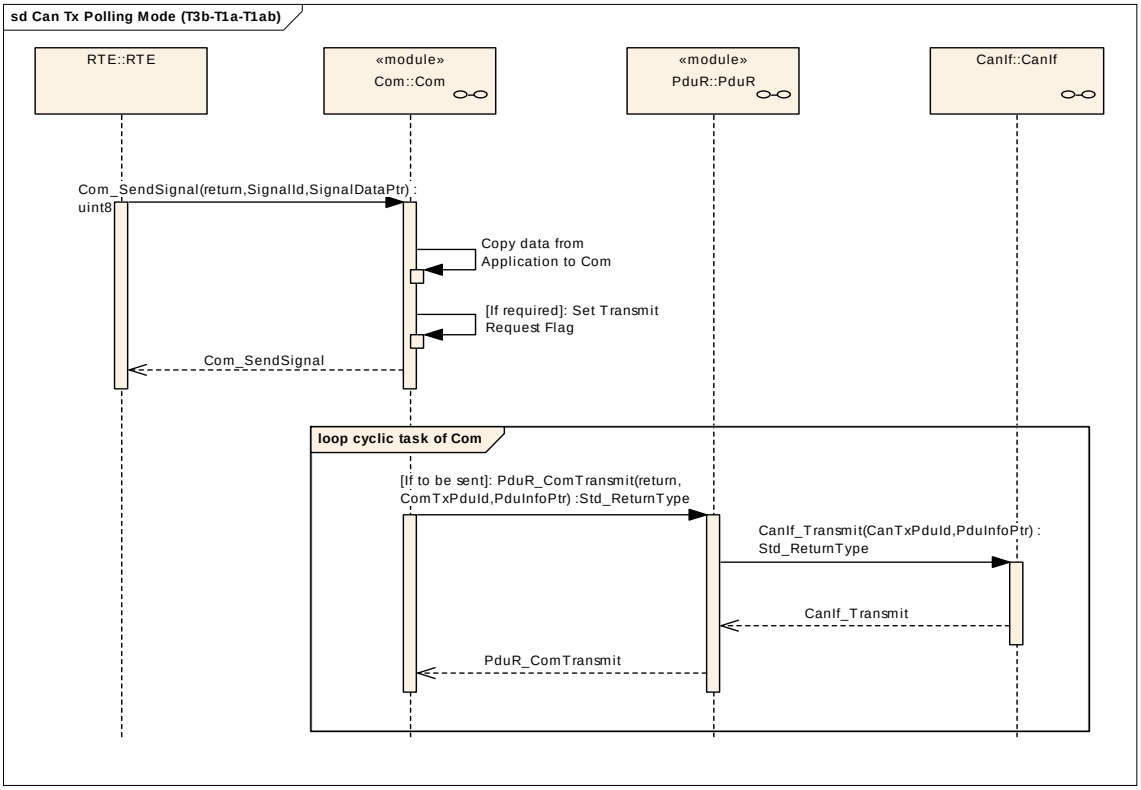
9 Sequence diagrams

With respect to data consistency, this section contains two sequence diagrams: One sequence diagram as an example for a globally accessible resource and one sequence diagram as an example for a locally accessible resource.

Example: Globally accessible buffer:



Example: Locally accessible buffer:



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 module Scheduler Module.

Chapter 10.3 specifies published information of the module Scheduler Module.

10.1 How to read this chapter

In addition to this section, it is highly recommended to read the documents:

- AUTOSAR Layered Software [2]
- AUTOSAR ECU Configuration Specification [6]
  This document describes the AUTOSAR configuration methodology and the AUTOSAR configuration meta-model in detail.

The following is only a short survey of the topic and it will not replace the ECU Configuration Specification document.

10.1.1 Configuration and configuration parameters

Configuration parameters define the variability of the generic part(s) of an implementation of a module. This means that only generic or configurable module implementation can be adapted to the environment (software/hardware) in use during system and/or ECU configuration.

The configuration of parameters can be achieved at different times during the software process: before compile time, before link time or after build time. In the following, the term “configuration class” (of a parameter) shall be used in order to refer to a specific configuration point in time.

10.1.2 Variants

Variants describe sets of configuration parameters. E.g., variant 1: only pre-compile time configuration parameters; variant 2: mix of pre-compile- and post build time-configuration parameters. In one variant a parameter can only be of one configuration class.

10.1.3 Containers

Containers structure the set of configuration parameters. This means:

- *all* configuration parameters are kept in containers.
- (sub-) containers can reference (sub-) containers. It is possible to assign a multiplicity to these references. The multiplicity then defines the possible number of instances of the contained parameters.

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.

10.2.1 Variants

INTEGR108: Variant 1: This variant only allows pre-compile time parameters.
Variant 2: none
Variant 3: none

10.2.2 SchM

Module Name	**SchM**
Module Description	Configuration of the SchM (BSW Scheduler) module.

Included Containers		
Container Name	***Multiplicity***	***Scope / Dependency***
SchMGeneral	1	General configuration parameters of the SchM.
SchMMainFunctionMapping	1..*	Maps a MainFunction onto one OS Task.
SchMModuleConfiguration	0..*	Contains module specific configuration items.

10.2.3 SchMGeneral

SWS Item	**INTEGR067 :**
Container Name	SchMGeneral
Description	General configuration parameters of the SchM.
Configuration Parameters	

SWS Item	**--**		
Name	SchMDevErrorDetect {SCHM_DEV_ERROR_DETECT}		
Description	Switches the Development Error Detection and Notification ON or OFF.		
Multiplicity	1		
Type	BooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

SWS Item	**--**		
Name	SchMVersionInfoApi {SCHM_VERSION_INFO_API}		
Description	Switches the service SchM_GetVersionInfo ON or OFF.		
Multiplicity	1		
Type	BooleanParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	

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

No Included Containers

10.2.4 SchMMainFunctionMapping

SWS Item	**INTEGR068 :**
Container Name	SchMMainFunctionMapping{MainFunctionMapping}
Description	Maps a MainFunction onto one OS Task.
Configuration Parameters	

SWS Item	**--**		
Name	SchMPositionInTask {SCHM_POSITION_IN_TASK}		
Description	The parameter depicts the specific Position of the MainFunction within the OS Task. Note: The dependencies between the main processing functions mapped to the same task have been resolved by the configuration (process) beforehand. The result of this resolution is the order of the main processing functions within this task.		
Multiplicity	1		
Type	IntegerParamDef		
Range	0 .. 255		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: ECU		

SWS Item	**--**		
Name	SchMMainFunctionRef {SCHM_MAINFUNCTION_REF}		
Description	The parameter depicts the reference to the MainFunction.		
Multiplicity	1		
Type	Foreign reference to BswSchedulableEntity		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: Module		

SWS Item	**--**		
Name	SchMMappedToTask {SCHM_MAPPED_TO_TASK}		
Description	The parameter depicts the reference to the OS Task the MainFunction is mapped to. Note: The AUTOSAR OS Task has already been available and is configured. Therefore, the configuration attributes of the task do not need to mention again.		
Multiplicity	1		
Type	Reference to OsTask		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: ECU		

Included Containers		
Container Name	***Multiplicity***	***Scope / Dependency***

SchMScheduleTableMapping	0..*	Assigns a MainFunction to a OS Schedule Table

10.2.5 SchMScheduleTableMapping

SWS Item	**INTEGR095 :**
Container Name	SchMScheduleTableMapping{ScheduleTableMapping}
Description	Assigns a MainFunction to a OS Schedule Table
Configuration Parameters	

SWS Item	**--**		
Name	SchMScheduletableRef {SCHM_SCHEDULETABLE_REF}		
Description	The parameter depicts the reference to the OS SchedulaTable the Main-Function is mapped to.		
Multiplicity	1		
Type	Reference to OsScheduleTable		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency			

No Included Containers

10.2.6 SchMModuleConfiguration

SWS Item	**INTEGR087 :**
Container Name	SchMModuleConfiguration{ModuleConfiguration}
Description	Contains module specific configuration items.
Configuration Parameters	

SWS Item	**--**		
Name	SchMModuleLiteral {SCHM_MODULE_LITERAL}		
Description	The parameter depicts a symbolic name (a literal) for the unambigous identification of a BSW module; in fact it is the <ModulePrefix> specified for each BSW module in the Basic Software Module List.		
Multiplicity	1		
Type	StringParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: BSW		

Included Containers		
Container Name	***Multiplicity***	***Scope / Dependency***
InstanceConfiguration	1..*	Contains instance specific configuration items. One instance of this container for each instance of the module.

10.2.7 InstanceConfiguration

SWS Item	**INTEGR088 :**

Container Name	InstanceConfiguration{InstanceConfiguration}
Description	Contains instance specific configuration items. One instance of this container for each instance of the module.
Configuration Parameters	

SWS Item	**--**		
Name	SchMInstanceId {SCHM_INSTANCE_ID}		
Description	The parameter depicts a value for the unambigous identification of a BSW module instance.		
Multiplicity	1		
Type	IntegerParamDef		
Range	0 .. 255		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: BSW dependency: SchMInstanceLiteral		

SWS Item	**--**		
Name	SchMInstanceLiteral {SCHM_INSTANCE_LITERAL}		
Description	The parameter depicts a symbolic name for the unambigous identification of a BSW module instance.		
Multiplicity	1		
Type	StringParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: BSW dependency: SchMInstanceId		

Included Containers		
Container Name	***Multiplicity***	***Scope / Dependency***
ActivationPointConf	0..*	Contains configuration items of ActivationPoints in the context of a BSW module.
CancelationPointConf	0..*	Contains configuration items of CancelationPoints in the context of a BSW module.
ExclusiveAreaConf	0..*	Contains configuration items of critical sections (ExclusiveArea) in the context of a BSW module.
SporadicEventConf	0..*	Contains configuration items of SporadicEvents.

10.2.8 ExclusiveAreaConf

SWS Item	**INTEGR086 :**
Container Name	ExclusiveAreaConf{ExclusiveAreaConfiguration}
Description	Contains configuration items of critical sections (ExclusiveArea) in the context of a BSW module.
Configuration Parameters	

SWS Item	**--**
Name	SchMExclusiveAreaId {SCHM_EXCLUSIVE_AREA_ID}
Description	The parameter depicts a value for the unambigous identification of an ExclusiveArea.

Multiplicity	1		
Type	IntegerParamDef		
Range	0 .. 255		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: BSW dependency: SchMExclusiveAreaLiteral		

SWS Item	**--**		
Name	SchMExclusiveAreaLiteral {SCHM_EXCLUSIVE_AREA_LITERAL}		
Description	The parameter depicts a symbolic name for the unambigous identification of an ExclusiveArea.		
Multiplicity	1		
Type	StringParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: SchMExclusiveAreaId		

No Included Containers

10.2.9 ActivationPointConf

SWS Item	**INTEGR089 :**
Container Name	ActivationPointConf{ActivationPointConfiguration}
Description	Contains configuration items of ActivationPoints in the context of a BSW module.
Configuration Parameters	

SWS Item	**--**		
Name	SchMActivationId {SCHM_ACTIVATION_ID}		
Description	The parameter depicts a value for the unambigous identification of an ActivationPoint.		
Multiplicity	1		
Type	IntegerParamDef		
Range	0 .. 255		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: BSW dependency: SchMActivationLiteral		

SWS Item	**--**		
Name	SchMActivationLiteral {SCHM_ACTIVATION_LITERAL}		
Description	The parameter depicts a symbolic name for the unambigous identification of an ActivationPoint.		
Multiplicity	1		
Type	StringParamDef		
Default value	--		

ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: BSW dependency: SchMActivationId		

No Included Containers

10.2.10 CancelationPointConf

SWS Item	**INTEGR090 :**
Container Name	CancelationPointConf{CancelationPointConfiguration}
Description	Contains configuration items of CancelationPoints in the context of a BSW module.
Configuration Parameters	

SWS Item	**--**		
Name	SchMCancelationId {SCHM_CANCELATION_ID}		
Description	The parameter depicts a value for the unambigous identification of an CancelationPoint.		
Multiplicity	1		
Type	IntegerParamDef		
Range	0 .. 255		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: BSW dependency: SchMCancelationLiteral		

SWS Item	**--**		
Name	SchMCancelationLiteral {SCHM_CANCELATION_LITERAL}		
Description	The parameter depicts a symbolic name for the unambigous identification of a CancelationPoint.		
Multiplicity	1		
Type	StringParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: BSW dependency: SchMCancelationId		

No Included Containers

10.2.11 SporadicEventConf

SWS Item	**INTEGR069 :**
Container Name	SporadicEventConf{SporadicEventConfiguration}
Description	Contains configuration items of SporadicEvents.
Configuration Parameters	

SWS Item	**--**		
Name	DelayTime {DELAY_TIME}		
Description	The parameter depicts the minimum delay time in seconds until a main processing functions shall be activated. This configuration parameter is an input for integration. It represents the base for the real, implementation specific values.		
Multiplicity	1		
Type	FloatParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: BSW		

SWS Item	**--**		
Name	SchMSporadicLiteral {SCHM_SPORADIC_LITERAL}		
Description	The parameter depicts a symbolic name dfor the unambiguous identification of a sporadiv event.		
Multiplicity	1		
Type	StringParamDef		
Default value	--		
ConfigurationClass	***Pre-compile time***	X	All Variants
	Link time	--	
	Post-build time	--	
Scope / Dependency	scope: BSW		

No Included Containers

10.3 Published Information

Published information contains data defined by the implementer of the SW module that does not change when the module is adapted (i.e. configured) to the actual HW/SW environment. It thus contains version and manufacturer information.

The standard common published information like

vendorId (<Module>_VENDOR_ID),
moduleId (<Module>_MODULE_ID),
arMajorVersion (<Module>_AR_MAJOR_VERSION),
arMinorVersion (<Module>_ AR_MINOR_VERSION),
arPatchVersion (<Module>_ AR_PATCH_VERSION),
swMajorVersion (<Module>_SW_MAJOR_VERSION),
swMinorVersion (<Module>_ SW_MINOR_VERSION),
swPatchVersion (<Module>_ SW_PATCH_VERSION),
vendorApiInfix (<Module>_VENDOR_API_INFIX)

is provided in the BSW Module Description Template (see [9] Figure 4.1 and Figure 7.1).

Additional published parameters are listed below if applicable for this module.

11 Changes to Release 3.0

11.1 Deleted SWS Items

SWS Item	*Rationale*
INTEGR006	ID removed only because requirement is on this specification
INTEGR025	Requirement is on EcuM, not on SchM

11.2 Replaced SWS Items

SWS Item of Release 1	*replaced by SWS Item*	*Rationale*
INTEGR013	INTEGR096, INTEGR097	Atomization of requirement

11.3 Changed SWS Items

SWS Item	*Rationale*
INTEGR017	Assumption moved to body text

11.4 Added SWS Items

SWS Item	*Rationale*

12 Changes during SWS Improvements by Technical Office

12.1 Deleted SWS Items

None

12.2 Replaced SWS Items

None

12.3 Changed SWS Items

None

12.4 Added SWS Items

SWS Item	*Rationale*
INTEGR098	UML model linking of imported types
INTEGR099	UML model linking of SchM_Init
INTEGR100	UML model linking of SchM_Deinit
INTEGR101	UML model linking of SchM_GetVersionInfo
INTEGR102	UML model linking of SchM_Enter_<ModulePrefix>
INTEGR103	UML model linking of SchM_Exit_<ModulePrefix>
INTEGR104	UML model linking of SchM_ActMainFunction_<ModulePrefix>
INTEGR105	UML model linking of SchM_CancelMainFunction_<ModulePrefix>
INTEGR106	UML model linking of Mandatory Interfaces
INTEGR107	UML model linking of Optional Interfaces
INTEGR108	Definition of configuration variant needs an ID