

MicroSFSC

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# Chapter 1

## MicroSFSC

The [Shop-Floor Service Connector \(SFSC\)](#) is an easy-to-use, service-orientated communication framework for [Industry 4.0](#), developed at the [University of Stuttgart](#). MircoSFSC is a micro-controller ready implementation of the SFSC adapter role. This documentation provides a quick overview about the usage and the features of the MicroSFSC framework, whereas an in deep analysis can be found in this [white-paper](#) (German). This README presumes that you are familiar with SFSC and its concepts like adapters, cores, services (i.e. server services and publisher services), subscriptions, requests, the service registry, etc.

This implementation is written in C and [conforms the C99 freestanding standard](#). If your compiler only supports ANSI-C, some platform depended adjustments are required.

The RAM and ROM footprint is configuration depended; in default configuration 25kB ROM and about 7-11kB RAM are needed. A configuration for your specific use-case will most likely result in lower resource requirements.

This framework does not use dynamic memory allocation.

### 1.1 Repository structure

[This repository](#) is structured the following way:

- The **src/sfsc** folder contains the actual source code you should copy into your project.
- The **src/platforms** folder contains implementations for the platform dependencies for some platforms. Platform dependencies are explained in the next section.
- The **docs** folder contains a doxygen html documentation of the public header. It can be accessed via [github pages](#). Also, the **docs** folder contains latex code and the complete documentation as [PDF](#).
- The **src/examples/scenarios** folder contains the actual examples. Every example comes with its own pre-processor directive that must be defined to enable that example. Only one of the examples should be active at the same time. Where to define the directives is up to the used build system. The **src/examples/shared** folder contains shared example code for the platforms, most notably a common API to log things. The other subfolders of the **src/examples** folder contain the initialization logic and example build instructions to get the examples running on the corresponding platform. A good starting point for the examples is the pubsub example, then you can study the a bit more complex reqrepack example and finally the query example.

## 1.2 Porting to your platform

The **sfsc/platform** folder contains headers you have edit or implement for your platform if you want to use this framework. There are some existing platform ports in the **platforms** folder in the root of this repository. For example, there are implementations for POSIX (and Windows with MinGW) systems and the ESP32 microcontroller family. This framework does not contain an IP stack, so you need to provide one (most network ready platforms will already include one). Below are some more information on the headers you need to look at.

### 1.2.1 sfsc\_types.h

`sfsc_types.h` contains declarations of different datatypes. If your platform provides `stdint.h` and `stdbool.h` (like all conforming freestanding C99 environments should), there is no need to edit this file. The other needed header files are from the ANSI-C (C90) standard.

### 1.2.2 sfsc\_strings.h

This framework needs some functions from the `strings.h` header (namely `memcpy`, `memset` and `strlen`), which is not part of any freestanding C standard. Many platforms will provide it anyway, and if you platform does, make sure to define `HAS_STRING_H` in `sfsc_adapter_cofig.h` (more about configuration can be read below). If this define is missing, the framework will fall back to self-provided, but not as efficient implementations of these functions.

### 1.2.3 sfsc\_platform.h

This header provides four functions you need to implement. They should behave as their function documentation demands, some important additional details are given here:

- `time_ms` is used for timing and must return some means of the current time, in millisecond resolution. It is not necessary (but allowed) to provide the absolute unix time, a relative value to indicate time since the system start (or even first call of the `time_ms` function) is sufficient.
- `random_bytes` needs to generate the requested amount of random bytes and write them to the specified buffer. These bytes are not used for cryptographically functions, so it's ok for them to be pseudo-random. On the other hand, it is very important that the generated byte sequences are different on each system start! If your platform does not provide such a mechanism you have to do this yourself: You can use a pseudo-random generator algorithms seeded with some random sensor noise (read more on the [von Neumann whitening algorithm](#)) or the absolute unix time (if you can access it). An other approach is to store the last generated bytes in persistent memory (EEPROM), and seed your pseudo-random algorithm with them on system start. If you use this framework on multiple microcontrollers simultaneously, the generated random sequences must not be the same, too!
- The `lock` and `unlock` functions are only needed for multi-threading, if you don't use multi-threading you can provide empty implementations of these functions. If you use multi-threading you have to ensure that only one thread is accessing a socket for writing at the same time. This should be no problem, since the most kernels and operating systems (which most likely provide the multi-threading in the first place) provide synchronization mechanisms. The framework will call you with an address to an `uint_8`. The address identifies the socket that should be locked/unlocked for access through other threads (you can treat the address like a numerical handle). The `uint_8t` is a single byte you can freely use as memory if needed (e.g. to store locking information).



### 1.2.4 sfsc\_sockets.h

SFSC adapters communicate with SFSC cores using TCP/IP, and you need a to provide functions to establish this connection. The framework does not contain a own network-stack, since if your platform is IP-ready, it will most likely feature a platform optimized implementation. The API demanded by this framework is based on the POSIX Socket API (also known as BSD Socket), with the extension that most functions need to operate in a non-blocking way. Examples for providing this functions can be found in the **platforms** folder.

### 1.2.5 Protobuf

This framework uses NanoPB v0.4.2 for protobuf serialization/deserialization. It is configured to not use dynamic memory allocation, and is pointed towards `sfsc_strings.h` instead of the normal `strings.h`. NanoPB also depends on `stdbool.h`, `stdint.h`, `stddef.h`, and `limits.h` in its `pb.h`. If your compiler does not conform the freestanding C99 standard, you might need to edit the `pb.h` header. For more information on NanoPB see [it's official page](#).

## 1.3 The Execution model

The framework needs some background tasks to be handled. But it does not include any concept of threading (since your platform might already have a concept, or is not powerful enough to have such a concept). Instead, it is your responsibility to call the background tasks in a cyclic manor. There are two main tasks you need to call: The system task and the user task. Both tasks are designed to be non-blocking, but for the user task, there are some restrictions.

### 1.3.1 System Task

The system task handles connection setup and heartbeating. It will also read the network using your `sfsc_socket.h` implementation. It is important that the system task is called with a high enough frequency, or it will fail to send heartbeats to the core in time. If this happens, the core will treat the corresponding adapter as disconnected. As a guideline, try to call the system task at least once every 5ms. The system tasks runtime is designed to be constant, which is achieved by only using non-blocking operations. As a consequence, the system task does not invoke your callbacks, as the framework can not know, what you are doing in your callbacks. So, instead of executing callbacks based on the data the system task receives from the network, it writes the data to an intermediate ring buffer, called the user ring.

### 1.3.2 User Task

Among other things, the user task will then go ahead and read data from the user ring, and based on them, invoke callbacks you defined during an API call. Since the user task directly executes your callbacks, what you do in them will influence the runtime of the user task. Reading one entry of data from the user ring and invoking a callback is called a micro step. How many micro steps should be taken in a single call to the user task function can be configured (using `REPLAYS_PER_TASK`). The data supplied as parameters to your callbacks are only valid during the current micro step, meaning that after your callback returns, the data will be removed from the user ring and you should no longer try to access them. If you need the data from the callback outside the callback, you have two options:

1. Simply copy the data somewhere else. This is the easiest and safest way, but requires additional memory.
2. If you can not afford to copy the data, you can enter the *user task pause state*. In the user task pause state, the user task won't advance to the next micro step after your callback returns. You will need to leave the pause state explicitly by calling a function. Keep in mind, that as long as you are in the pause state, no further callbacks will be invoked (exceptions are listed below). Note that even while you are currently in the pause state, you still must ensure that the system and user task functions are called (since as noted above, the user tasks needs to do other things then taking micro steps, too)!

### 1.3.2.1 Exceptions to the user task pause state

The pause state actually only affects messages that are stored in the user ring. Some callbacks that are triggered by the user task are not subject to data from the user ring: The user ring is used to transport data of variable length from the system task to the user task. To transport data of known length, like a single numerical value or even a bitflag, it is more appropriate to use strongly typed struct fields. The following callbacks are not affected by the user task pause state:

- `command_callback` from `register_publisher`, `unregister_publisher`, `register_server`, `unregister_server`
- `on_subscription_change` callbacks of a `sfsc_publisher` struct
- `on_ack` callbacks from `answer_request` and `answer_channel_request`,
- `on_answer` callbacks from `request` and `channel_request`, both ONLY in the timeout case, the data case is subject to the user ring
- `on_service` callbacks `query_services`

Think of the following scenario to see that this behavior (of some things continue running) is actually beneficial (this scenario seems a little out-of-the-sky for now, but as you start getting familiar with the framework, something similar will most likely come to your mind):

1. You provide a non-fire-and-forget (meaning that your answers must be acknowledged by the requestor) server service
2. You receive a request and the servers `on_request` callback is triggered
3. You make an answer call using `answer_request`, which requires the `reply_topic` parameter from the `on_request` callback
4. According to the documentation, the `reply_topic` must be valid until the `on_ack` callback is triggered BUT the parameters of the `on_request` callback (i.e. `reply_topic`) are subject to the user ring and thus only valid during the current `on_request` call UNLESS you decide to pause the user task, what you then do by setting `*b_auto_advance=0` and thus using option 2 (see above)
5. Since `on_ack` callbacks are still triggered in the user task pause state, `on_ack` will eventually be triggered and you can leave the pause state from there

### 1.3.3 Blocking the User Task

An other important question is: Am I allowed to perform a blocking or long taking operation in a callback? As stated above, system and user task are designed to be non-blocking. Consider the following code snippet:

```
// Note that this code is not runnable since it ignores multiple return values of functions that indicate
// the operability of the adapter
sfsc_adapter adapter;
start_session_bootstrapped(&adapter, host, PORT);
while(1){ //global execution loop
    system_task(&adapter);
    user_task(&adapter);
}
```

So if your callback now blocks execution, the user task will also block, and therefore, the whole program is blocked, preventing the system task from running. An approach to move the blocking code out of the callback will lead to this:

```
sfsc_adapter adapter;
start_session_bootstrapped(&adapter, host, PORT);
while(1){ //global execution loop
    system_task(&adapter);
    user_task(&adapter);
    blocking_user_code();
}
```

```
}

```

This is obviously not better than the first approach, since it will also prevent `system_task` from being called. You can try to design your function in the system and user tasks manor and split your long taking operation in multiple substeps and use only non-blocking functions yourself. Then, each invocation of your function it will execute only a tiny step of your overall goal. This will result in the following, valid approach:

```
sfsc_adapter adapter;
start_session_bootstrapped(&adapter, host, PORT);
int step_number=0;
while(1){ //global execution loop
    system_task(&adapter);
    user_task(&adapter);
    non_blocking_user_code(step_number);
    step_number++;
}
```

So to conclude, if your system task and user task run in the same thread, callbacks and other things you do in your global execution loop should not block.

### 1.3.4 Multi-threading

If you decide to use multi-threading you can set up the system and the user task as different threads. Then, blocking the user task won't interfere with the execution of the system task and is thus allowed. This framework does not include a scheduler, so you have to use your own threading solution. Keep in mind that if you use the a multi-threaded execution model, you might have to add some synchronization (see the *sfsc\_platform.h* section above).

### 1.3.5 Message drop

Since the system task writes data to the user ring, and the user tasks takes data from the user ring, it can happen that the user ring gets filled faster than it is emptied (especially if the user task is paused for too long!). In this case, newly received data are dropped (according to the [ZMTP PUBSUB specification](#) on which SFSC is based).

### 1.3.6 Further reading

For an in deep discussion and reasoning why this execution model is used, see the white-paper, chapter 4.9.

## 1.4 Configuration

There are several configuration options to adjust the MircoSFSC framework. They can be found in *sfsc\_adapter\_config.h* and *zmtp\_config.h* and will influence the RAM (and some even ROM) consumption of a *sfsc\_adapter* struct. The table below list the configuration options, where they can be found, what they are for, and how they change memory consumption. Also, the default values (either a numerical value, or whether the option is defined or not) are listed. Note that all memory sizes are only guide values, the actual values will depend on your platform (e.g. on the pointer size or your memory alignment rules). A xN (where N is a number) in the memory column means that the configured value times N bytes of memory is needed.

Parameter Name	Header	Default	Memory Impact	Description
REPLAYS_PER_TASK↔	sfsc↔ adapter↔ config.h	0	-	The maximum number of micro steps that should be taken per user_task function invocation, 0 for as many as possible. Example: If there are 6 items in the user ring, and REPLAYS_PER_TASK is set to 4, only the first 4 of them will be processed in this user_task call, the next 2 have to wait until the next user_task call.
HEARTBEAT_SEND_RATE_MS↔	sfsc↔ adapter↔ config.h	400	-	The time to wait between sending outgoing heartbeats in milliseconds.
HEARTBEAT_DEADLINE_OUTGOING_MS↔	sfsc↔ adapter↔ config.h	HEARTBEAT_SEND_RATE_MS * 4	-	If it was not possible to send at least one heartbeat in this time (denoted in milliseconds) - most likely due to the system_task function not being called frequent enough - an error will be raised.
HEARTBEAT_DEADLINE_INCOMING_MS↔	sfsc↔ adapter↔ config.h	4000	-	The amount of time in milliseconds in which a heartbeat from the core needs to arrive. If there is no heartbeat in this amount of time, the SFSC session will be treated as terminated.
HAS_STRING_H	sfsc↔ adapter↔ config.h	defined	a few bytes of ROM if NOT set	Should be defined if your platform has a memcpy, memset and strlen function. If not defined, inefficient fallback implementations of this functions will be used.

Parameter Name	Header	Default	Memory Impact	Description
MAX_ PUBLISHERS	sfsc_ adapter_ config.h	6	x4 RAM	Amount of publisher services, a single adapter can operate at the same time. See the register_ _publisher function documentation for more information.
MAX_ SUBSCRIBERS	sfsc_ adapter_ config.h	12	x4 RAM	Amount of subscriptions to publisher services, a single adapter can operate at the same time. See the register_ _subscriber function documentation for more information.
MAX_PENDING_ _ACKS	sfsc_ adapter_ config.h	6	x48 RAM	Amount of pending acknowledges to transmitted server-service-answers a single adapter can keep track of at the same time. See the answer_ request function documentation for more information.
MAX_SERVERS	sfsc_ adapter_ config.h	6	x4 RAM	Amount of server services, a single adapter can operate at the same time. See the register_ server function documentation for more information.

Parameter Name	Header	Default	Memory Impact	Description
MAX_ SIMULTANIOUS_ _COMMANDS	sfsc_ adapter_ config.h	6	x24 RAM	Amount of commands (used for creating or deleting something from a SFSC cores service registry) a single adapter can issue at the same time. Needed in the register_ _publisher, register_ _server and unregister_ _publisher, unregister_ server functions, see there for more information.
MAX_ SIMULTANIOUS_ _REQUESTS	sfsc_ adapter_ config.h	6	x40 RAM	Amount pending (not-yet answered) requests a single adapter can make at the same time. See the request function for more information.
REGISTRY_ BUFFER_SIZE	sfsc_ adapter_ config.h	512	x1 RAM	When querying the service registry, received services are stored in a buffer of this size. Must not be greater then ZMTP_IN_ _BUFFER_SIZE (see below; there is no point in storing a service you can not even receive).

Parameter Name	Header	Default	Memory Impact	Description
MAX_DELETED_MEMORY	sfsc_adapter_config.h	32	x37 RAM	When querying the service registry, it is necessary to keep track of services in the registry that are marked as deleted (see chapter 4.2 in the white-paper). This value determines, how many delete events can be stored; if you know that there are many services in your service registry, you may want to increase this value. Note however, that this is not a 1:1 relation and you don't need to set this value to the total number of services (if you have 100 services, you don't need to set this value to 100, 32 might be fine). To find the value suited the most for your usecase, you need to experiment a little.
USER_RING_SIZE	sfsc_adapter_config.h	5120	x1 RAM	The size of the user ring. The default value is chosen this high to prevent message drop, for platforms with lower RAM capabilities, a more appropriate value might be 1024.
NO_CURVE	zmtplib_config.h	defined	5 KB(!) RAM and ROM if NOT set	Curve encryption is wip. It is recommended that you disable the functions related to CRUVE to speed up compilation and reduce the RAM and ROM footprint of the framework.

Parameter Name	Header	Default	Memory Impact	Description
ZMTP_IN_BUFFER_SIZE	zmtplib config.h	512	x4 RAM	The size of the ZMTP receive buffer; determines, how big a single ZMTP message can be. If you know, that the services you use need to receive bigger payloads (e.g. because you want to subscribe a publisher whose messages are 1KB in size), you need to adjust this value.
ZMTP_METADATA_BUFFER_SIZE	zmtplib config.h	32	x8 RAM	ZMTP needs a place to store its meta data. You usually don't need to adjust this buffers size, unless you tweak the ZMTP implementation itself.
ENABLE_PRINTS	Your build system	defined	~1KB of ROM	The examples use platform depended mechanics to print something (to the closes thing to a console their is for the platform), to give you some more insights in what is happening. You can disable this for production. Where you set this directive is up to the used build system.

## 1.5 Using the API

All public API functions are defined in [sfsc\\_adapter.h](#). You should include this header everywhere you want to use one of the frameworks function. To use most of the functions, you need a pointer to a `sfsc_adapter`. To declare a `sfsc_adapter`, you also need to include `sfsc_adapter_struct.h`. You should only include this header in the compilation unit you declare the adapter and not modify the struct fields of the adapter. The adapter has a stats field, which tells you some information about its current state. To access the stats field of an adapter, use the `adapter_stats` function. After declaring a adapter, you can use it to start a session. Use the `start_session_bootstrapped` or `start_session` function with a pointer the the adapter. After the `start_session` method returns, your SFSC adapter is ready to perform the SFSC handshake, and you should start using the `system_task` function on the adapter. Once the state of the adapter (accessible through the stats field of the adapter struct) is operational, you can also start invoking the `user_task` function on the adapter, and use the other API functions with the adapter.



Most functions, including the `system_task` and `user_task` functions return error codes. An error code of `SFSC_OK` indicates, that a function call was successful. A full list of error codes can be found in [sfsc\\_error\\_codes.h](#) and `zmtplib_stats.h`. All errors of `zmtplib_stats.h` indicate that there was something wrong with data transport: either the network or the ZMTP protocol (on which SFSC is based) somehow failed. These errors are not recoverable, you should initiate a new SFSC session (you can reuse the adapter struct for that, as long as you set all the fields according to `sfsc_adapter_DEFAULT_INIT`, see section *Struct initialization* below). Errors of [sfsc\\_error\\_codes.h](#) are higher level and indicate problems with SFSC itself. They are well documented, and some are even recoverable, so look at their documentation.

### 1.5.1 Struct initialization

There are some struct types you'll encounter while using the framework. If you want to initialize a struct to its default values (just 0 in almost all cases), you can use the corresponding `<struct_name>_DEFAULT_INIT` macro. For some structs there is a constant default instance you can use to copy the default values over, and if there is, its name is `<struct_name>_default`.



## Chapter 2

# Data Structure Index

### 2.1 Data Structures

Here are the data structures with brief descriptions:

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<a href="#">_relative_server_tags</a>	Represents service tags specific to server services . . . . .	17
<a href="#">_relative_sfsc_service_descriptor</a>	Represents all information about a service . . . . .	18
<a href="#">_sfsc_adapter_stats</a>	The sfsc_adapter_stats struct contains the information needed by the user . . . . .	19
<a href="#">_sfsc_buffer</a>	A simple structure to store binary data and their length . . . . .	20
<a href="#">_sfsc_channel_answer</a>	A struct containing all information needed to answer a channel request . . . . .	21
<a href="#">_sfsc_publisher</a>	State memory for a publisher service . . . . .	21
<a href="#">_sfsc_publisher_or_server</a>	Container to point either to a sfsc_server or sfsc_publisher . . . . .	22
<a href="#">_sfsc_server</a>	State memory for a server service . . . . .	23
<a href="#">_sfsc_subscriber</a>	Struct that contains the necessary state memory to subscribe to a publisher service . . . . .	24



## Chapter 3

# File Index

### 3.1 File List

Here is a list of all documented files with brief descriptions:

src/sfsc/sfsc_adapter/ <a href="#">sfsc_adapter.h</a>	
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src/sfsc/sfsc_adapter/ <a href="#">sfsc_error_codes.h</a>	
SFSC related error codes . . . . .	<a href="#">48</a>



## Chapter 4

# Data Structure Documentation

### 4.1 `_relative_publisher_tags` Struct Reference

Represents service tags specific to publisher services.

```
#include <sfsc_adapter.h>
```

#### Data Fields

- sfsc\_size **topic\_offset**
- sfsc\_size **topic\_len**
- sfsc\_size **output\_message\_type\_offset**
- sfsc\_size **output\_message\_type\_len**
- sfsc\_bool **unregistered**

#### 4.1.1 Detailed Description

Represents service tags specific to publisher services.

The format and idea of the fields is very similar to `relative_sfsc_service_descriptor`, see there for an explanation.

An exception to this is the `unregistered` field. See the `sfsc_publisher` struct documentation for an explanation.

The documentation for this struct was generated from the following file:

- `src/sfsc/sfsc_adapter/sfsc_adapter.h`

### 4.2 `_relative_server_tags` Struct Reference

Represents service tags specific to server services.

```
#include <sfsc_adapter.h>
```

## Data Fields

- sfsc\_size **topic\_offset**
- sfsc\_size **topic\_len**
- sfsc\_size **input\_message\_type\_offset**
- sfsc\_size **input\_message\_type\_len**
- sfsc\_size **output\_message\_type\_offset**
- sfsc\_size **output\_message\_type\_len**
- sfsc\_SfscServiceDescriptor\_ServiceTags\_ServerTags\_AckSettings **ack\_settings**

### 4.2.1 Detailed Description

Represents service tags specific to server services.

The format and idea of the fields is very similar to `relative_sfsc_service_descriptor`, see there for an explanation.

An exception to this is the `ack_settings` field. See the `sfsc_server` struct documentation for an explanation.

The documentation for this struct was generated from the following file:

- `src/sfsc/sfsc_adapter/sfsc_adapter.h`

## 4.3 `_relative_sfsc_service_descriptor` Struct Reference

Represents all information about a service.

```
#include <sfsc_adapter.h>
```

## Data Fields

- sfsc\_SfscId **core\_id**
- sfsc\_SfscId **adapter\_id**
- sfsc\_SfscId **service\_id**
- sfsc\_size **name\_offset**
- sfsc\_size **name\_len**
- sfsc\_size **custom\_tags\_offset**
- sfsc\_size **custom\_tags\_len**
- sfsc\_uint8 **service\_type**
- - union {
    - `relative_publisher_tags` **publisher\_tags**
    - `relative_server_tags` **server\_tags**
  - service\_tags**



### 4.3.1 Detailed Description

Represents all information about a service.

A relative `_sfsc_service_descriptor` is relative because it does not contain information about a service directly, but it merely serves as an index structure. The indexes (which end with `_offset`) are relative to a memory area. The memory areas address (called `start` in the following) is usually delivered with the descriptor. For example, to now access the name of the service, read `name_len` bytes from `(start+name_offset)`. For reasoning, why this relative approach is used, read the last paragraph.

An exception to the above are the `core_id`, `adapter_id`, and `service_id` fields, which actually contain the respective ids, and thereby denote the core and adapter this service belongs to, as well as this services own id.

The `service_type` field is either `SERVICE_TYPE_SERVER` or `SERVICE_TYPE_PUBLISHER` and indicates, how the `service_tags` union should be treated.

Why is this relative approach used? The binary size of a service in `sfsc` is not limited, so we can not know the size of the respective service fields in advance. On the other hand, this framework does not use dynamic memory allocation (`malloc`). A possible solution is to statically allocate memory for each field and add an length field, to indicate, how much memory is actually used. The difference between the allocated and actually used size is called waste. Instead of allocation a memory area for each field, we use one bigger memory area for all fields. The idea is that, because of the individual waste, this single field size can be smaller than sum of all individual field sizes, while still containing enough space to store all necessary information.

The documentation for this struct was generated from the following file:

- `src/sfsc/sfsc_adapter/sfsc_adapter.h`

## 4.4 \_sfsc\_adapter\_stats Struct Reference

The `sfsc_adapter_stats` struct contains the information needed by the user.

```
#include <sfsc_adapter.h>
```

### Data Fields

- `const char * address`
- `sfsc_uint8 adapter_id [UUID_LEN]`
- `sfsc_uint8 core_id [UUID_LEN]`
- `sfsc_uint8 state`
- `sfsc_uint32 discarded_message_count`
- `sfsc_bool query_in_progress`

### 4.4.1 Detailed Description

The `sfsc_adapter_stats` struct contains the information needed by the user.

The stats of an adapter should be accessed through the `adapter_stats` function. The fields of this struct are all read-only and should not be modified by you.

The `address` field specifies the address of the core and is implicitly set by you during the `start_session_bootstrapped` or `start_session` functions. The format of the address is up to you and can be anything, as long as it is understood by your implementation of `socket_connect` (see `sfsc_sockets.h`).

The `adapter_id` and `core_id` fields indicate this adapter's id and the id of the core it is connected to respectively. They are both filled during the handshake, and ready to use once the adapter's state is operational.

The `state` indicates the current connection state of an adapter. The various states are defined in `sfsc_states.h` and are all prefixed with `SFSC_STATE_`. An adapter is considered operational if the value of this field is `>= SFSC_STATE_OPERATIONAL`.

Due to the execution and memory model of this framework it can occur that some messages received from the network are dropped (see the `system_task` function for details). The `discarded_message_count` keeps track of the number of lost messages.

The `query_in_progress` is set to 1 if you started a query process using `query_services`, and will be reset to 0 if the query process is terminated. See the query functions for more information.

The documentation for this struct was generated from the following file:

- `src/sfsc/sfsc_adapter/sfsc_adapter.h`

## 4.5 \_sfsc\_buffer Struct Reference

A simple structure to store binary data and their length.

```
#include <sfsc_adapter.h>
```

### Data Fields

- `const sfsc_uint8 * content`
- `sfsc_size length`

### 4.5.1 Detailed Description

A simple structure to store binary data and their length.

This structure type is widely used in the framework for compact data storing. It is important to notice that some functions will take a `sfsc_buffer` struct as parameter directly, while others will work with pointers. In the most cases, this says something about the mutability of the content.

In general, for the use-time of a `sfsc_buffer` (usually defined in the respective functions documentation), the memory area the buffer points to must be valid and of the in the struct specified length.

When passing the struct to a function, it must be immutable, meaning that for the use-time of the `sfsc_buffer`, the content must not change.

When passing a pointer to a function, the content is allowed to be mutable, meaning that during the use-time of the `sfsc_buffer`, you are allowed to change the content pointer and thereby change the memory area this `sfsc_buffer` is backed by. If you do so, don't forget to update the `length` field accordingly.

The documentation for this struct was generated from the following file:

- `src/sfsc/sfsc_adapter/sfsc_adapter.h`

## 4.6 \_sfsc\_channel\_answer Struct Reference

A struct containing all information needed to answer a channel request.

```
#include <sfsc_adapter.h>
```

### Data Fields

- sfsc\_uint8 \* **service\_id**
- sfsc\_uint8 \* **adapter\_id**
- sfsc\_uint8 \* **core\_id**
- [sfsc\\_buffer](#) **publisher\_output\_topic**
- [sfsc\\_buffer](#) **name**
- [sfsc\\_buffer](#) **custom\_tags**
- [sfsc\\_buffer](#) **output\_message\_type**
- sfsc\_bool **unregistered**

### 4.6.1 Detailed Description

A struct containing all information needed to answer a channel request.

Instead of normal binary payload, a channel request is answered with the definition of a publisher service.

The `core_id`, `adapter_id` and `service_id` represent the core and adapter the publisher service is connected to, as well as the publisher service itself. Their length must be `UUID_LEN` and their format must be standard-hexgroup-format (see the `random_uuid` function). The reason a `sfsc_channel_answer` uses `sfsc_uint8*` instead of `sfsc_uint8[]` is to remove copying and to save memory: The publisher you are describing is most likely hosted by the same adapter that will send this channel answer. Instead of allocating `3*UUID_LEN` memory and copy the details from the adapter to the `sfsc_channel_answer`, you can just let the fields point to `&adapter_states()->core_id` and `&adapter_states()->adapter_id` respectively.

All `sfsc_buffers` must be valid during the use-time of the `sfsc_channel_answer` struct and are optional. If `publisher->_output_topic` is set to `SERVICE_TOPIC_AUTOGEN` the topic autogenerate rule (as described in `sfsc_publisher`) will be applied, and the `service_id` will be used as topic.

The `unregistered` should be set to 0 if the publisher you are describing in this `sfsc_channel_answer` is also registered in the service registry, or to 1 if it is not.

The documentation for this struct was generated from the following file:

- `src/sfsc/sfsc_adapter/sfsc_adapter.h`

## 4.7 \_sfsc\_publisher Struct Reference

State memory for a publisher service.

```
#include <sfsc_adapter.h>
```

## Data Fields

- void(\* **on\_subscription\_change** )(sfsc\_adapter \*adapter, sfsc\_publisher \*publisher, sfsc\_uint8 last\_↵ subscribers, sfsc\_uint8 current\_subscribers)
- sfsc\_uint8 **last\_subscribers**
- sfsc\_uint8 **current\_subscribers**
- sfsc\_SfscId **service\_id**
- sfsc\_buffer **topic**
- sfsc\_bool **unregistered**

### 4.7.1 Detailed Description

State memory for a publisher service.

To create a publisher, declare a sfsc\_publisher struct, fill it, and use either the register\_publisher or the register\_↵\_publisher\_unregistered function. The sfsc\_publisher struct must be valid until it is unregistered by an call to the unregister\_publisher function.

Filling a publisher is optional and means to set values to the on\_subscription\_change, the service\_id and topic fields.

If you want to choose a service id for the publisher yourself, you can fill the service\_id before registration with an valid 128bit UUID in standard-hexgroup-format (see the random\_uuid for more information). Usually, you want to set this field to sfsc\_SfscId\_init\_default (what it already is for any instance initialized with sfsc\_publisher\_DEFAULT\_↵INIT) and let the framework automatically generate a service id. After registration, you should not change the value of this field.

If you want to choose a topic for the publisher yourself you can configure the topic buffer to point to a valid topic. The topic buffer must be valid and immutable (see the sfsc\_buffer documentation for more insight on this) as long as the publisher is registered. If you want the framework to choose a topic for you, set this field to SERVICE\_TOPIC\_↵AUTOGEN (what it already is for any instance initialized with sfsc\_publisher\_DEFAULT\_INIT). To save memory, the framework will then simply use the service\_id as topic.

If the subscription count of a publisher changes, the on\_subscription\_change callback is invoked. The parameters of the callback indicate the old and new subscription count. They are either 0 or at maximum 1, even if there might be more subscribers, since sfsc can only tell if there is at least 1 subscriber. During execution of the callback function, the last\_subscribers and current\_subscribers fields (not callback parameters!) are unfedined. After the callback function returns, they will match the values of the parameters. In any case, they are read-only!

The unregistered field is set by the framework and depends on wether you registered a publisher with the register\_↵\_publisher or the register\_publisher\_unregistered function. It indicates if the publisher is registered in the cores service registry. You must not change it!

The documentation for this struct was generated from the following file:

- src/sfsc/sfsc\_adapter/sfsc\_adapter.h

## 4.8 \_sfsc\_publisher\_or\_server Struct Reference

Container to point either to a sfsc\_server or sfsc\_publisher.

```
#include <sfsc_adapter.h>
```

## Data Fields

- sfsc\_bool **is\_server**
- union {  
   sfsc\_publisher \* **publisher**  
   sfsc\_server \* **server**  
 } **service**

### 4.8.1 Detailed Description

Container to point either to a sfsc\_server or sfsc\_publisher.

The documentation for this struct was generated from the following file:

- src/sfsc/sfsc\_adapter/sfsc\_adapter.h

## 4.9 \_sfsc\_server Struct Reference

State memory for a server service.

```
#include <sfsc_adapter.h>
```

## Data Fields

- void(\* **on\_request**)(sfsc\_adapter \*adapter, sfsc\_server \*server, sfsc\_buffer payload, sfsc\_int32 expected\_reply\_id, sfsc\_buffer reply\_topic, sfsc\_bool \*b\_auto\_advance)
- sfsc\_SfscServiceDescriptor\_ServiceTags\_ServerTags\_AckSettings **ack\_settings**
- sfsc\_SfscId **service\_id**
- sfsc\_buffer **topic**
- sfsc\_bool **is\_channel**

### 4.9.1 Detailed Description

State memory for a server service.

To create a server, declare a sfsc\_server struct, fill it, and use the register\_service function. The sfsc\_server struct must be valid until it is unregistered by an call to the unregister\_server function.

In constrast to the creating process of a publisher, filling a server is NOT optional.

If you want to choose a service id for the server yourself, you can fill the service\_id before registration with an valid 128bit UUID in standard-hexgroup-format (see the random\_uuid for more information). Usually, you want to set this field to sfsc\_SfscId\_init\_default (what it already is for any instance initialized with sfsc\_server\_DEFAULT\_INIT) and let the framework automatically generate a service id. After registration, you should not change the value of this field.

If you want to choose a topic for the server yourself you can configure the topic buffer to point to a valid topic. The topic buffer must be valid and immutable (see the `sfsc_buffer` documentation for more insight on this) as long as the server is registered. If you want the framework to choose a topic for you, set this field to `SERVICE_TOPIC↵_AUTOGEN` (what it already is for any instance initialized with `sfsc_server_DEFAULT_INIT`). To save memory, the framework will then simply use the `service_id` as topic.

The `is_channel` field indicates if this server service is a channel service. Channel services do not answer requests with normal binary payload, but answer them with publisher service definitions. Then, the adapter that made the request can subscribe to the publisher and receive values in a streamlike way. After registration, you should not change the value of this field.

The `ack_settings` field describes this server's acknowledge strategy: usually, if a server answers a request, the requestor will send back an acknowledge message to the server, so that the server knows that the request was successfully served. If this acknowledge message does not reach the server after `ack_settings.timeout_ms` milliseconds, the server will attempt to retransmit the answer, up to `ack_settings.send_max_tries` times. If `ack_settings.send↵_max_tries` is set to 0, this server won't wait for acknowledges and use a fire-and-forget approach. This has some beneficial implications to the `answer_request` and `answer_channel_request` functions, documented there. In most cases, using a fire-and-forget approach is valid, since most transmission errors will be corrected on the tcp layer, and a performant `sfsc` core will rarely drop messages on the `zmq` layer.

The `on_request` callback is invoked every time a request for this server service is received. It is allowed to change the `on_request` callback, even after registering the service. After receiving a request, you will usually take some actions based on the payload and eventually send an answer back to the requestor using the `answer_request` or `answer_channel_request` function.

The payload buffer is only valid during the current user task micro step (see the `user_task` documentation). `b↵_auto_advance` is an out-parameter (meaning that you should set it), that lets you pause the user task on the current micro step: if you set it to 0, you will enter the pause state and the payload pointer will be valid, even after the callback returns. On the other hand, the user task will not advance to the next micro step until you leave the pause state manually (see `advance_user_ring`).

The `expected_reply_id` and `reply_topic` are pull-through parameters, meaning that you don't need to interact with them, but pass them to the `answer_request` or `answer_channel_request` once you want to answer the request. The `reply_topic` is like the payload also only valid during the current user task micro step.

If you attempt to answer a request right in the callback consider the following: For fire-and-forget servers, this is valid, since the `reply_topic` you receive by the `on_request` callback will be passed to the `answer_request` function, which will return before the `on_request` callback returns. For non-fire-and-forget servers, this is not valid, since the `reply_topic` must be valid till the corresponding `on_ack` call, and not till the `answer_request` function returns. To work around this, you can either copy the content of the `reply_topic` somewhere global (recommended) or pause the user task, until the corresponding `on_ack` is invoked. Even if the user task is in pause state, the `on_ack` callback of an `answer_request` will be invoked, so there will be no deadlock.

The documentation for this struct was generated from the following file:

- `src/sfsc/sfsc_adapter/sfsc_adapter.h`

## 4.10 `_sfsc_subscriber` Struct Reference

Struct that contains the necessary state memory to subscribe to a publisher service.

```
#include <sfsc_adapter.h>
```

## Data Fields

- [sfsc\\_buffer](#) topic
- `void(* on_data)(sfsc_adapter *adapter, sfsc_subscriber *subscriber, sfsc_buffer payload, sfsc_bool *b_↵ auto_advance)`

### 4.10.1 Detailed Description

Struct that contains the necessary state memory to subscribe to a publisher service.

To subscribe to a publisher service, declare a `sfsc_subscriber` somewhere, fill it and then register it with an adapter using the `register_subscriber` function. The subscriber struct must be valid as long as the subscriber is registered.

Filling a subscriber means to configure the topic field and the `on_data` callback.

Usually, you will receive the topic of the publisher service you want to subscribe to from the `query_services` function. The topics region must be immutable while the subscriber is registered (for more information what immutable means, see the `sfsc_buffer` documentation).

The `on_data` field is allowed to change. It is invoked, when the corresponding publisher publishes a message. The payload buffer is only valid during the current user task micro step (see the `user_task` documentation). `b_auto_↵ advance` is an out-parameter (meaning that you should set it), that lets you pause the user task on the current micro step: if you set it to 0, you will enter the pause state and the payload pointer will be valid, even after the callback returns. On the other hand, the user task will not advance to the next micro step until you leave the pause state manually (see `advance_user_ring`). Usually, you want to set `b_auto_advance` to 1.

The documentation for this struct was generated from the following file:

- `src/sfsc/sfsc_adapter/sfsc_adapter.h`





## Chapter 5

# File Documentation

### 5.1 src/sfsc/sfsc\_adapter/sfsc\_adapter.h File Reference

Public header that contains all SFSC functions.

```
#include "../platform/sfsc_strings.h"
#include "../platform/sfsc_types.h"
#include "../proto_gen/generated.pb.h"
#include "sfsc_adapter_config.h"
#include "sfsc_error_codes.h"
#include "sfsc_states.h"
```

#### Data Structures

- [struct \\_sfsc\\_adapter\\_stats](#)  
*The sfsc\_adapter\_stats struct contains the information needed by the user.*
- [struct \\_sfsc\\_buffer](#)  
*A simple structure to store binary data and their length.*
- [struct \\_sfsc\\_subscriber](#)  
*Struct that contains the necessary state memory to subscribe to a publisher service.*
- [struct \\_sfsc\\_publisher](#)  
*State memory for a publisher service.*
- [struct \\_sfsc\\_server](#)  
*State memory for a server service.*
- [struct \\_sfsc\\_publisher\\_or\\_server](#)  
*Container to point either to a sfsc\_server or sfsc\_publisher.*
- [struct \\_relative\\_publisher\\_tags](#)  
*Represents service tags specific to publisher services.*
- [struct \\_relative\\_server\\_tags](#)  
*Represents service tags specific to server services.*
- [struct \\_relative\\_sfsc\\_service\\_descriptor](#)  
*Represents all information about a service.*
- [struct \\_sfsc\\_channel\\_answer](#)  
*A struct containing all information needed to answer a channel request.*

## Macros

- `#define SFSC_OK 0`
- `#define SERVICE_TYPE_SERVER 1`
- `#define SERVICE_TYPE_PUBLISHER 0`
- `#define UUID_LEN 36`
- `#define sfsc_adapter_stats_DEFAULT_INIT { NULL, {0}, {0}, SFSC_STATE_NONE, 0, 0 }`
- `#define sfsc_buffer_DEFAULT_INIT { NULL, 0 }`
- `#define SERVICE_TOPIC_AUTOGEN sfsc_buffer_DEFAULT_INIT`
- `#define sfsc_subscriber_DEFAULT_INIT { sfsc_buffer_DEFAULT_INIT, NULL }`
- `#define sfsc_publisher_DEFAULT_INIT { NULL, 0, 0, sfsc_Sfscld_init_default, SERVICE_TOPIC_↵  
AUTOGEN, 0 }`
- `#define sfsc_server_DEFAULT_INIT`
- `#define sfsc_publisher_or_server_INIT_DEFAULT { 0, {NULL} }`
- `#define relative_publisher_tags_DEFAULT_INIT { 0, 0, 0, 0, 0 }`
- `#define relative_server_tags_DEFAULT_INIT`
- `#define relative_sfsc_service_descriptor_DEFAULT_INIT`

## Typedefs

- typedef struct \_sfsc\_adapter [sfsc\\_adapter](#)  
*Contains all state memory for a sfsc\_adapter instance.*
- typedef struct \_sfsc\_adapter\_stats [sfsc\\_adapter\\_stats](#)  
*The sfsc\_adapter\_stats struct contains the infromation needed by the user.*
- typedef struct \_sfsc\_buffer [sfsc\\_buffer](#)  
*A simple structure to store binary data and their length.*
- typedef struct \_sfsc\_subscriber [sfsc\\_subscriber](#)
- typedef struct \_sfsc\_publisher [sfsc\\_publisher](#)
- typedef struct \_sfsc\_server [sfsc\\_server](#)
- typedef struct \_sfsc\_publisher\_or\_server [sfsc\\_publisher\\_or\\_server](#)  
*Container to point either to a sfsc\_server or sfsc\_publisher.*
- typedef struct \_relative\_publisher\_tags [relative\\_publisher\\_tags](#)  
*Represents service tags specific to publisher services.*
- typedef struct \_relative\_server\_tags [relative\\_server\\_tags](#)  
*Represents service tags specific to server services.*
- typedef struct \_relative\_sfsc\_service\_descriptor [relative\\_sfsc\\_service\\_descriptor](#)  
*Represents all infromation about a service.*
- typedef struct \_sfsc\_channel\_answer [sfsc\\_channel\\_answer](#)  
*A struct containing all information needed to answer a channel request.*
- typedef void() [sfsc\\_command\\_callback](#)([sfsc\\_adapter](#) \*adapter, [sfsc\\_publisher\\_or\\_server](#) service, sfsc\_bool created)  
*Called when a command to create or delete a service succeeds.*
- typedef void() [sfsc\\_query\\_callback](#)([sfsc\\_adapter](#) \*adapter, [relative\\_sfsc\\_service\\_descriptor](#) descriptor, sfsc\_uint8 \*offset, sfsc\_size length, sfsc\_bool is\_last)  
*Called during a query process with a service descriptor, or to indicate that the query process is done.*
- typedef void() [sfsc\\_request\\_callback](#)([sfsc\\_adapter](#) \*adapter, [sfsc\\_buffer](#) payload, sfsc\_bool timeout, void \*mapping\_arg, sfsc\_bool \*b\_auto\_advance)  
*Invoked when an answer to a request is receieved, or when the request times out.*
- typedef void() [sfsc\\_channel\\_request\\_callback](#)([sfsc\\_adapter](#) \*adapter, sfsc\_bool timeout, sfsc\_int8 decode\_↵  
\_error, [relative\\_sfsc\\_service\\_descriptor](#) \*descriptor, sfsc\_uint8 \*descirptor\_offset, sfsc\_size descirptor\_↵  
length, void \*mapping\_arg, sfsc\_bool \*b\_auto\_advance)  
*Invoked when an answer to a channel request is receieved, or when the request times out.*
- typedef void() [sfsc\\_answer\\_ack\\_callback](#)([sfsc\\_adapter](#) \*adapter, [sfsc\\_server](#) \*server, sfsc\_bool timeout, void \*mapping\_arg)  
*Invoked if an ack message for an answer was receieved, or the servers timeout condition was meet.*

## Functions

- [sfsc\\_adapter\\_stats](#) \* [adapter\\_stats](#) ([sfsc\\_adapter](#) \*adapter)  
*Recommended way to access the stats of an adapter.*
- [sfsc\\_int8 start\\_session\\_bootstrapped](#) ([sfsc\\_adapter](#) \*adapter, const char \*address, int original\_control\_pub\_port, int original\_control\_sub\_port)  
*Starts a sfsc adapter session with bootstrapping.*
- [sfsc\\_int8 start\\_session](#) ([sfsc\\_adapter](#) \*adapter, const char \*address, int original\_control\_pub\_port, int original\_control\_sub\_port, int original\_data\_pub\_port, int original\_data\_sub\_port)  
*Starts a sfsc adapter session without bootstrapping.*
- [sfsc\\_int8 register\\_subscriber](#) ([sfsc\\_adapter](#) \*adapter, [sfsc\\_subscriber](#) \*subscriber)  
*Subscribes to a sfsc publisher through the given adapter.*
- [sfsc\\_int8 unregister\\_subscriber](#) ([sfsc\\_adapter](#) \*adapter, [sfsc\\_subscriber](#) \*subscriber)  
*Unregisters a subscriber and unsubscribe messages on that topic.*
- [sfsc\\_int8 query\\_services](#) ([sfsc\\_adapter](#) \*adapter, [sfsc\\_query\\_callback](#) \*on\_service)  
*Starts a query process to obtain registered services from the core.*
- void [query\\_services\\_next](#) ([sfsc\\_adapter](#) \*adapter, [sfsc\\_bool](#) next)  
*Tells the framework to continue or to end a currently ongoing query process.*
- [sfsc\\_int8 register\\_publisher](#) ([sfsc\\_adapter](#) \*adapter, [sfsc\\_publisher](#) \*publisher, [sfsc\\_buffer](#) name, [sfsc\\_buffer](#) custom\_tags, [sfsc\\_buffer](#) output\_message\_type, [sfsc\\_command\\_callback](#) \*command\_callback)  
*Sets up a publisher service and registers it with the core.*
- [sfsc\\_int8 register\\_publisher\\_unregistered](#) ([sfsc\\_adapter](#) \*adapter, [sfsc\\_publisher](#) \*publisher)  
*Sets up a publisher you can publish with, but does not register it in the cores service registry.*
- [sfsc\\_int8 unregister\\_publisher](#) ([sfsc\\_adapter](#) \*adapter, [sfsc\\_publisher](#) \*publisher, [sfsc\\_command\\_callback](#) \*command\_callback)  
*Unregisters a publisher.*
- [sfsc\\_int8 publish](#) ([sfsc\\_adapter](#) \*adapter, [sfsc\\_publisher](#) \*publisher, [sfsc\\_buffer](#) payload)  
*Publishes data through a publisher.*
- [sfsc\\_int8 request](#) ([sfsc\\_adapter](#) \*adapter, [sfsc\\_buffer](#) topic, [sfsc\\_buffer](#) payload, [sfsc\\_uint64](#) timeout\_time, [sfsc\\_request\\_callback](#) \*on\_answer, void \*mapping\_arg)  
*Makes a request call to a server service.*
- [sfsc\\_int8 channel\\_request](#) ([sfsc\\_adapter](#) \*adapter, [sfsc\\_buffer](#) topic, [sfsc\\_buffer](#) payload, [sfsc\\_uint64](#) timeout\_time, [relative\\_sfsc\\_service\\_descriptor](#) \*descriptor, [sfsc\\_uint8](#) \*descriptor\_space, [sfsc\\_size](#) descriptor\_space\_lenght, [sfsc\\_channel\\_request\\_callback](#) \*on\_answer, void \*mapping\_arg)  
*Makes a request call to a channel server service.*
- [sfsc\\_int8 register\\_server](#) ([sfsc\\_adapter](#) \*adapter, [sfsc\\_server](#) \*server, [sfsc\\_buffer](#) name, [sfsc\\_buffer](#) custom\_tags, [sfsc\\_buffer](#) output\_message\_type, [sfsc\\_buffer](#) input\_message\_type, [sfsc\\_command\\_callback](#) \*command\_callback)  
*Sets up a server service and registers it with the core.*
- [sfsc\\_int8 unregister\\_server](#) ([sfsc\\_adapter](#) \*adapter, [sfsc\\_server](#) \*server, [sfsc\\_command\\_callback](#) \*command\_callback)  
*Unregisters a server.*
- [sfsc\\_int8 answer\\_request](#) ([sfsc\\_adapter](#) \*adapter, [sfsc\\_server](#) \*server, [sfsc\\_int32](#) expected\_reply\_id, [sfsc\\_buffer](#) reply\_topic, [sfsc\\_buffer](#) \*payload, void \*mapping\_arg, [sfsc\\_answer\\_ack\\_callback](#) \*on\_ack)  
*Answers a request.*
- [sfsc\\_int8 answer\\_channel\\_request](#) ([sfsc\\_adapter](#) \*adapter, [sfsc\\_server](#) \*server, [sfsc\\_int32](#) expected\_reply\_id, [sfsc\\_buffer](#) reply\_topic, [sfsc\\_channel\\_answer](#) \*channel\_answer, void \*mapping\_arg, [sfsc\\_answer\\_ack\\_callback](#) \*on\_ack)  
*Used to answer a channel request.*
- void [random\\_uuid](#) ([sfsc\\_uint8](#) target[UUID\_LEN])  
*Generates and writes a random 128bit UUID in standard-hexgroup-format to the target buffer.*
- [sfsc\\_int8 system\\_task](#) ([sfsc\\_adapter](#) \*adapter)  
*Executes a single system task step on the adapter.*

- `sfsc_int8 user_task (sfsc_adapter *adapter)`  
*Executes a single system task step on the adapter.*
- `void advance_user_ring (sfsc_adapter *adapter)`  
*Leaves the user task pause state.*

## Variables

- `const sfsc_buffer sfsc_buffer_default`
- `const relative_publisher_tags relative_publisher_tags_default`
- `const relative_server_tags relative_server_tags_default`

### 5.1.1 Detailed Description

Public header that contains all SFSC functions.

### 5.1.2 Macro Definition Documentation

#### 5.1.2.1 relative\_server\_tags\_DEFAULT\_INIT

```
#define relative_server_tags_DEFAULT_INIT
```

Value:

```
{
    0, 0, 0, 0, 0, 0,
    sfsc_SfscServiceDescriptor_ServiceTags_ServerTags_AckSettings_init_default
}
```

#### 5.1.2.2 relative\_sfsc\_service\_descriptor\_DEFAULT\_INIT

```
#define relative_sfsc_service_descriptor_DEFAULT_INIT
```

Value:

```
{
    sfsc_SfscId_init_default, sfsc_SfscId_init_default,
    sfsc_SfscId_init_default, 0, 0, 0, 0, SERVICE_TYPE_PUBLISHER,
    {relative_publisher_tags_DEFAULT_INIT}
}
```

#### 5.1.2.3 sfsc\_server\_DEFAULT\_INIT

```
#define sfsc_server_DEFAULT_INIT
```

Value:

```
{
    NULL,
    sfsc_SfscServiceDescriptor_ServiceTags_ServerTags_AckSettings_init_default,
    sfsc_SfscId_init_default, SERVICE_TOPIC_AUTOGEN, 0
}
```

### 5.1.3 Typedef Documentation

#### 5.1.3.1 relative\_publisher\_tags

```
typedef struct _relative_publisher_tags relative_publisher_tags
```

Represents service tags specific to publisher services.

The format and idea of the fields is very similar to `relative_sfsc_service_descriptor`, see there for an explanation.

An exception to this is the `unregistered` field. See the `sfsc_publisher` struct documentation for an explanation.

#### 5.1.3.2 relative\_server\_tags

```
typedef struct _relative_server_tags relative_server_tags
```

Represents service tags specific to server services.

The format and idea of the fields is very similar to `relative_sfsc_service_descriptor`, see there for an explanation.

An exception to this is the `ack_settings` field. See the `sfsc_server` struct documentation for an explanation.

#### 5.1.3.3 relative\_sfsc\_service\_descriptor

```
typedef struct _relative_sfsc_service_descriptor relative_sfsc_service_descriptor
```

Represents all information about a service.

A `relative_sfsc_service_descriptor` is relative because it does not contain information about a service directly, but it merely serves as an index structure. The indexes (which end with `_offset`) are relative to a memory area. The memory areas address (called `start` in the following) is usually delivered with the descriptor. For example, to now access the name of the service, read `name_len` bytes from `(start+name_offset)`. For reasoning, why this relative approach is used, read the last paragraph.

An exception to the above are the `core_id`, `adapter_id`, and `service_id` fields, which actually contain the respective ids, and thereby denote the core and adapter this service belongs to, as well as this services own id.

The `service_type` field is either `SERVICE_TYPE_SERVER` or `SERVICE_TYPE_PUBLISHER` and indicates, how the `service_tags` union should be treated.

Why is this relative approach used? The binary size of a service in `sfsc` is not limited, so we can not know the size of the respective service fields in advance. On the other hand, this framework does not use dynamic memory allocation (`malloc`). A possible solution is to statically allocate memory for each field and add an length field, to indicate, how much memory is actually used. The difference between the allocated and actually used size is called waste. Instead of allocation a memory area for each field, we use one bigger memory area for all fields. The idea is that, because of the individual waste, this single field size can be smaller then sum of all individual field sizes, while still containing enough space to store all necessary information.

#### 5.1.3.4 sfsc\_adapter

```
typedef struct _sfsc_adapter sfsc_adapter
```

Contains all state memory for a sfsc\_adapter instance.

In most cases, you do not need to interact with the fields of a sfsc\_adapter struct directly. Therefor, the struct members are not exposed in this header. The for you relevant fields should be accessed through the adapter\_stats function.

Note however, that the compilation unit declaring the sfsc\_adapter struct needs a full specification of it. Only this compilation unit should include sfsc\_adapter\_struct.h.

#### 5.1.3.5 sfsc\_adapter\_stats

```
typedef struct _sfsc_adapter_stats sfsc_adapter_stats
```

The sfsc\_adapter\_stats struct contains the information needed by the user.

The stats of an adapter should be accessed through the adapter\_stats function. The fields of this struct are all read-only and should not be modified by you.

The address field specifies the address of the core and is implicitly set by you during the start\_session\_bootstrapped or start\_session functions. The format of the address is up to you and can be anything, as long it is understood by your implementation of socket\_connect (see sfsc\_sockets.h).

The adapter\_id and core\_id fields indicate this adapters id and the id of the core it is connected to respectively. They are both filled during the handshake, and ready to use once the adapters state is operational.

The state indicates to current connection state of an adapter. The various states are defined in sfsc\_states.h and are all prefixed with SFSC\_STATE\_. An adapter is considered operational if the value of this field is >= SFSC\_STATE\_OPERATIONAL.

Due to the execution and memory model of this framework it can occur that some messages received from the network are dropped (see the system\_task function for details). The discarded\_message\_count keeps track of the number of lost messages.

The query\_in\_progress is set to 1 if you started a query process using query\_services, and will be reset to 0 if the query process is terminated. See the query functions for more information.

#### 5.1.3.6 sfsc\_answer\_ack\_callback

```
typedef void() sfsc_answer_ack_callback(sfsc_adapter *adapter, sfsc_server *server, sfsc_bool timeout, void *mapping_arg)
```

Invoked if an ack message for an answer was received, or the servers timeout condition was met.

If timeout is set to 1 all retransmission attempts failed (see the sfsc\_server.ack\_settings), if it is set to 0, the requestor acknowledged the answer.

The mapping\_arg parameter is a mapping-argument (explained in the request functions documentation with an example).

### 5.1.3.7 sfsc\_buffer

```
typedef struct _sfsc_buffer sfsc_buffer
```

A simple structure to store binary data and their length.

This structure type is widely used in the framework for compact data storing. It is important to notice that some functions will take a sfsc\_buffer struct as parameter directly, while others will work with pointers. In the most cases, this says something about the mutability of the content.

In general, for the use-time of a sfsc\_buffer (usually defined in the respective functions documentation), the memory area the buffer points to must be valid and of the in the struct specified length.

When passing the struct to a function, it must be immutable, meaning that for the use-time of the sfsc\_buffer, the content must not change.

When passing a pointer to a function, the content is allowed to be mutable, meaning that during the use-time of the sfsc\_buffer, you are allowed to change the content pointer and thereby change the memory area are this sfsc\_buffer is backed by. If you do so, don't forget to update the length field accordingly.

### 5.1.3.8 sfsc\_channel\_answer

```
typedef struct _sfsc_channel_answer sfsc_channel_answer
```

A struct containing all information needed to answer a channel request.

Instead of normal binary payload, a channel request is answered with the definition of a publisher service.

The core\_id, adapter\_id and service\_id represent the core and adapter the publisher service is connected to, as well as the publisher service itself. Their length must be UUID\_LEN and their format must be standard-hexgroup-format (see the random\_uuid function). The reason a sfsc\_channel\_answer uses sfsc\_uint8\* instead of sfsc\_uint8[] is to remove copying and to save memory: The publisher you are describing is most likely hosted by the same adapter that will send this channel answer. Instead of allocating 3\*UUID\_LEN memory and copy the details from the adapter to the sfsc\_channel\_answer, you can just let the fields point to &adapter\_states()->core\_id and &adapter\_states()->adapter\_id respectively.

All sfsc\_buffers must be valid during the use-time of the sfsc\_channel\_answer struct and are optional. If publisher->output\_topic is set to SERVICE\_TOPIC\_AUTOGEN the topic autogenerate rule (as described in sfsc\_publisher) will be applied, and the service\_id will be used as topic.

The unregistered should be set to 0 if the publisher you are describing in this sfsc\_channel\_answer is also registered in the service registry, or to 1 if it is not.

### 5.1.3.9 sfsc\_channel\_request\_callback

```
typedef void() sfsc_channel_request_callback(sfsc_adapter *adapter, sfsc_bool timeout, sfsc_
int8 decode_error, relative_sfsc_service_descriptor *descriptor, sfsc_uint8 *descriptor_offset,
sfsc_size descriptor_length, void *mapping_arg, sfsc_bool *b_auto_advance)
```

Invoked when an answer to a channel request is received, or when the request times out.

The timeout parameter is set to 1 if the callback invocation is caused by a timeout, to 0 if an answer is delivered.

The mapping\_arg parameter is a mapping-argument (explained in the request functions documentation with an example).

If decode\_error is not SFSC\_OK, an error occurred during decoding the received service definition. This will most likely happen due to a too small memory area for the descriptor. In this case decode\_error is set to E\_BUFFER\_INSUFFICIENT, and descriptor\_length indicates, how much memory would have been needed.

In contrast to the payload in a normal sfsc\_request\_callback, you have allocated the descriptor struct and the descriptor memory area yourself, so they will be valid until you do something with them, and won't become invalid once the callback returns. Thus, the b\_auto\_advance does not influence the validity, and is just there as a convenience tool to enter the user task pause state (see the user\_task documentation).

### 5.1.3.10 sfsc\_command\_callback

```
typedef void() sfsc_command_callback(sfsc_adapter *adapter, sfsc_publisher_or_server service,
sfsc_bool created)
```

Called when a command to create or delete a service succeeds.

A create command means that the service was registered in the cores event-log, a delete command means taht the service was unregistered from it.

#### Parameters

<i>adapter</i>	the executing adapter
<i>service</i>	a struct describing the service
<i>created</i>	1 if the command was a create command, 0 if it was a delete command

### 5.1.3.11 sfsc\_query\_callback

```
typedef void() sfsc_query_callback(sfsc_adapter *adapter, relative_sfsc_service_descriptor
descriptor, sfsc_uint8 *offset, sfsc_size length, sfsc_bool is_last)
```

Called during a query process with a service descriptor, or to indicate that the query process is done.

The descriptor is valid as long as you don't continue the query process (using query\_services\_next). If you need to access the service data of a service delivered by the callback after continuation, you need to write the descriptor to a global place, and also copy length bytes from offset to a global place. Alternatively, if you call query\_services\_next to end the query process (by setting next to 0), the descriptor is valid until the next query process.

In the last call to this method, is\_last is set to 1. The last call might not contain a service. An offset value of NULL indicates that this invocation of the callback does not contain a service.

Even after the is\_last call you have to invoke query\_services\_next with next set to 0, to explicitly end the query process.

### 5.1.3.12 sfsc\_request\_callback

```
typedef void() sfsc_request_callback(sfsc_adapter *adapter, sfsc_buffer payload, sfsc_bool
timeout, void *mapping_arg, sfsc_bool *b_auto_advance)
```

Invoked when an answer to a request is receieved, or when the request times out.

The timeout parameter is set to 1 if the callback invocation is caused by a timeout, to 0 if an answer is deleivered.

mapping\_arg is a mapping-argument (explained in the request functions documentation with an example).

The payload buffer is only valid during the current user task micro step (see the user\_task documentation). b\_↵ auto\_advance is an out-parameter (meaning that you should set it), that lets you pause the user task on the current mirco step: if you set it to 0, you will enter the pause state and the payload pointer will be valid, even after the callback returns. On the other hand, the user task will not advance to the next micro step until you leave the pause state manually (see advance\_user\_ring). Usually, you want to set b\_auto\_advance to 1. If the request timed out, you should not modify b\_auto\_advance, as it will point to NULL.



## 5.1.4 Function Documentation

### 5.1.4.1 adapter\_stats()

```
sfsc_adapter_stats* adapter_stats (
    sfsc_adapter * adapter )
```

Recommended way to access the stats of an adapter.

#### Parameters

<i>adapter</i>	The target adapter
----------------	--------------------

#### Returns

sfsc\_adapter\_stats\* Pointer to that adapters stats

### 5.1.4.2 advance\_user\_ring()

```
void advance_user_ring (
    sfsc_adapter * adapter )
```

Leaves the user task pause state.

Some callback functions allow you to pause the user task and freeze it on the current micro step. To continue execution you have to call this function. You should only call this function if you entered the pause state, and never call it from the callback you entered the pause state, as this will skip messages and leave your adapter in a undefined state.

#### Parameters

<i>adapter</i>	The adapter whichs user task is currently in the pause state and should continue execution
----------------	--

### 5.1.4.3 answer\_channel\_request()

```
sfsc_int8 answer_channel_request (
    sfsc_adapter * adapter,
    sfsc_server * server,
    sfsc_int32 expected_reply_id,
    sfsc_buffer reply_topic,
    sfsc_channel_answer * channel_answer,
    void * mapping_arg,
    sfsc_answer_ack_callback * on_ack )
```

Used to answer a channel request.

This function must only be called by channel server services. It behaves just like `answer_request`, so see there for documentation.

The only difference is that instead of passing a pointer to a binary payload, you have to pass a pointer to a `sfsc_channel_answer`. The `channel_answers` use-time equals the use-time of the payload in the `answer_request` function. It is also mutable, meaning that you are allowed to edit it.

#### 5.1.4.4 `answer_request()`

```
sfsc_int8 answer_request (
    sfsc_adapter * adapter,
    sfsc_server * server,
    sfsc_int32 expected_reply_id,
    sfsc_buffer reply_topic,
    sfsc_buffer * payload,
    void * mapping_arg,
    sfsc_answer_ack_callback * on_ack )
```

Answers a request.

After sending an answer, the original requestor will (hopefully) receive it and send an acknowledge for the answer. If the acknowledge is received in time, the `on_ack` callback will be invoked. If not, an attempt is automatically made to send it again. The maximal send again attempt count and the wait time are configured in the `server_struct` (see there for more information). If a server does not require its answers to be acknowledged and which are thus only send once, it is called a fire-and-forget server.

The `expected_reply_id` and `reply_topic` are given to you by the `on_request` function of the corresponding `sfsc_server`. The use-time of the `reply_topic` is the time until the `on_ack` callback is invoked. During this time, it must be valid and immutable. For fire-and-forget servers, the use-time of the `reply_topic` is only this functions runtime, meaning that its only necessary to be valid and immutable until this function returns.

The payload parameter is a pointer to the actual payload you want to transmitt in the answer. The use-time for this is either until the `on_ack` callback is invoked, or for fire-and-forget servers, this functions runtime. Since this is a pointer to a `sfsc_buffer` and not a `sfsc_buffer`, both, the pointer to the `sfsc_buffer` and the content pointer inside that buffer must be valid during the use-time. The payload buffer can be mutable: you are allowed to change the content pointer or the content it points to. This is usefull in some situation, e.g.: Imaging answering a request with a sensor measurement, stored behind `payload->content`. You do not receive an acknowledge in time, so the answer is send again. But during this peroid, the the measurement changed. Since you were allowed to change `payload->content`, you updated it, and the retransmission of the answer will contain the new measurement.

Answering a request to an non-fire-and-forget server will require a free acknowledge memory slot. If an attempt is made to answer a request on such a server and there are already `MAX_PENDING_ACKS` answer processes ongoing, a `E_NO_FREE_SLOT` will be returned. The acknowledge memory slot is freed once the `on_ack` callback is invoked.

The `mapping_arg` parameter is a mapping-argument (explained in the request functions documentation with an example).

#### Parameters

<i>adapter</i>	An operational adapter
<i>server</i>	The server that is answering a request
<i>expected_reply_id</i>	An answer identification number obtained by the original request
<i>reply_topic</i>	The answers reply topic, obtained by the original request
<i>payload</i>	The actual answer payload
<i>mapping_arg</i>	Optional; Serves as mapping-argument
<i>on_ack</i>	A callback to invoke once an acknowledge is received, can be NULL

**Returns**

sfsc\_int8 SFSC\_OK or one of the error codes below

**Return values**

<i>E_NO_FREE_SLOT</i>	If there is no free acknowledge memory slot while trying to answer a non-fire-and-forget request
<i>Various</i>	Network Errors There are serveral other, network-related errors that can occure

**5.1.4.5 channel\_request()**

```
sfsc_int8 channel_request (
    sfsc_adapter * adapter,
    sfsc_buffer topic,
    sfsc_buffer payload,
    sfsc_uint64 timeout_time,
    relative_sfsc_service_descriptor * descriptor,
    sfsc_uint8 * descriptor_space,
    sfsc_size descriptor_space_lenght,
    sfsc_channel_request_callback * on_answer,
    void * mapping_arg )
```

Makes a request call to a channel server service.

This function behaves like the request function, so see there for documentation. The only difference is, what the answer is, and how it is delivered.

Instead of normal binary payload, a channel\_request will result in a publisher service description as answer, in the same format as the query\_service function would return it. The difference to the query\_service function is, that the framework can not know, how many simultaneous channel requests you want to make. Thus it can not statically allocate memory for the service descriptors. As consequence, you have to allocate this memory yourself and pass it to this method. The memory must be large enough to hold the received service. If you do not know anything about the size of the service, it might be a good idea to use REGISTRY\_BUFFER\_SIZE as orientation. What happens if the descriptor\_space\_lenght is insufficient is described in the sfsc\_channel\_request\_callback documentation.

**Parameters**

<i>descriptor</i>	Pointer to a relative_sfsc_service_descriptor which will be filled
<i>descriptor_space</i>	Pointer to the start of the usable memory area
<i>descriptor_space_lenght</i>	Length of the usable memory area

**5.1.4.6 publish()**

```
sfsc_int8 publish (
    sfsc_adapter * adapter,
```

```
sfsc_publisher * publisher,
sfsc_buffer payload )
```

Publishes data through a publisher.

The publisher must be registered with this adapter, either by the `register_publisher` or the `register_publisher_↔` `unregistered` function.

The use-time of the payload is this functions runtime and must be immutable for the duration.

#### Parameters

<i>adapter</i>	An operational adapter this publisher is registered to
<i>publisher</i>	The publisher to publish the data
<i>payload</i>	The data to publish

#### Returns

sfsc\_int8 SFSC\_OK

#### 5.1.4.7 query\_services()

```
sfsc_int8 query_services (
    sfsc_adapter * adapter,
    sfsc_query_callback * on_service )
```

Starts a query process to obtain registered services from the core.

Only one query process might be running simultaneously. During a query process, all valid services will be delivered through the callback. The query process queries the cores event log in reversed order, so that more recently registered services will be found first.

After a service is found and delivered to the calling application throught the callback, the query process is paused, until it is explicitly continued by a call to the `query_services_next` function. See the documentation of the `sfsc_↔` `query_callback` for more information on the delivered service data.

#### Parameters

<i>adapter</i>	An operational adapter throught which the core is queried
<i>on_service</i>	The callback all receieved services are delivered to

#### Returns

sfsc\_int8 SFSC\_OK if starting the query process was successfull, or one of the error codes below

#### Return values

<i>E_QUERY_IN_PROGRESS</i>	If there is already an other query process
<i>Various</i>	Network Errors There are serveral other, network-related errors that can occure

#### 5.1.4.8 query\_services\_next()

```
void query_services_next (
    sfsc_adapter * adapter,
    sfsc_bool next )
```

Tells the framework to continue or to end a currently ongoing query process.

Once a service is found during the query process, the associated callback is invoked and the query process enters a pause state. It is then either continued by a call to this function with next set to 1 or ended with next set to 0.

It is not necessary, but allowed, that this function is invoked from a query callback. It is also allowed for it to be invoked from any other part of the program, as long as it is invoked eventually.

Calling this function while there is no query process ongoing (checkable by the adapter\_stats function) will result in undefined behaviour.

##### Parameters

<i>adapter</i>	The adapter which is currently in a query process
<i>next</i>	1 to continue the query process, 0 to end it

#### 5.1.4.9 random\_uuid()

```
void random_uuid (
    sfsc_uint8 target[UUID_LEN] )
```

Generates and writes a random 128bit UUID in standard-hexgroup-format to the target buffer.

Since the generated UUID is random, it can be classified as type 4 UUID.

This method generates 2 random sfsc\_uint64 and formats them in standard-hexgroup-format. Standard-hexgroup-format consists of 5 datagroups, each group represented by ASCII letters a-f and numbers 0-9. The groups are separated by the - ASCII symbol.

Examples: 23236572-6963-6973-7473-757065722323, 550e8400-e29b-11d4-a716-446655440000

##### Parameters

<i>target</i>	A at least UUID_LEN bytes long buffer to write the formatted UUID to
---------------	--

#### 5.1.4.10 register\_publisher()

```
sfsc_int8 register_publisher (
    sfsc_adapter * adapter,
```

```
sfsc_publisher * publisher,
sfsc_buffer name,
sfsc_buffer custom_tags,
sfsc_buffer output_message_type,
sfsc_command_callback * command_callback )
```

Sets up a publisher service and registers it with the core.

If you want to set up the services id and topic manually, see the sfsc\_publisher struct documentation for instructions.

After successful registration, this function will set the unregistered field of the publisher to 0.

All sfsc\_buffer parameters for this method must be immutable and must be valid until this function returns (their use-time equals this function's run time). For more information about mutability, see the sfsc\_buffer struct documentation. To omit an optional sfsc\_buffer parameter use sfsc\_buffer\_default as value.

Registering a publisher saves a pointer to that publisher in the adapter state, so you must not copy the publisher struct around as long as it is registered with the adapter! Also, registering will fail if there is no free publisher memory slot to store the pointer to that publisher in the adapter. In this case E\_NO\_FREE\_SLOT will be returned. The maximal number of at the same time registered publisher per adapter can be configured using MAX\_PUBLISHERS.

Also, since the publisher will be registered in the service registry, this call requires a free command memory slot and will also return E\_NO\_FREE\_SLOT if there are currently already MAX\_SIMULTANEOUS\_COMMANDS ongoing. The command memory slot will be occupied until the callback is invoked.

#### Parameters

<i>adapter</i>	An operational adapter
<i>publisher</i>	The publisher to register with this adapter, see the sfsc_publisher struct for more information
<i>name</i>	The name of this publisher
<i>custom_tags</i>	Optional; custom tags for the publisher
<i>output_message_type</i>	Optional; can be used to annotate the format of the published messages
<i>command_callback</i>	Optional; a callback that is invoked after service registration with the core was successful

#### Returns

sfsc\_int8 SFSC\_OK or one of the error codes below

#### Return values

<i>SFSC_OK</i>	This indicates that registering the publisher into the adapter was successful, and that the appropriate command to register the publisher into the core's service registry was issued.
<i>E_NO_FREE_SLOT</i>	There are already MAX_PUBLISHERS registered with this adapter, so there is no memory slot left for this one OR if there are currently already MAX_SIMULTANEOUS_COMMANDS ongoing
<i>Various</i>	Network Errors There are several other, network-related errors that can occur

#### 5.1.4.11 register\_publisher\_unregistered()

```
sfsc_int8 register_publisher_unregistered (
    sfsc_adapter * adapter,
    sfsc_publisher * publisher )
```

Sets up a publisher you can publish with, but does not register it in the cores service registry.

This function behaves mostly like register\_publisher, but since this publisher is not registered into the service registry, it does not have a name, custom\_tags or an output\_message\_type.

It will still have an service id and a topic, which are either setup manually or automatically generated, according to the rules specified in the sfsc\_publisher documentation. Also, for registering the publisher with the adapter, the adapter needs to have a free publisher memory slot (again, see register\_publisher).

This function will set the unregistred field of the publisher to 1.

A subscriber can subscribe to an unregistred publisher, if it knows the unregistered publishers topic. In most cases, this will happen in the context of a channel request.

Even if the publisher is not registered into the service registry, it sill needs to be properly unregistered form the adapter after usage by the unregister\_publisher function!

##### Parameters

<i>adapter</i>	An operational adapter
<i>publisher</i>	The publisher to register with this adapter, see the sfsc_publisher struct for more information

##### Returns

sfsc\_int8 SFSC\_OK or one of the error codes below

##### Return values

<i>SFSC_OK</i>	This indicates that registering the publisher into the adapter was successfull, and that the appropriate command to register the publisher into the cores service registry was issued.
<i>E_NO_FREE_SLOT</i>	There are already MAX_PUBLISHERS registered with this adapter, so there is no memory slot left for this one
<i>Various</i>	Network Errors There are serveral other, network-related errors that can occure

#### 5.1.4.12 register\_server()

```
sfsc_int8 register_server (
    sfsc_adapter * adapter,
    sfsc_server * server,
    sfsc_buffer name,
    sfsc_buffer custom_tags,
    sfsc_buffer output_message_type,
```

```
sfsc_buffer input_message_type,
sfsc_command_callback * command_callback )
```

Sets up a server service and registers it with the core.

If you want to set up the services id and topic manually, see the `sfsc_server` struct documentation for instructions.

Also, the function that is invoked when receiving requests, the servers acknowledge strategy and if this is a channel service must be configured in the `sfsc_server` before calling this function, so see their for instructions.

All `sfsc_buffer` parameters for this method must be immutable and must be valid until this function returns (their use-time equals this functions run time). For more information about mutability, see the `sfsc_buffer` struct documentation. To omit an optional `sfsc_buffer` parameter use `sfsc_buffer_default` as value.

Registering a server saves a pointer to that server in the adapter state, so you must not copy the server struct around as long as it is registered with the adapter! Also, registering will fail if there is no free server memory slot to store the pointer to that server in the adapter. In this case `E_NO_FREE_SLOT` will be returned. The maximal number of at the same time registered server per adapter can be configured using `MAX_SERVERS`.

Also, since the server will be registered in the service registry, this call requires a free command memory slot and will also return `E_NO_FREE_SLOT` if their are currently already `MAX_SIMULTANIOUS_COMMANDS` ongoing. The command memory slot will be occupied until the callback is invoked.

#### Parameters

<i>adapter</i>	An operational adapter
<i>server</i>	The server to register with this adapter, see the <code>sfsc_server</code> struct for more information
<i>name</i>	The name of this server
<i>custom_tags</i>	Optional; custom tags for the server
<i>output_message_type</i>	Optional; can be used to annotate the format of the messages the server sends as answers
<i>input_message_type</i>	Optional; can be used to annotate the format of the messages the server accepts on requests
<i>command_callback</i>	Optional; a callback that is invoked after service registration with the core was successful

#### Returns

`sfsc_int8` `SFSC_OK` or one of the error codes below

#### Return values

<i>SFSC_OK</i>	This indicates that registering the server into the adapter was successfull, and that the appropriate command to register the into into the cores service registry was issued.
<i>E_NO_FREE_SLOT</i>	There are already <code>MAX_SERVERS</code> registered with this adapter, so there is no memory slot left for this one OR if there are currently already <code>MAX_SIMULTANIOUS_COMMANDS</code> ongoing
<i>Various</i>	Network Errors There are serveral other, network-related errors that can occure



#### 5.1.4.13 register\_subscriber()

```
sfsc_int8 register_subscriber (
    sfsc_adapter * adapter,
    sfsc_subscriber * subscriber )
```

Subscribes to a sfsc publisher through the given adapter.

The publishers topic which should be subscribed to and the callback function which should be invoked can be set in the corresponding sfsc\_subscriber struct. For mutability rules of topic and callback function (if they are allowed to change), see the sfsc\_subscriber structs documentation.

Registering a subscriber saves a pointer to that subscriber in the adapter state, so you must not copy the subscriber struct around as long as it is registered with the adapter! Also, registering will fail if there is no free subscriber memory slot to store the pointer to that subscriber in the adapter. In this case E\_NO\_FREE\_SLOT will be returned. The maximal number of at the same time registered subscribers per adapter can be configured using MAX\_↵ SUBSCRIBERS.

Calling this function with an non-operational adapter will result in unpredictable behaviour! Registering the same subscriber multiple times will also result in unpredictable behaviour!

##### Parameters

<i>adapter</i>	An operational adapter which will be used for the subscription
<i>subscriber</i>	Pointer to the subscriber struct holding the topic and callback information

##### Returns

sfsc\_int8 SFSC\_OK on success or one of the error codes below

##### Return values

<i>E_NO_FREE_SLOT</i>	There are already MAX_SUBSCRIBERS registered with this adapter, so there is no memory slot left for this one
<i>Various</i>	Network Errors There are serveral other, network-related errors that can occure

#### 5.1.4.14 request()

```
sfsc_int8 request (
    sfsc_adapter * adapter,
    sfsc_buffer topic,
    sfsc_buffer payload,
    sfsc_uint64 timeout_time,
    sfsc_request_callback * on_answer,
    void * mapping_arg )
```

Makes a request call to a server service.

The topic of the server service is usually obtained by a registry query. The use-time of the topic and the payload equal the functions runtime ( until this function returns) and must both be immutable for this time (see the sfsc\_buffer documentation for more information about mutability).

If an answer to the request is received, the callback is invoked. For information on how the data will be delivered, see the callbacks documentation.

You can specify a `timeout_time` in ms. If this time passes without receiving an answer to this request, the callback is invoked with timeout set to 1.

Each request you want to make needs a request memory slot in the given adapter for the time of the request (until the callback is invoked). If there is no free request memory slot, `E_NO_FREE_SLOT` will be returned. You can configure the amount of available request memory slots using `MAX_SIMULTANIOUS_REQUESTS`.

As the use-time of the request topic and payload is only the functions runtime, they are both not necessarily valid when an answer is received, and thus can not be passed to the callback. But most certainly you want to know to which request the received answer belongs. One way is to declare a separate callback function for each of your requests. An other way to let you know which request function call the callbacks invocation belongs to, is to use the optional `mapping_arg` parameter as a so called mapping-argument. If and what you store behind the `mapping_arg` pointer is opaque to the framework. The callback function will be invoked with this `mapping_arg`. You can then, based on the `mapping_arg`, reason, what request call the answer belongs to. For example, if you know that even if the use-time of the request topic buffer is over it will continue to be valid, you can pass this as `mapping_arg`. Or you define that you will use the `mapping_arg` pointer as numerical value and treat it as an normal integer number instead of a pointer. Then you can assign unique request ids to your topics.

#### Parameters

<i>adapter</i>	The operational adapter to make the request with
<i>topic</i>	The server services topic to make the request to
<i>payload</i>	The payload of the request
<i>timeout_time</i>	The timeout time in ms, 0 for no timeout restrictions
<i>on_answer</i>	The callback that is invoked when receiving an answer or on timeout
<i>mapping_arg</i>	Optional; Serves as mapping-argument (see the text above for explanation)

#### Returns

`sfsc_int8` `SFSC_OK` or one of the error codes below

#### Return values

<i>SFSC_OK</i>	This indicates that registering the publisher into the adapter was successfull, and that the appropriate command to register the publisher into the cores service registry was issued.
<i>E_NO_FREE_SLOT</i>	There currently already <code>MAX_SIMULTANIOUS_REQUESTS</code> <code>MAX_PUBLISHERS</code> ongoing
<i>Various</i>	Network Errors There are several other, network-related errors that can occur

#### 5.1.4.15 start\_session()

```
sfsc_int8 start_session (
    sfsc_adapter * adapter,
    const char * address,
    int original_control_pub_port,
    int original_control_sub_port,
```

```
int original_data_pub_port,  
int original_data_sub_port )
```

Stats a sfsc adapter session without bootstrapping.

See `start_session_bootstrapped` for details.

#### 5.1.4.16 start\_session\_bootstrapped()

```
sfsc_int8 start_session_bootstrapped (  
    sfsc_adapter * adapter,  
    const char * address,  
    int original_control_pub_port )
```

Starts a sfsc adapter session with bootstrapping.

The adapter is not operational after this function returns. It first needs to do a handshake and connect to the other sfsc sockets of the core. You should start system-tasking (see the `system_task` function) with this adapter and check the state field of the stats object (accessible with the `adapter_stats` function) after each step. It will eventually become `SFSC_STATE_OPERATIONAL`, making the adapter operational.

##### Parameters

<i>adapter</i>	Pointer to the adapter struct, all state information will be saved there
<i>address</i>	The address of the core, it will be passed to your socket implementation
<i>original_control_pub_port</i>	The port of the cores control pub socket

##### Returns

sfsc\_int8 SFSC\_OK or an error code

#### 5.1.4.17 system\_task()

```
sfsc_int8 system_task (  
    sfsc_adapter * adapter )
```

Executes a single system task step on the adapter.

This function is non-blocking, and must be called cyclicly, with a high enough frequency on an adapter, on which the `start_session` or `start_session_bootstrapped` function was called. To read more about the execution model, see the [readme](#).

This function returns an error code, which is `SFSC_OK` on success. An other return code indicates an error, a list or error codes can be found in `sfsc_errors.h` and `zmtplib_states.h`. Some errors are recoverable, again, see the [readme](#).

##### Parameters

<i>adapter</i>	An adapter
----------------	------------

**Returns**

sfsc\_int8 SFSC\_OK or an error code

**5.1.4.18 unregister\_publisher()**

```
sfsc_int8 unregister_publisher (
    sfsc_adapter * adapter,
    sfsc_publisher * publisher,
    sfsc_command_callback * command_callback )
```

Unregisters a publisher.

Unregistering frees the publishers publisher memory slot in the adapter.

If this publisher is registered with the service registry, it will be removed from it. Removing requires a free command memory slot and will return E\_NO\_FREE\_SLOT if there are currently already MAX\_SIMULTANIOUS\_COMMANDS ongoing. The command memory slot will be occupied until the callback is invoked.

Even if the publisher is not registered with the service registry (because it was created with register\_publisher\_↵ unregistered), this function must still be called!

The callback is invoked after the publisher was removed from the service registry, with created set to 0. Since with unregistered publishers this is never the case, the callback is ignored and should be set to NULL.

**Parameters**

<i>adapter</i>	An operational adapter
<i>publisher</i>	The publisher to shut down
<i>command_callback</i>	For registered publishers only; Invoked after the publisher was removed from the service registry

**Returns**

sfsc\_int8 SFSC\_OK or one of the error codes below

**Return values**

<i>SFSC_OK</i>	This indicates that unregistering the publisher from the adapter was successfull, and if this publisher is registered in the service registry, that the appropriate command to unregister the publisher from there was issued
<i>E_NO_FREE_SLOT</i>	There are currently already MAX_SIMULTANIOUS_COMMANDS ongoing
<i>Various</i>	Network Errors There are serveral other, network-related errors that can occure

**5.1.4.19 unregister\_server()**

```
sfsc_int8 unregister_server (
    sfsc_adapter * adapter,
```

```
sfsc_server * server,
sfsc_command_callback * command_callback )
```

Unregisters a server.

Unregistering frees the servers server memory slot in the adapter.

The server will be removed from the service registry. Removing requires a free command memory slot and will return `E_NO_FREE_SLOT` if there are currently already `MAX_SIMULTANIOUS_COMMANDS` ongoing. The command memory slot will be occupied until the callback is invoked. The callback is invoked after the server was removed from the service registry, with `created` set to 0.

#### Parameters

<i>adapter</i>	An operational adapter
<i>server</i>	The server to shut down
<i>command_callback</i>	Invoked after the server was removed from the service registry

#### Returns

`sfsc_int8` `SFSC_OK` or one of the error codes below

#### Return values

<i>SFSC_OK</i>	Indicates that unregistering the server from the adapter was successfull and that the appropriate command to unregister the server from the service registry was issued
<i>E_NO_FREE_SLOT</i>	There are currently already <code>MAX_SIMULTANIOUS_COMMANDS</code> ongoing
<i>Various</i>	Network Errors There are serveral other, network-related errors that can occure

#### 5.1.4.20 unregister\_subscriber()

```
sfsc_int8 unregister_subscriber (
    sfsc_adapter * adapter,
    sfsc_subscriber * subscriber )
```

Unregisters a subscriber and unsubscribe messages on that topic.

If the given subscriber is registered with this adapter to receive published messages, it will be unregistered and a subscriber memory slot in the adapter will be freed. After this function returns, the callback of the subscriber will not be invoked again.

Unregistering a not registered subscriber will result in a success.

#### Parameters

<i>adapter</i>	The operational adapter, from which to unregister the subscriber
<i>subscriber</i>	The subscriber to remove

**Returns**

sfsc\_int8 SFSC\_OK on success or one of the Various Network Errors

**5.1.4.21 user\_task()**

```
sfsc_int8 user_task (
    sfsc_adapter * adapter )
```

Executes a single system task step on the adapter.

The adapter must be in an operational state, or this call will lead to undefined behaviour.

If this function is called, it will execute callbacks you registered. Whether using blocking or long taking code in your callbacks is allowed or not, depends on your execution modell (see the corresponding section in the readme).

It is important to continue calling this function, even if you entered the user task pause state (mentioned in the documentation of most callback functions).

This function returns an error code, which is SFSC\_OK on success. An other return code indicates an error, a list or error codes can be found in sfsc\_errors.h and zmtplib\_states.h. Some errors are recoverable, again, see the readme.

**Parameters**

<i>adapter</i>	An operational adapter
----------------	------------------------

**Returns**

sfsc\_int8 SFSC\_OK or an error code

**5.2 src/sfsc/sfsc\_adapter/sfsc\_error\_codes.h File Reference**

SFSC related error codes.

**Macros**

- **#define E\_PROTO\_DECODE -19**  
*Failed to decode an incoming sfsc message.*
- **#define E\_PROTO\_ENCODE -20**  
*Failed to encode an outgoing sfsc message.*
- **#define E\_TOO\_SLOW -21**  
*This indicates that you are calling the system\_task function with a too low frequency.*
- **#define E\_HEARTBEAT\_MISSING -22**  
*The core failed to send a heartbeat in time.*
- **#define W\_MESSAGE\_DROP -23**  
*Indicates that the system task was not able to write a message to the user ring, so the message is dropped instead.*
- **#define E\_QUERY\_IN\_PROGRESS -24**  
*Indicates that there is already a query process ongoing.*
- **#define E\_NO\_FREE\_SLOT -25**  
*Indicates that an adapter has no free memory slot of a certain type, but a function would need one.*

## 5.2.1 Detailed Description

SFSC related error codes.

## 5.2.2 Macro Definition Documentation

### 5.2.2.1 E\_HEARTBEAT\_MISSING

```
#define E_HEARTBEAT_MISSING -22
```

The core failed to send a heartbeat in time.

If this error happens, the core is most likely not longer available, either because of a core or a network failure. You should treat this session as expired and start a new one.

This error is not recoverable, meaning that you start a new sfsc session once you encounter it!

### 5.2.2.2 E\_NO\_FREE\_SLOT

```
#define E_NO_FREE_SLOT -25
```

Indicates that an adapter has no free memory slot of a certain type, but a function would need one.

This error is recoverable, meaning that you can continue to use the sfsc adapter.

### 5.2.2.3 E\_PROTO\_DECODE

```
#define E_PROTO_DECODE -19
```

Failed to decode an incoming sfsc message.

This usually means that your communication peer sends malformed messages, or at least that you are receiving malformed messages. There is not much you can do to prevent this error.

This error is not recoverable, meaning that you start a new sfsc session once you encounter it!

### 5.2.2.4 E\_PROTO\_ENCODE

```
#define E_PROTO_ENCODE -20
```

Failed to encode an outgoing sfsc message.

This usually happens if you call a sfsc function with malformed content. If you are working with sfsc\_buffers, check that they are valid for as long as the function you are using requires them.

This error is not recoverable, meaning that you start a new sfsc session once you encounter it!

#### 5.2.2.5 E\_QUERY\_IN\_PROGRESS

```
#define E_QUERY_IN_PROGRESS -24
```

Indicates that there is already a query process ongoing.

This error will usually occur if there is already a query process ongoing, and you try to start another one. Keep in mind that you have to end a query process manually and that it counts as running until you end id. See the `qery_services` function for more details.

This error is recoverable, meaning that you can continue to use the sfsc adapter.

#### 5.2.2.6 E\_TOO\_SLOW

```
#define E_TOO_SLOW -21
```

This indicates that you are calling the `system_task` function with a too low frequency.

This error happens if the system task can not send outgoing heartbeats in time. The solution is not to rise the `HEARTBEAT_SEND_RATE_MS`, but to call the system task more often.

This error is not recoverable, meaning that you start a new sfsc session once you encounter it!

#### 5.2.2.7 W\_MESSAGE\_DROP

```
#define W_MESSAGE_DROP -23
```

Indicates that the system task was not able to write a message to the user ring, so the message is dropped instead.

To understand the relation between system task and user ring, see the `readme`, section `execution model`.

This is more a warning than a error, and the framework should continue working.

If you encounter message drops very frequent, try to rise `USER_RING_SIZE` (see `sfsc_adapter_config.h`).