Application Note

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ADSP Driver for Android
RCG3AHPDA9001ZDO

Application Note - Driver -

RCG3AHPDA9001ZDOE_AN_EXT

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1. Overview

The below figure shows the basic configuration of ADSP driver and the connection with the ALSA framework when performs playback and record to ADSP device.

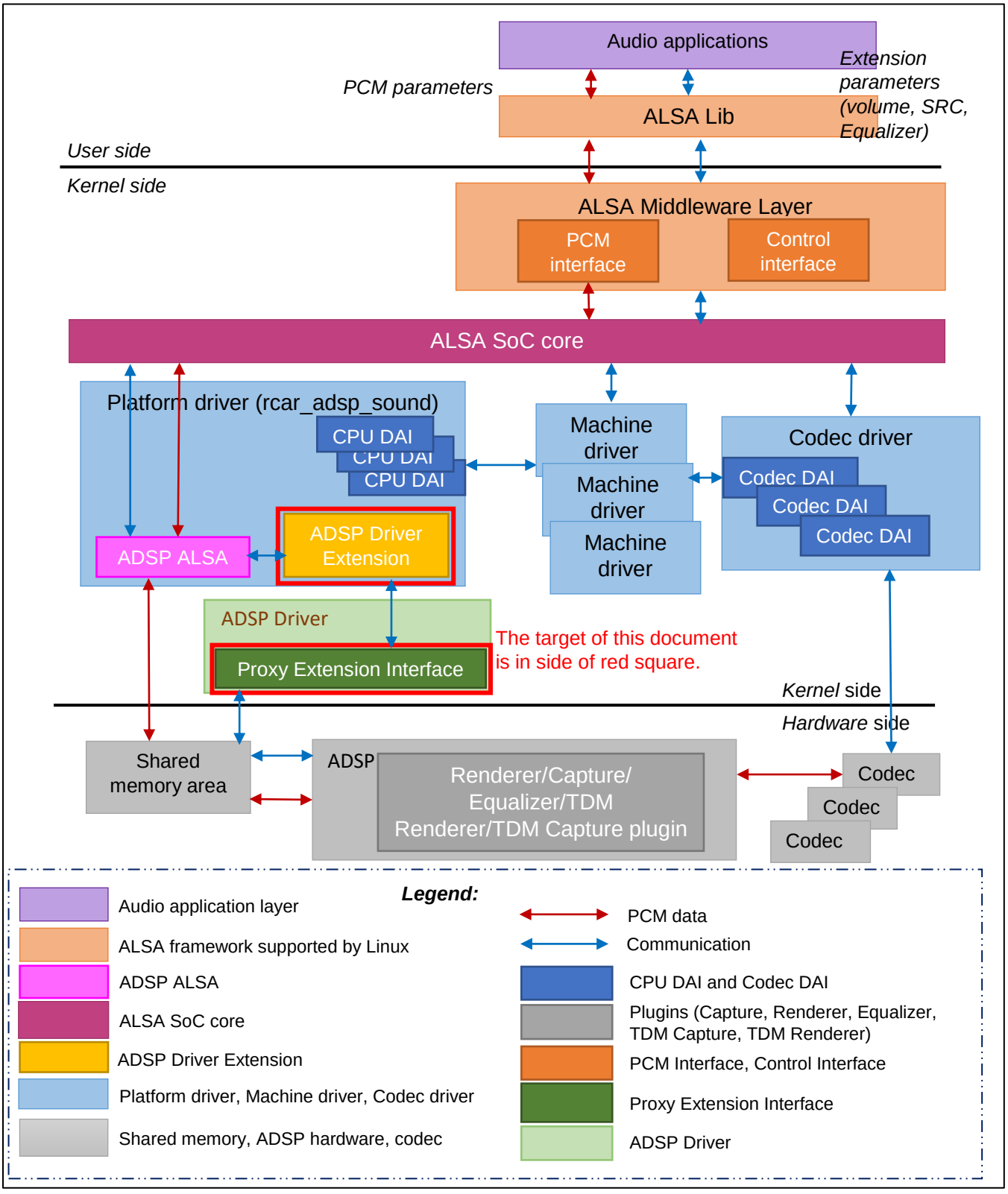

Figure 1-1 Overview configuration of ADSP driver

- **Audio applications (aplay, arecord, amixer, etc)**:
  The user applications that support to play or record sound by using ALSA library.

- **ALSA Lib**:
  The ALSA library APIs are the interface to the ALSA drivers.

- **ALSA Middle Layer**:
  It is a set of libraries which APIs gives applications access to the sound card drivers. And it can be broken down into the major interfaces such as control interface, PCM interface, raw MIDI interface, timer interface, sequencer interface and mixer interface.

- **ALSA SoC core:**
  It is part of ALSA Framework and does processing of PCM data

- **ADSP ALSA**:
  It is an ALSA device driver, implements to register a sound card for ADSP device. It provides callback functions for the native supports from ALSA framework to perform both playback and record. For playback/TDM playback, it receives PCM data from user app and transfers to ADSP Renderer plugin/ADSP TDM Renderer plugin. For record, it receives PCM data from ADSP Capture plugin/ADSP TDM Capture plugin and transfers to user app. The equalization function can be integrated into playback and record by routing between Equalizer and Renderer plugin, and between Equalizer and Capture plugins.

- **CPU DAI**:
  DAI stands for Digital Audio Interface. CPU DAI is the interface for the platform driver to communicate with other drivers.

- **Platform driver**:
  This is used to register ADSP sound card into ASoC framework. It holds ADSP ALSA driver, ADSP Driver Extension and ADSP sound card.

- **Codec driver**:
  It represents interface for codecs.

- **Codec DAI**:
  The DAI for codecs to communicate with other drivers

- **Machine driver**:
  The ASoC machine (or board) driver is the code that glues together the platform driver and codec driver.

- **Proxy Extension Interface**:
  APIs of methods through which ADSP Driver Extension communicates with shared memory area in Hardware side.

- **Shared memory area**:
  Shared memory is a memory area which can be read and written by both CPU and ADSP.

- **ADSP**:

  It is an audio DSP hardware unit. It provides ADSP framework which has the capability to control and execute multiple plugins (Renderer/Capture/Equalizer/TDM Renderer/TDM Capture) for playback, record, TDM and equalization. The communication between ADSP side and CPU side is performed by the interrupt, and the shared memory area.

2. ADSP Base

The below table shows list of structures in the ADSP base.

No.	Structures	Descriptions
1	struct xf_callback_func	The callback functions for ADSP ALSA driver
2	struct xf_callback_base_cmd	The callback functions for ADSP base
3	struct xf_handle	The registered handle's data
4	struct xf_adsp_base	ADSP base's processing data
5	struct xf_adsp_renderer_params	Renderer plugin's parameters
6	struct xf_adsp_renderer	Renderer component's data
7	struct xf_adsp_capture_params	Capture plugin's parameters
8	struct xf_adsp_capture	Capture component's data
9	struct xf_equalizer_parametric_coef	Parametric coefficients of Equalizer plugin
10	struct xf_equalizer_graphic_coef	Graphic coefficients of Equalizer plugin
11	struct xf_adsp_equalizer_params	Equalizer plugin's parameters
12	struct xf_adsp_equalizer	Equalizer component's data
13	struct xf_adsp_tdm_renderer_params	TDM Renderer plugin's parameters
14	struct xf_adsp_tdm_renderer	TDM Renderer component's data
15	struct xf_adsp_tdm_capture_params	TDM Capture plugin's parameters
16	struct xf_adsp_tdm_capture	TDM Capture component's data

Table 2-1 List of structure in ADSP base

The below table shows list of APIs in the ADSP base.

No.	APIs	Descriptions
1	xf_adsp_base_create	Create ADSP base control
2	xf_adsp_base_destroy	Destroy ADSP base control
3	xf_adsp_empty_this_buffer	Send data to ADSP plugin
4	xf_adsp_fill_this_buffer	Get data from ADSP plugin
5	xf_adsp_allocate_mem_pool	Allocate memory pool from ADSP
6	xf_adsp_free_mem_pool	Free memory pool to ADSP
7	xf_adsp_get_data_from_pool	Get data buffer from the given pool
8	xf_adsp_set_param	Set a single parameter to a registered plugin
9	xf_adsp_get_param	Get a single parameter to a registered plugin
10	xf_adsp_route	Route two registered plugins together
11	xf_adsp_renderer_create	Register Renderer component
12	xf_adsp_renderer_destroy	Unregister Renderer component
13	xf_adsp_renderer_set_params	Set parameters to Renderer plugin
14	xf_adsp_renderer_get_params	Get parameters from Renderer plugin
15	xf_adsp_capture_create	Register Capture component
16	xf_adsp_capture_destroy	Unregister Capture component
17	xf_adsp_capture_set_params	Set parameters to Capture plugin
18	xf_adsp_capture_get_params	Get parameters from Capture plugin
19	xf_adsp_equalizer_create	Register Equalizer component

20	xf_adsp_equalizer_destroy	Unregister Equalizer component
21	xf_adsp_equalizer_set_params	Set parameters to Equalizer plugin
22	xf_adsp_equalizer_get_params	Get parameters from Equalizer plugin
23	xf_adsp_tdm_renderer_create	Register TDM Renderer component
24	xf_adsp_tdm_renderer_destroy	Unregister TDM Renderer component
25	xf_adsp_tdm_renderer_set_params	Set parameters to TDM Renderer plugin
26	xf_adsp_tdm_renderer_get_params	Get parameters to TDM Renderer plugin
27	xf_adsp_tdm_capture_create	Register TDM Capture component
28	xf_adsp_tdm_capture_destroy	Unregister TDM Capture component
29	xf_adsp_tdm_capture_set_params	Set parameters to TDM Capture plugin
30	xf_adsp_tdm_capture_get_params	Get parameters to TDM Capture plugin

Table 2-2 List of APIs in ADSP base

2.1 Structure

2.1.1 xf_callback_func structure

struct xf_callback_func	
int (*empty_buf_done)(void *data, int opcode, int length, char *buffer)	Callback function for response message of XF_EMPTY_THIS_BUFFER command
int (*fill_buf_done)(void *data, int opcode, int length, char *buffer)	Callback function for response message of XF_FILL_THIS_BUFFER command
int (*event_handler)(void *data)	Callback for event handler

2.1.2 xf_adsp_base_cmd structure

struct xf_adsp_base_cmd	
int (*client_register)(void **private_data)	Callback function for registering a new client from proxy driver for ADSP base control
int (*client_unregister)(void *private_data)	Callback function for freeing the registered client to proxy driver
int (*recv)(void *private_data, void *buf)	Callback function for getting the message from client message queue
int (*send)(void *private_data, void *buf)	Callback function for sending command to from ADSP base for ADSP transfer process to proxy driver
int (*poll)(void *private_data, int *condition)	Callback function to sleep and wait until there is a response message available from the client message queue or the condition flag becomes true.

2.1.3 xf_handle structure

struct xf_handle		
int	comp_id	Component ID of handler that registered in ADSP
struct xf_callback_func	*cb	Callback functions to ADSP ALSA driver
void	*private_data	A data in ADSP ALSA driver that is used as a parameter in the callback functions

2.1.4 xf_adsp_base structure

struct xf_adsp_base		
struct xf_adsp_base_cmd	cmd	Struct of extension APIs for ADSP base
void	*client	Client data which registered on proxy driver
struct xf_pool	*aux_pool	Auxiliary pool data which registered to ADSP [*]
struct xf_handle	*handle[256]	Handle data which registered by ADSP ALSA driver
struct task_struct	*rsp_thread	Response thread of ADSP base [*]
wait_queue_head_t	base_wait	Wait queue for the response messages [*]
struct xf_message	base_msg	The message for stored the response message [*]
int	base_flag	The flag for ADSP base waiting
int	err_flag	The flag to indicate an error from plugins
int	wait_flag	The flag for ADSP base polling waiting
spinlock_t	lock	Spinlock data

2.1.5 xf_adsp_renderer_params structure

struct xf_adsp_renderer_params		
int	channel	PCM channels
int	pcm_width	PCM width
int	frame_size	Size of a frame in sample
int	in_rate	Input sampling rate
int	out_rate	Output sampling rate
int	vol_rate	Volume rate
int	dev1	Index of first output device
int	dev2	Index of second output device
int	dma1	Index of first DMA channel
int	dma2	Index of second DMA channel
int	out_channel	Output PCM channels
int	mix_ctrl	Mix control flag
int	state	Operation state control
int	ring_num	Total number of ring buffers

2.1.6 xf_adsp_renderer structure

struct xf_adsp_renderer	
struct xf_adsp_renderer_params params	Store the parameters of Renderer plugin
struct xf_pool *buf_pool	Buffer pool data that used for PCM transfer
int handle_id	Handle ID that Renderer has registered in ADSP base

2.1.7 xf_adsp_capture_params structure

struct xf_adsp_capture_params		
int	channel	PCM channels
int	pcm_width	PCM width
int	frame_size	Size of a frame in sample
int	in_rate	Input sampling rate
int	out_rate	Output sampling rate
int	vol_rate	Volume rate
int	dev1	Index of first input device
int	dev2	Index of second input device
int	dma1	Index of first DMA channel
int	dma2	Index of second DMA channel
int	state	Operation state control
int	ring_num	Total number of ring buffers

2.1.8 xf_adsp_capture structure

struct xf_adsp_capture	
struct xf_adsp_capture_params params	Store the parameters of Capture plugin
struct xf_pool *buf_pool	Buffer pool data that used for PCM transfer
int handle_id	Handle ID that Capture has registered in ADSP base

2.1.9 xf_equalizer_parametric_coef structure

struct xf_equalizer_parametric_coef	
int type[9]	Parametric filter type
int fc[9]	Parametric filter center frequency
int gain[9]	Parametric filter gain
int band_width[9]	Parametric filter band width
int gain_base[9]	Parametric filter gain base

2.1.10 xf_equalizer_graphic_coef structure

struct xf_equalizer_graphic_coef	
int gain_g[5]	Graphic filter gain

- Note:
  There are 9 filters for parametric equalizer type and 5 filters for graphic equalizer type.

2.1.11 xf_adsp_equalizer_params structure

struct xf_adsp_equalizer_params	
int channel	PCM channel
int pcm_width	PCM width
int rate	Sampling rate
int eqz_type	Equalizer type
struct xf_equalizer_parametric_coef p_coef	Parametric coefficients
struct xf_equalizer_graphic g_coef	Graphic coefficient

2.1.12 xf_adsp_equalizer structure

struct xf_adsp_equalizer	
struct xf_adsp_equalizer_params params	Store the parameters of Equalizer plugin
struct xf_pool *buf_pool	Buffer pool data that used for PCM transfer
int handle_id	Handle ID that Equalizer has registered

2.1.13 xf_adsp_tdm_renderer_params structure

struct xf_adsp_tdm_renderer_params		
int	ch_mode	Channel mode
int	pcm_width	PCM width
int	frame_size	Size of a frame in sample
int	in_rate	Input sampling rate
int	out_rate	Output sampling rate
int	vol_rate	Volume rate
int	dev1	Index of first output device
int	dev2	Index of second output device
int	dma1	Index of first DMA channel
int	dma2	Index of second DMA channel

2.1.14 xf_adsp_tdm_renderer structure

struct xf_adsp_tdm_renderer	
struct xf_adsp_tdm_renderer_params params	Store the parameters of TDM Renderer plugin
struct xf_pool *buf_pool	Buffer pool data that used for PCM transfer
int handle_id	Handle ID that TDM Renderer has registered in ADSP base

2.1.15 xf_adsp_tdm_capture_params structure

struct xf_adsp_tdm_capture_params		
int	ch_mode	Channel mode
int	pcm_width	PCM width
int	frame_size	Size of a frame in sample
int	in_rate	Input sampling rate
int	out_rate	Output sampling rate
int	vol_rate	Volume rate
int	dev1	Index of first input device
int	dev2	Index of second input device
int	dma1	Index of first DMA channel
int	dma2	Index of second DMA channel

2.1.16 xf_adsp_tdm_capture structure

struct xf_adsp_tdm_capture	
struct xf_adsp_tdm_capture_params params	Store the parameters of TDM Capture plugin
struct xf_pool *buf_pool	Buffer pool data that used for PCM transfer
int handle_id	Handle ID that TDM Capture has registered in ADSP base

2.2 Interface APIs

2.2.1 xf_adsp_base_create

xf_adsp_base_create		
Synopsis	This API creates and initializes ADSP base data that ADSP ALSA driver can use to control ADSP plugins (Renderer/Capture/Equalizer/TDM Capture/TDM Renderer).	
Syntax	int xf_adsp_base_create(struct xf_adsp_base_cmd *cmd)	
Parameter	struct xf_adsp_base_cmd *cmd	Pointer to struct of commands for extension interface
Return value	0	ADSP base registers successful.
	-EINVAL	ADSP base has been alive. Parameter cmd is invalid.
	-ENOMEM	Cannot allocate memory for ADSP base usage.
	-EBUSY	ADSP base cannot register to proxy driver due to number of client has been exceeded.

2.2.2 xf_adsp_base_destroy

xf_adsp_base_destroy		
Synopsis	This API frees all resources that ADSP base has registered.	
Syntax	int xf_adsp_base_destroy (void)	
Parameter	-	-
Return value	0	ADSP base destroy successful.
	-EINVAL	ADSP base has not been registered yet.

2.2.3 xf_adsp_empty_this_buffer

xf_adsp_empty_this_buffer		
Synopsis	This API sends a XF_EMPTY_THIS_BUFFER command to ADSP framework.	
Syntax	int xf_adsp_empty_this_buffer(int handle_id, char *buffer, int length)	
Parameter	int handle_id	Handle ID that registered in ADSP base
	char *buffer	Pointer to PCM buffer
	int length	Size of buffer in byte
Return value	0	Success
	-EINVAL	ADSP base has not registered yet, or the handle ID has not registered to ADSP base yet.

2.2.4 xf_adsp_fill_this_buffer

xf_adsp_fill_this_buffer		
Synopsis	This API sends a XF_FILL_THIS_BUFFER command to ADSP framework.	
Syntax	int xf_adsp_fill_this_buffer(int handle_id, char *buffer, int length)	
Parameter	int handle_id	Handle ID that registered in ADSP base
	char *buffer	Pointer to PCM buffer
	int length	Size of buffer in byte
Return value	0	Success
	-EINVAL	ADSP base has not registered yet, or the handle ID has not registered to ADSP base yet.

2.2.5 xf_adsp_mmap_this_buffer

xf_adsp_mmap_this_buffer		
Synopsis	This API sends a XF_MMAP_THIS_BUFFER command to ADSP framework.	
Syntax	int xf_adsp_mmap_this_buffer(int handle_id, char *buffer, int length)	
Parameter	int handle_id	Handle ID that registered in ADSP base
	char *buffer	Pointer to PCM buffer
	int length	Size of buffer in byte
Return value	0	Success
	-EINVAL	ADSP base has not registered yet, or the handle ID has not registered to ADSP base yet. Mapping buffer in ADSP is failed

2.2.6 xf_adsp_allocate_mem_pool

xf_adsp_allocate_mem_pool		
Synopsis	This API sends a XF_ALLOC to ADSP to request a memory pool with desired pool size and buffer length.	
Syntax	struct xf_pool *xf_adsp_allocate_mem_pool(int pool_size, int buf_length)	
Parameter	int pool_size	Number of buffer need to allocate from ADSP
	int buf_length	Size of buffer need to allocate from ADSP
Return value	Pointer	Pointer to registered memory pool
	-EINVAL	ADSP base has not registered yet.
	-ENOMEM	Cannot allocate memory for pool Cannot allocate buffers in ADSP

2.2.7 xf_adsp_free_mem_pool

xf_adsp_free_mem_pool

Synopsis	This API frees memory pool and sends a XF_FREE to ADSP to return the previous registered buffers.	
Syntax	int xf_adsp_free_mem_pool(struct xf_pool *pool)	
Parameter	struct xf_pool *pool	Pointer to allocated memory pool
Return value	0	Pool has been free successfully.
	-EINVAL	ADSP base has not registered yet, or memory pool is invalid.

2.2.8 xf_adsp_get_data_from_pool

xf_adsp_get_data_from_pool		
Synopsis	This API gets a data buffer from pool, which registered before.	
Syntax	char *xf_adsp_get_data_from_pool(struct xf_pool *pool, int index)	
Parameter	struct xf_pool *pool	Pointer to allocated memory pool
	int index	The index of buffer in pool
Return value	Pointer	Buffer address of pool
	-EINVAL	Memory pool is invalid or, the index is over than number of buffer in pool.

2.2.9 xf_adsp_set_param

xf_adsp_set_param		
Synopsis	This API sets a single parameter to a registered plugin.	
Syntax	int xf_adsp_set_param(int handle_id, int index, int value)	
Parameter	int handle_id	Handle ID that registered in ADSP base
	int index	The sub-command index of the setting value
	int value	The setting value
Return value	0	Success
	-EINVAL	ADSP base has not registered yet, or the handle ID has not registered to ADSP base yet, or the setting command makes a fatal error from ADSP plugin.

2.2.10 xf_adsp_get_param

xf_adsp_get_param		
Synopsis	This API gets a single parameter to a registered plugin.	
Syntax	int xf_adsp_get_param(int handle_id, int index, int *value)	
Parameter	int handle_id	Handle ID that registered in ADSP base
	int index	The sub-command index of the getting value
	int *value	Pointer of the stored getting value
Return value	0	Success
	-EINVAL	ADSP base has not registered yet, or the handle ID has not registered to ADSP base yet, or the pointer of value is invalid, or the getting command makes a fatal error from ADSP plugin.

2.2.11 xf_adsp_route

xf_adsp_route		
Synopsis	This API sends a XF_ROUTE command to ADSP framework to register a tunnel for transfer data between two ADSP plugins.	
Syntax	int xf_adsp_route(int src_handle_id, int dst_handle_id, int buf_cnt, int buf_size)	
Parameter	int src_handle_id	Handle ID of source component
	int dst_handle_id	Handle ID of destination component
	int buf_cnt	Number of buffer that used for tunnel
	int buf_size	Size of a buffer that used for tunnel
Return value	0	Success
	-EINVAL	ADSP base has not registered yet, or the src/dst handle ID have not registered to ADSP base yet, or the tunnel request cannot complete from ADSP.

2.2.12 xf_adsp_renderer_create

xf_adsp_renderer_create		
Synopsis	This API initializes a Renderer instance, registers ADSP Renderer plugin. After Renderer has registered successful, the API registers a handler to ADSP base, and get a handle ID which represents for a new handler which has been registered completely. Finally, it initializes all parameters as default values with default values of ADSP Renderer plugin.	
Syntax	int xf_adsp_renderer_create(struct xf_adsp_renderer **renderer, struct xf_callback_func *cb, void *private_data)	
Parameter	struct xf_adsp_renderer **renderer	The pointer to store the created Renderer instance
	struct xf_callback_func *cb	Pointer to the callback functions
	void *private_data	Pointer to a private data that used as a parameter in callback functions
Return value	0	Success
	-EINVAL	ADSP base has not registered yet, or cannot register new handler to ADSP base, or cannot register Renderer plugin to ADSP, or cannot get default value from ADSP Renderer plugin.
	-ENOMEM	Cannot allocate Renderer instance

2.2.13 xf_adsp_renderer_destroy

xf_adsp_renderer_destroy		
Synopsis	This API unregisters ADSP Renderer plugin, frees registered handler and instance.	
Syntax	int xf_adsp_renderer_destroy(struct xf_adsp_renderer *renderer)	
Parameter	struct xf_adsp_renderer *renderer	Pointer to Renderer instance
Return value	0	Success
	-EINVAL	ADSP base has not registered yet, or Renderer instance is invalid.

2.2.14 xf_adsp_renderer_set_params

xf_adsp_renderer_set_params		
Synopsis	This API sets all parameters for ADSP Renderer plugin based on the values in params structure of Renderer instance.	
Syntax	int xf_adsp_renderer_set_params(struct xf_adsp_renderer *renderer)	
Parameter	struct xf_adsp_renderer *renderer	Pointer to Renderer instance
Return value	0	Success
	-EINVAL	ADSP base has not registered yet, or Renderer instance is invalid, or Renderer instance has not register to ADSP base yet, or the setting command make a fatal error from ADSP Renderer plugin.

2.2.15 xf_adsp_renderer_get_params

xf_adsp_renderer_get_params		
Synopsis	This API gets all ADSP Renderer's parameters and stores the returned values in params structure of Renderer instance.	
Syntax	int xf_adsp_renderer_get_params(struct xf_adsp_renderer *renderer)	
Parameter	struct xf_adsp_renderer *renderer	Pointer to Renderer instance
Return value	0	Success
	-EINVAL	ADSP base has not registered yet, or Renderer instance is invalid, or Renderer instance has not register to ADSP base yet, or the getting command make a fatal error from ADSP Renderer plugin.

2.2.16 xf_adsp_capture_create

xf_adsp_capture_create		
Synopsis	This API initializes a Capture instance, registers ADSP Capture plugin. After Capture has registered successful, the API registers a handler to ADSP base, and get a handle ID which represents for a new handler which has been registered completely. Finally, it initializes all parameters as default values with default values of ADSP Capture plugin.	
Syntax	int xf_adsp_capture_create(struct xf_adsp_capture **capture, struct xf_callback_func *cb, void *private_data)	
Parameter	struct xf_adsp_capture **capture	The pointer to store the created Capture instance
	struct xf_callback_func *cb	Pointer to the callback functions
	void *private_data	Pointer to a private data that used as a parameter in callback functions
Return value	0	Success
	-EINVAL	ADSP base has not registered yet or cannot register new handler to ADSP base, or cannot register Capture plugin to ADSP, or cannot get default values from ADSP Capture plugin.
	-ENOMEM	Cannot allocate Capture instance

2.2.17 xf_adsp_capture_destroy

xf_adsp_capture_destroy		
Synopsis	This API unregisters ADSP Capture plugin, frees registered handler and instance.	
Syntax	int xf_adsp_capture_destroy(struct xf_adsp_capture *capture)	
Parameter	struct xf_adsp_capture *capture	Pointer to Capture instance
Return value	0	Success
	-EINVAL	ADSP base has not registered yet, or Capture instance is invalid.

2.2.18 xf_adsp_capture_set_params

xf_adsp_capture_set_params		
Synopsis	This API sets all parameters for ADSP Capture plugin based on the values in params structure of Capture instance.	
Syntax	int xf_adsp_capture_set_params(struct xf_adsp_capture *capture)	
Parameter	struct xf_adsp_capture *capture	Pointer to Capture instance
Return value	0	Success
	-EINVAL	ADSP base has not registered yet, or Capture instance is invalid, or Capture instance has not register to ADSP base yet, or the setting command make a fatal error from ADSP Capture plugin.

2.2.19 xf_adsp_capture_get_params

xf_adsp_capture_get_params		
Synopsis	This API gets all ADSP Capture's parameters and stores the returned values in params structure of Capture instance.	
Syntax	int xf_adsp_capture_get_params(struct xf_adsp_capture *capture)	
Parameter	struct xf_adsp_capture *capture	Pointer to Capture instance
Return value	0	Success
	-EINVAL	ADSP base has not registered yet, or Capture instance is invalid, or Capture instance has not register to ADSP base yet, or the getting command make a fatal error from ADSP Capture plugin.

2.2.20 xf_adsp_equalizer_create

xf_adsp_equalizer_create		
Synopsis	This API initializes an Equalizer instance, registers ADSP Equalizer plugin. After Equalizer has registered successful, the API registers a handler to ADSP base, and get a handle ID which represents for a new handler which has been registered completely. Finally, it initializes all parameters as default values with defaul values of ADSP Equalizer plugin.	
Syntax	int xf_adsp_equalizer_create(struct xf_adsp_equalizer **equalizer, struct xf_callback_func *cb, void *private_data)	
Parameter	struct xf_adsp_equalizer **equalizer	The pointer to store the created Equalizer instance
	struct xf_callback_func *cb	Pointer to the callback functions
	void *private_data	Pointer to a private data that used as a parameter in callback functions
Return value	0	Success
	-EINVAL	ADSP base has not registered yet or cannot register new handler to ADSP base, or cannot register Equalizer plugin to ADSP, or cannot get default values from ADSP Equalizer plugin.
	-ENOMEM	Cannot allocate Equalizer instance

2.2.21 xf_adsp_equalizer_destroy

xf_adsp_equalizer_destroy		
Synopsis	This API unregisters ADSP Equalizer plugin, frees registered handler and instance.	
Syntax	int xf_adsp_equalizer_destroy(struct xf_adsp_equalizer *equalizer)	
Parameter	struct xf_adsp_equalizer *equalizer	Pointer to Equalizer instance
Return value	0	Success
	-EINVAL	ADSP base has not registered yet, or Equalizer instance is invalid.

2.2.22 xf_adsp_equalizer_set_params

xf_adsp_equalizer_set_params		
Synopsis	This API sets all parameters for ADSP Equalizer plugin based on the values in params structure of Equalizer instance.	
Syntax	int xf_adsp_equalizer_set_params(struct xf_adsp_equalizer *equalizer)	
Parameter	struct xf_adsp_equalizer *equalizer	Pointer to Equalizer instance
Return value	0	Success
	-EINVAL	ADSP base has not registered yet, or Equalizer instance is invalid, or Equalizer instance has not register to ADSP base yet, or the setting command makes a fatal error from ADSP Equalizer plugin.

2.2.23 xf_adsp_equalizer_get_params

xf_adsp_equalizer_get_params		
Synopsis	This API gets all ADSP Equalizer's parameters and stores the returned values in params structure of Equalizer instance.	
Syntax	int xf_adsp_equalizer_get_params(struct xf_adsp_equalizer *equalizer)	
Parameter	struct xf_adsp_equalizer *equalizer	Pointer to Equalizer instance
Return value	0	Success
	-EINVAL	ADSP base has not registered yet, or Equalizer instance is invalid, or Equalizer instance has not register to ADSP base yet, or the getting command makes a fatal error from ADSP Equalizer plugin.

2.2.24 xf_adsp_tdm_renderer_create

xf_adsp_tdm_renderer_create		
Synopsis	This API initializes a TDM Renderer instance, registers ADSP TDM Renderer plugin. After TDM Renderer has been registered successfully, the API registers a handler to ADSP base, and gets a handle ID which represents for a new handler which has been registered completely. Finally, it initializes all parameters as default values with default values of TDM Renderer plugin.	
Syntax	int xf_adsp_tdm_renderer_create(struct xf_adsp_tdm_renderer **tdm_renderer, struct xf_callback_func *cb, void *private_data)	
Parameter	struct xf_adsp_tdm_renderer **tdm_renderer	The pointer to store the created TDM Renderer instance
	struct xf_callback_func *cb	Pointer to the callback functions
	void *private_data	Pointer to a private data that used as a parameter in callback functions
Return value	0	Success
	-EINVAL	ADSP base has not registered yet, or cannot register new handler to ADSP base, or cannot register TDM Renderer plugin to ADSP, or cannot get default values from ADSP TDM Renderer plugin.
	-ENOMEM	Cannot allocate TDM Renderer instance

2.2.25 xf_adsp_tdm_renderer_destroy

xf_adsp_tdm_renderer_destroy		
Synopsis	This API unregisters ADSP TDM Renderer plugin, frees registered handler and instance.	
Syntax	int xf_adsp_tdm_renderer_destroy(struct xf_adsp_tdm_renderer *tdm_renderer)	
Parameter	struct xf_adsp_tdm_renderer *tdm_renderer	Pointer to TDM Renderer instance
Return value	0	Success
	-EINVAL	ADSP base has not registered yet, or TDM Renderer instance is invalid.

2.2.26 xf_adsp_tdm_renderer_set_params

xf_adsp_tdm_renderer_set_params		
Synopsis	This API sets all parameters for ADSP TDM Renderer plugin based on the values in params structure of TDM Renderer instance.	
Syntax	int xf_adsp_tdm_renderer_set_params(struct xf_adsp_tdm_renderer *tdm_renderer)	
Parameter	struct xf_adsp_tdm_renderer *tdm_renderer	Pointer to TDM Renderer instance
Return value	0	Success
	-EINVAL	ADSP base has not registered yet, or TDM Renderer instance is invalid, or TDM Renderer instance has not register to ADSP base yet, or the setting command make a fatal error from ADSP TDM Renderer plugin.

2.2.27 xf_adsp_tdm_renderer_get_params

xf_adsp_tdm_renderer_get_params		
Synopsis	This API gets all ADSP TDM Renderer's parameters and stores the returned values in params structure of TDM Renderer instance.	
Syntax	int xf_adsp_tdm_renderer_get_params(struct xf_adsp_tdm_renderer *tdm_renderer)	
Parameter	struct xf_adsp_tdm_renderer *tdm_renderer	Pointer to TDM Renderer instance
Return value	0	Success
	-EINVAL	ADSP base has not registered yet, or TDM Renderer instance is invalid, or TDM Renderer instance has not register to ADSP base yet, or the getting command make a fatal error from ADSP TDM Renderer plugin.

2.2.28 xf_adsp_tdm_capture_create

xf_adsp_tdm_capture_create		
Synopsis	This API initializes a TDM Capture instance, registers ADSP TDM Capture plugin. After TDM Capture has been registered successfully, the API registers a handler to ADSP base, and get a handle ID which represents for a new handler has been registered completely. Finally, it initializes all parameters as default values with default values of the plugin.	
Syntax	int xf_adsp_tdm_capture_create(struct xf_adsp_tdm_capture **tdm_capture, struct xf_callback_func *cb, void *private_data)	
Parameter	struct xf_adsp_tdm_capture **tdm_capture	The pointer to store the created TDM Capture instance
	struct xf_callback_func *cb	Pointer to the callback functions
	void *private_data	Pointer to a private data that used as a parameter in callback functions
Return value	0	Success
	-EINVAL	ADSP base has not registered yet or cannot register new handler to ADSP base, or cannot register TDM Capture plugin to ADSP, or cannot get default values from ADSP TDM Capture plugin.
	-ENOMEM	Cannot allocate TDM Capture instance

2.2.29 xf_adsp_tdm_capture_destroy

xf_adsp_tdm_capture_destroy		
Synopsis	This API unregisters ADSP TDM Capture plugin, frees registered handler and instance.	
Syntax	int xf_adsp_tdm_capture_destroy(struct xf_adsp_tdm_capture *tdm_capture)	
Parameter	struct xf_adsp_tdm_capture *tdm_capture	Pointer to TDM Capture instance
Return value	0	Success
	-EINVAL	ADSP base has not registered yet, or TDM Capture instance is invalid.

2.2.30 xf_adsp_tdm_capture_set_params

xf_adsp_tdm_capture_set_params		
Synopsis	This API sets all parameters for ADSP TDM Capture plugin based on the values in params structure of TDM Capture instance.	
Syntax	int xf_adsp_tdm_capture_set_params(struct xf_adsp_tdm_capture *tdm_capture)	
Parameter	struct xf_adsp_tdm_capture *tdm_capture	Pointer to TDM Capture instance
Return value	0	Success
	-EINVAL	ADSP base has not registered yet, or TDM Capture instance is invalid, or TDM Capture instance has not register to ADSP base yet, or the setting command make a fatal error from ADSP TDM Capture plugin.

2.2.31 xf_adsp_tdm_capture_get_params

xf_adsp_tdm_capture_get_params		
Synopsis	This API gets all ADSP TDM Capture's parameters and stores the returned values in params structure of TDM Capture instance.	
Syntax	int xf_adsp_tdm_capture_get_params(struct xf_adsp_tdm_capture *tdm_capture)	
Parameter	struct xf_adsp_tdm_capture *tdm_capture	Pointer to TDM Capture instance
Return value	0	Success
	-EINVAL	ADSP base has not registered yet, or TDM Capture instance is invalid, or TDM Capture instance has not register to ADSP base yet, or the getting command make a fatal error from ADSP TDM Capture plugin.

3. Proxy Driver Interface - Extension APIs for ADSP Base

The below table shows list of extension APIs for proxy driver.

No.	APIs	Descriptions
1	xf_adsp_base_client_register	Register a proxy client for ADSP base
2	xf_adsp_base_client_unregister	Unregister the given client of ADSP base
3	xf_adsp_base_send	Send a command message to proxy driver
4	xf_adsp_base_recv	Receive a response message from proxy driver
5	xf_adsp_base_poll	Wait for the response message from proxy driver

Table 3-1 List of extension APIs for proxy driver

3.1 xf_adsp_base_client_register

xf_adsp_base_client_register		
Synopsis	This API registers a new client from proxy driver for ADSP base control.	
Syntax	int xf_adsp_base_client_register(void **private_data)	
Parameter	void **private_data	The pointer to store the registered proxy client.
Return value	0	Success
	-ENOMEM	Cannot allocate memory for client
	-EBUSY	Number of client in proxy has exceeded.

3.2 xf_adsp_base_client_unregister

xf_adsp_base_client_unregister		
Synopsis	This API frees the registered client to proxy driver.	
Syntax	int xf_adsp_base_client_unregister(void *private_data)	
Parameter	void *private_data	Pointer to registered client of ADSP base
Return value	0	Success
	-EINVAL	Client data is invalid.

3.3 xf_adsp_base_send

xf_adsp_base_send		
Synopsis	This API sends a command message from ADSP base for ADSP transfer process to proxy driver.	
Syntax	int xf_adsp_base_send(void *private_data, void *buf)	
Parameter	void *private_data	Pointer to registered client of ADSP base
	void *buf	Pointer to command message data
Return value	0	Success
	-EINVAL	Client data is invalid, or it has not registered to proxy driver yet, or cannot send message to proxy

3.4 xf_adsp_base_recv

xf_adsp_base_recv		
Synopsis	This API gets the message from client message queue	
Syntax	int xf_adsp_base_recv (void *private_data, void *buf)	
Parameter	void *private_data	Pointer to registered client of ADSP base
	void *buf	Pointer to the stored message data
Return value	0	Success
	-EINVAL	Client data is invalid, or it has not registered to proxy driver yet, or the response message is invalid.

3.5 xf_adsp_base_poll

xf_adsp_base_poll		
Synopsis	This API sleeps and waits until there are a response message is available from client message queue or the condition flag becomes true.	
Syntax	int xf_adsp_base_poll (void *private_data, int *condition)	
Parameter	void *private_data	Pointer to registered client of ADSP base
	int *condition	Pointer to a waiting condition flag Valid value: 0: wait for the valid response message from client queue 1: cancel the waiting
Return value	0	Responded message is available.
	1	Responded message is not available.
	-EINVAL	Client or condition data is invalid, or the value of condition is not supported, or the waiting of event is interrupted.

4. Processing Flow

This part shows the processing flow of ADSP base, Renderer, Capture, and Equalizer component.

4.1 ADSP Base Flow

4.1.1 ADSP Base Creation

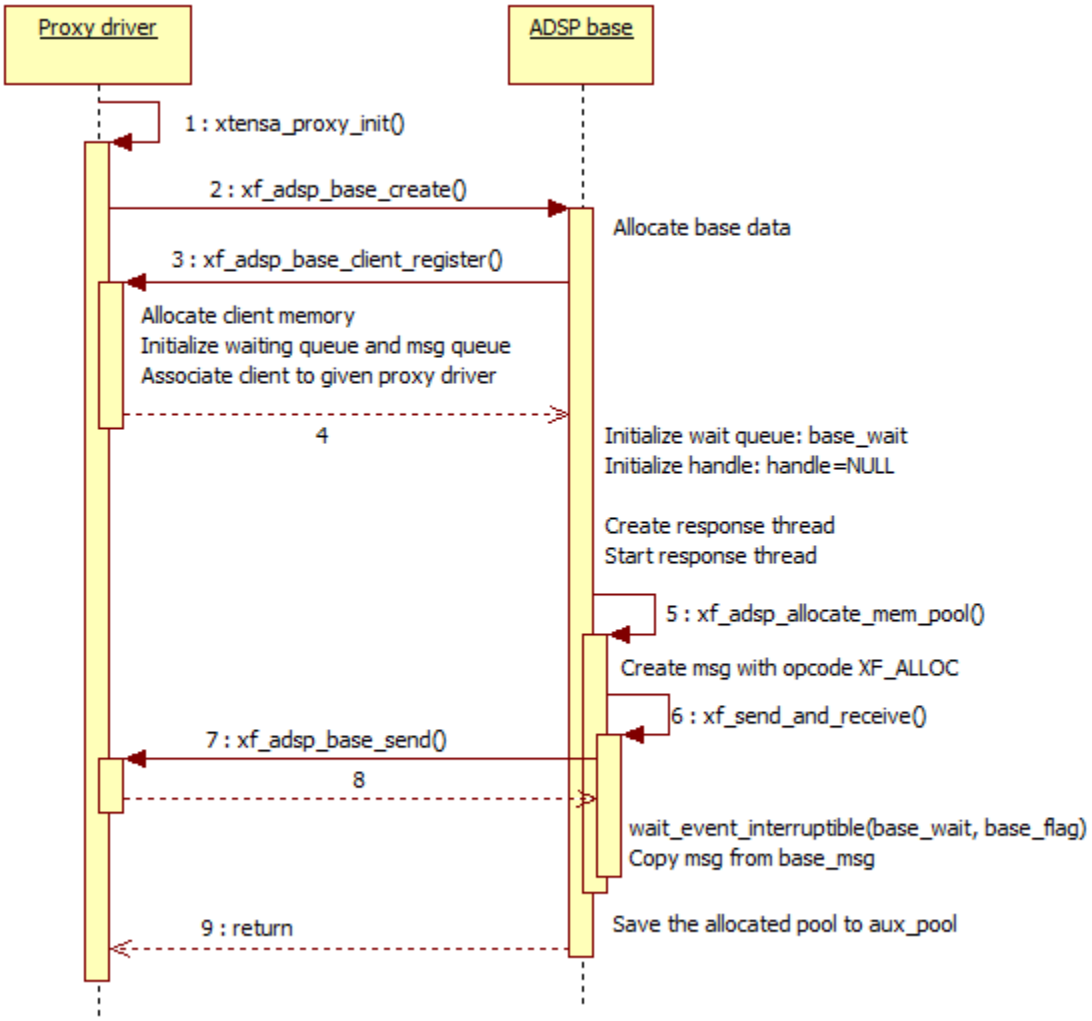

Figure 4-1 ADSP base creation flow chart

4.1.2 ADSP Base Destruction

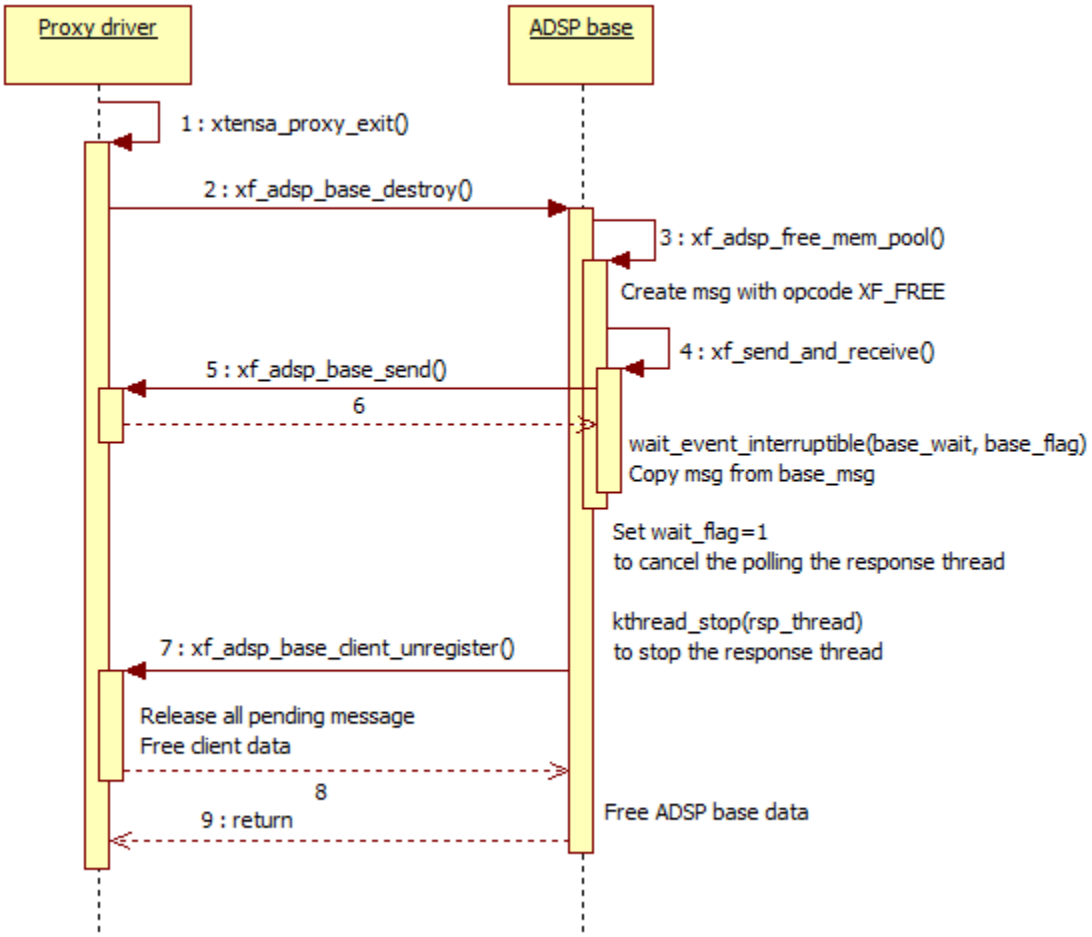

Figure 4-2 ADSP base destruction flow chart

4.2 Renderer Flow

4.2.1 Renderer Creation

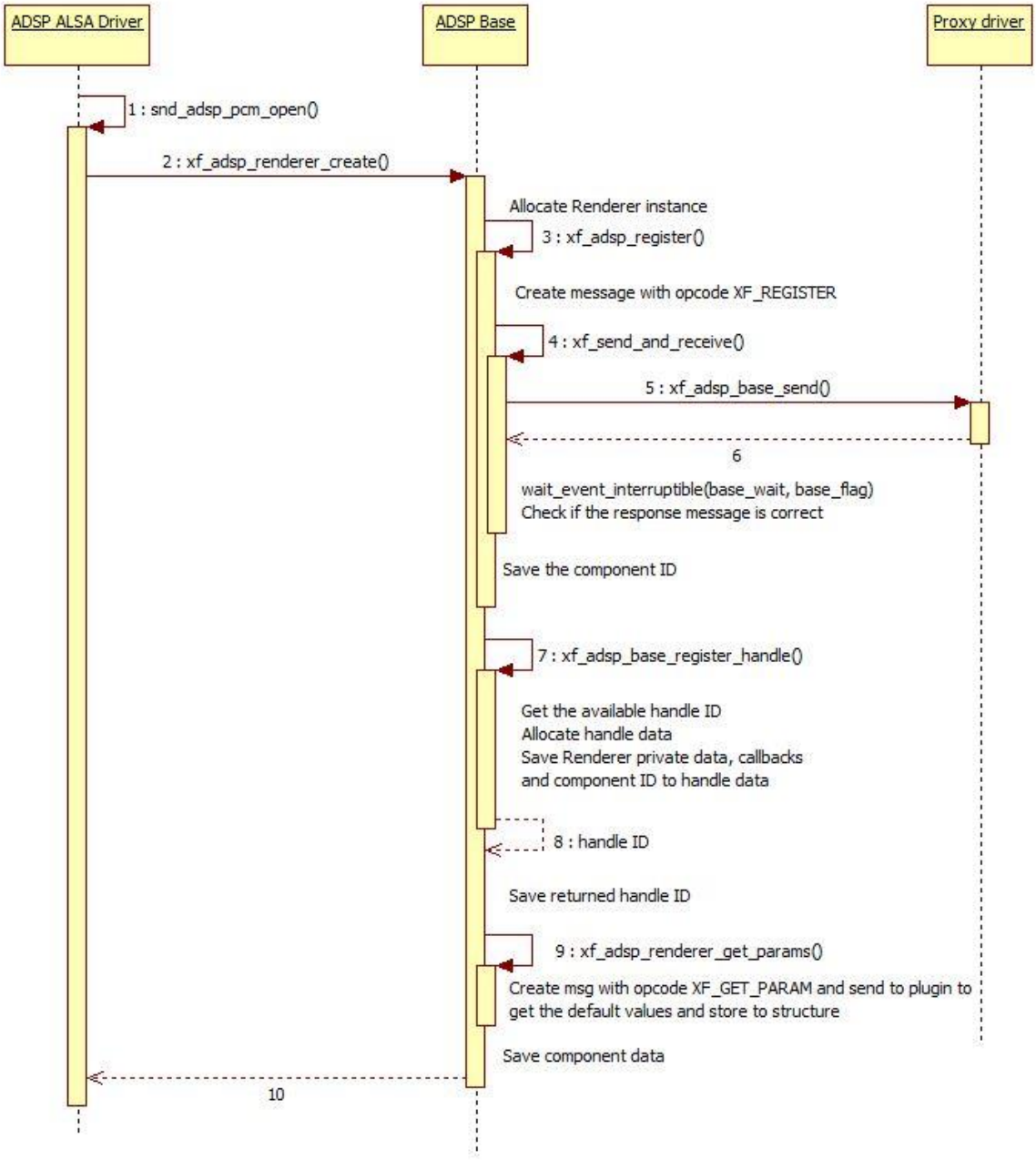

Figure 4-3 Renderer creation flow chart

4.2.2 Renderer Execution

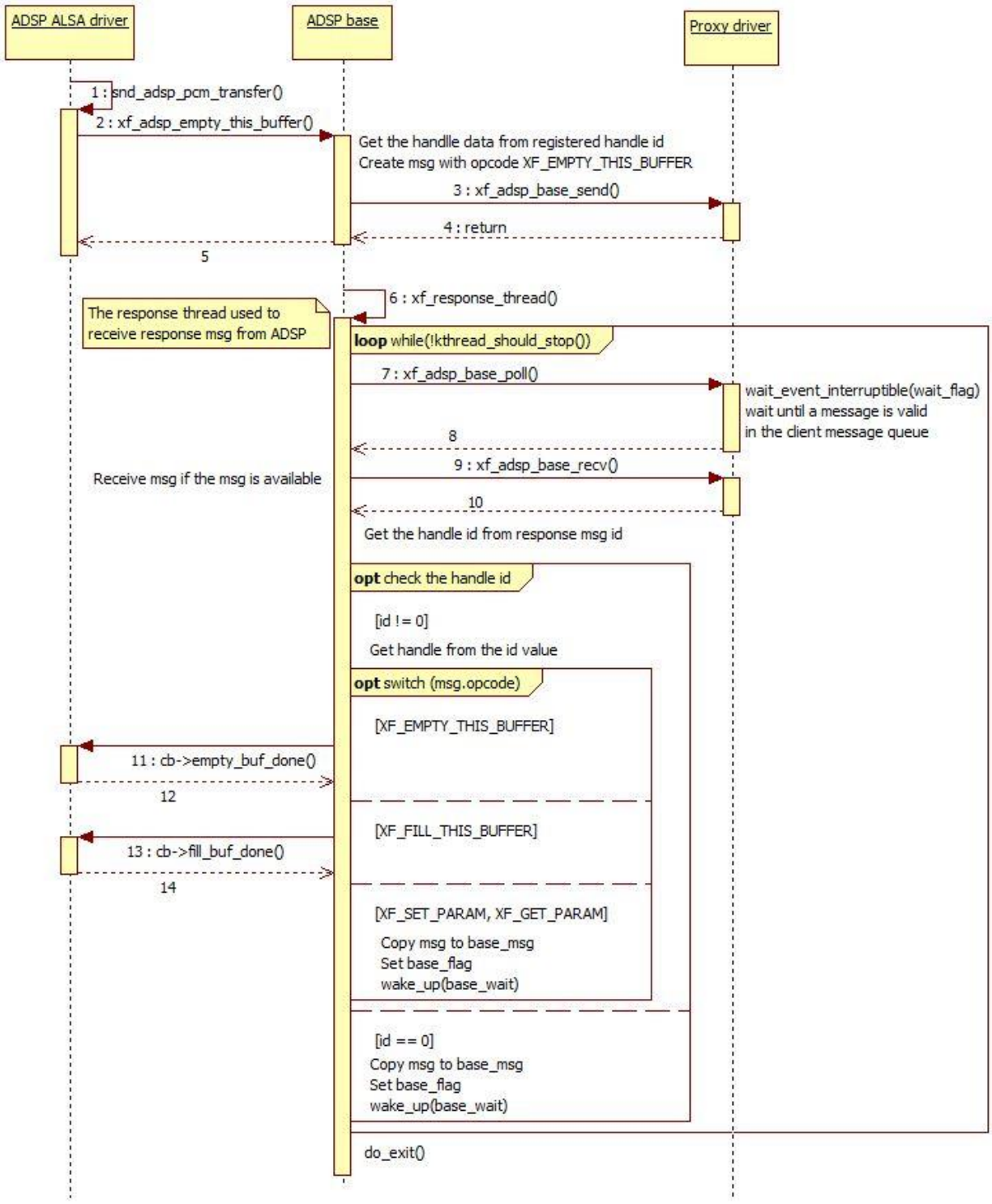

Figure 4-4 Renderer execution flow chart

4.2.3 Renderer Destruction

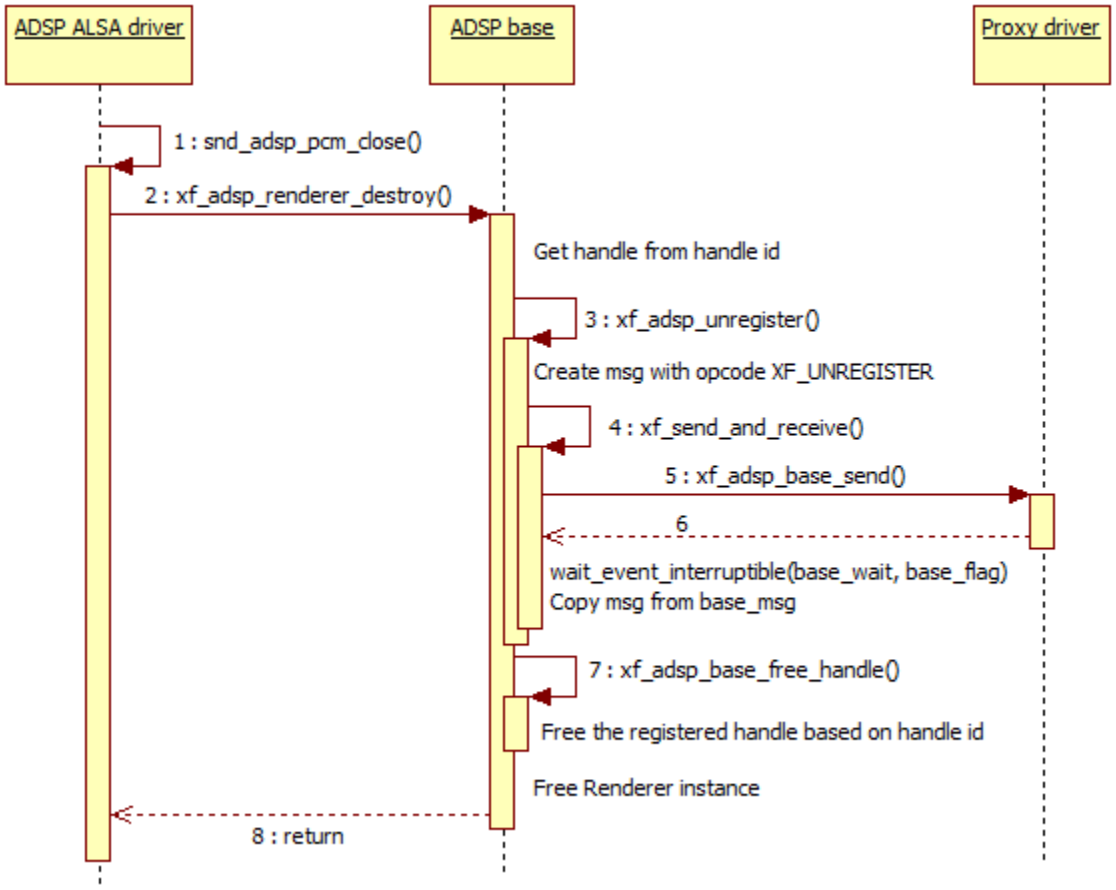

Figure 4-5 Renderer destruction flow chart

4.3 Capture Flow

4.3.1 Capture Creation

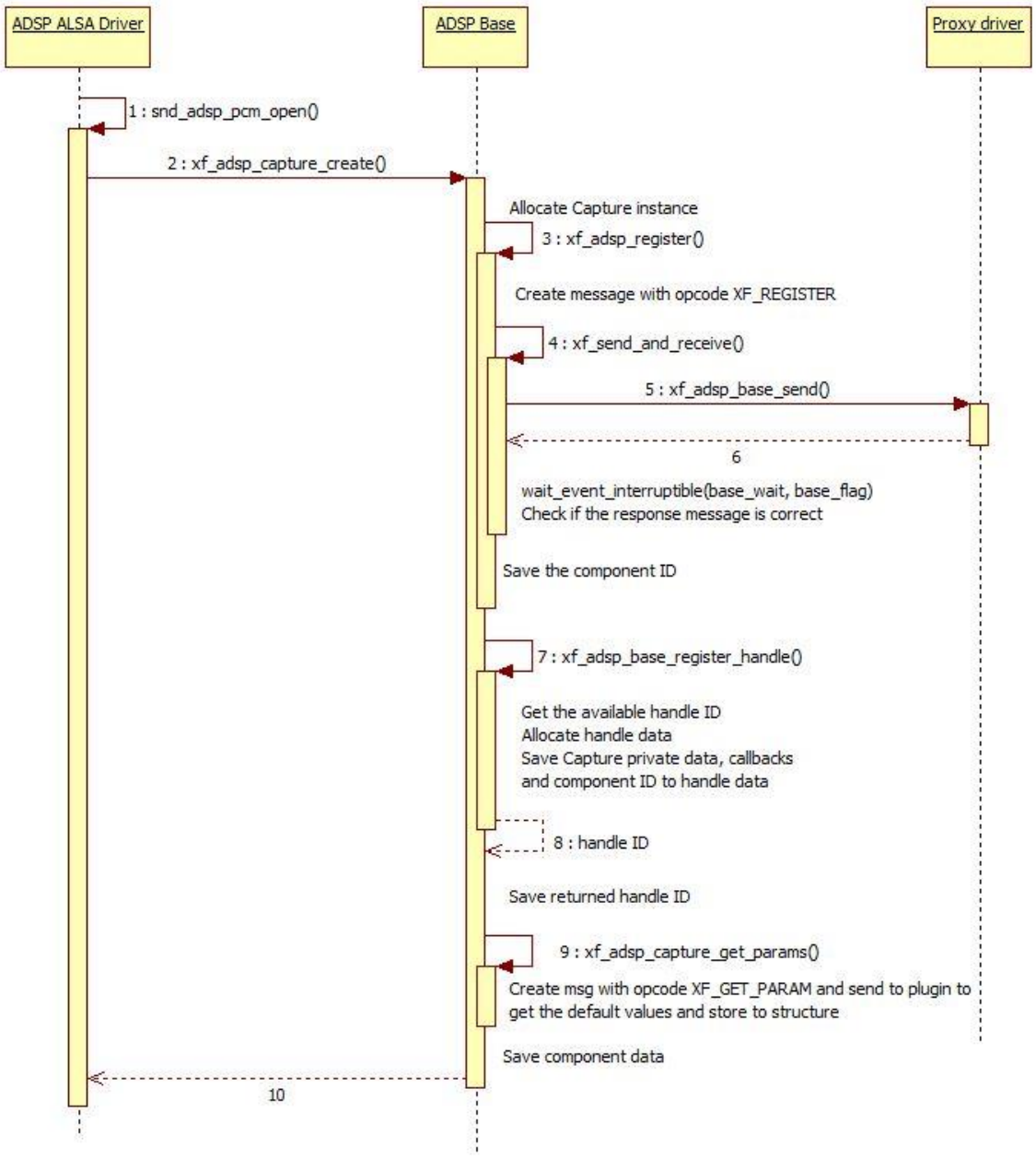

Figure 4-6 Capture creation flow chart

4.3.2 Capture Execution

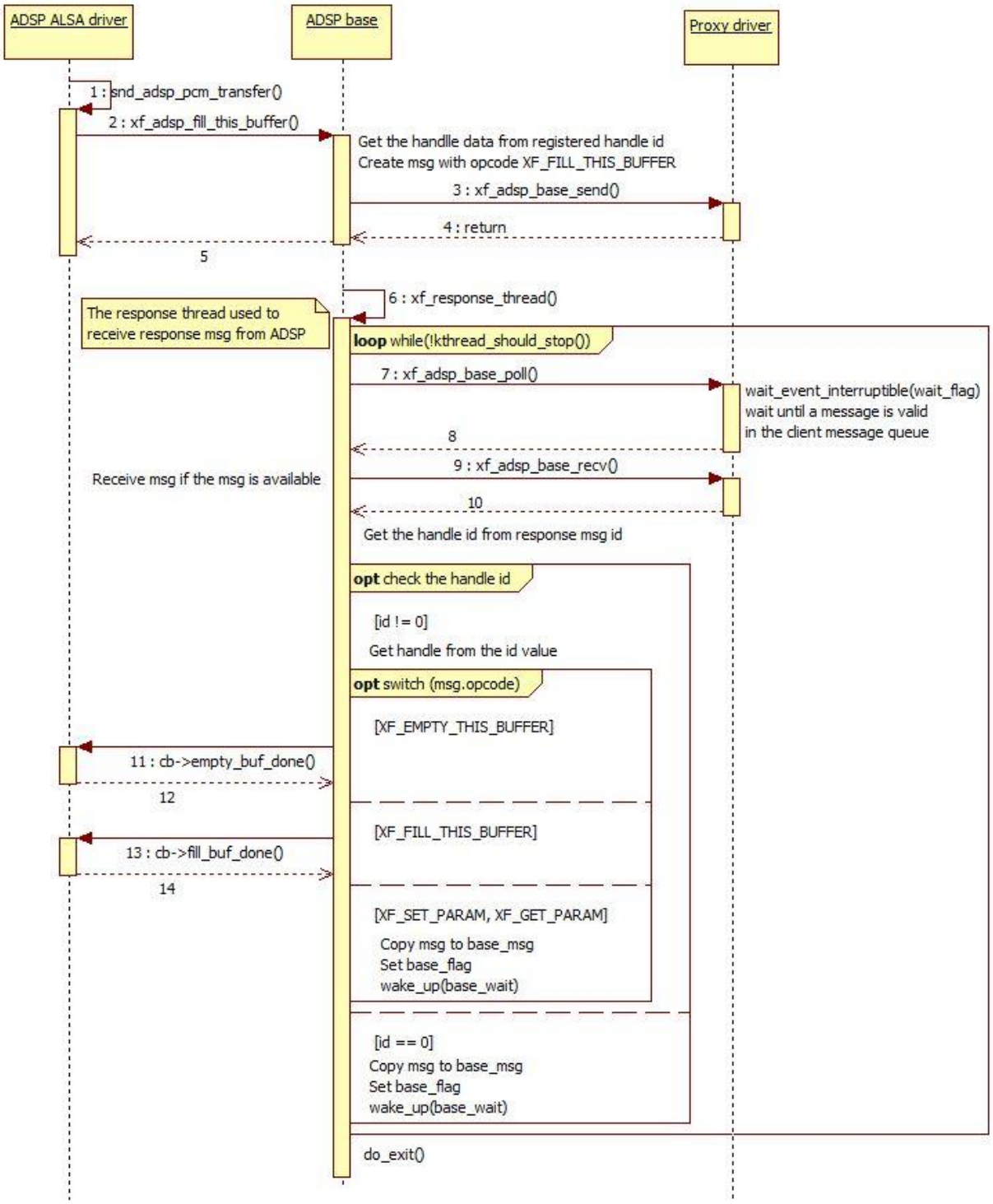

Figure 4-7 Capture execution flow chart

4.3.3 Capture Destruction

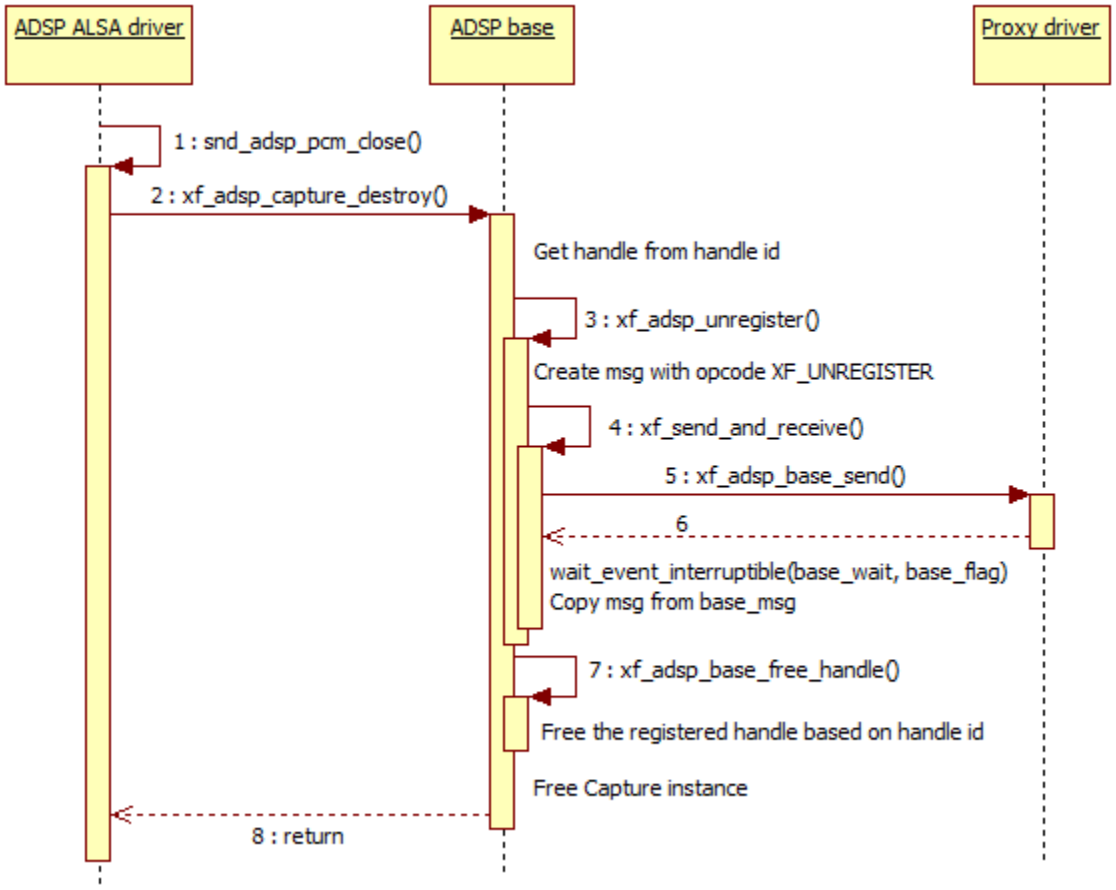

Figure 4-8 Capture destruction flow chart

4.4 Equalizer Flow

4.4.1 Equalizer Creation

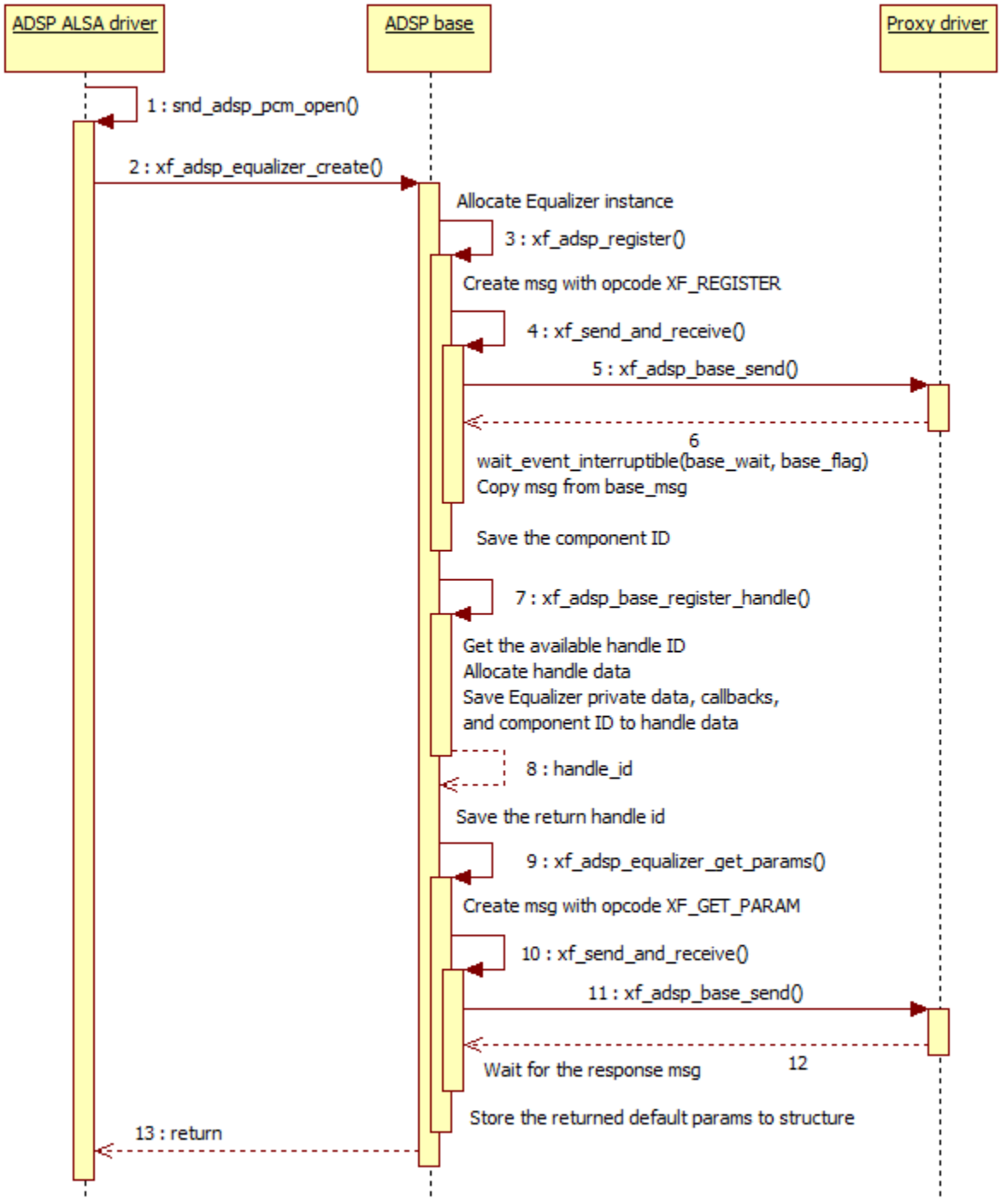

Figure 4-9 Equalizer creation flow chart

4.4.2 Equalizer Execution

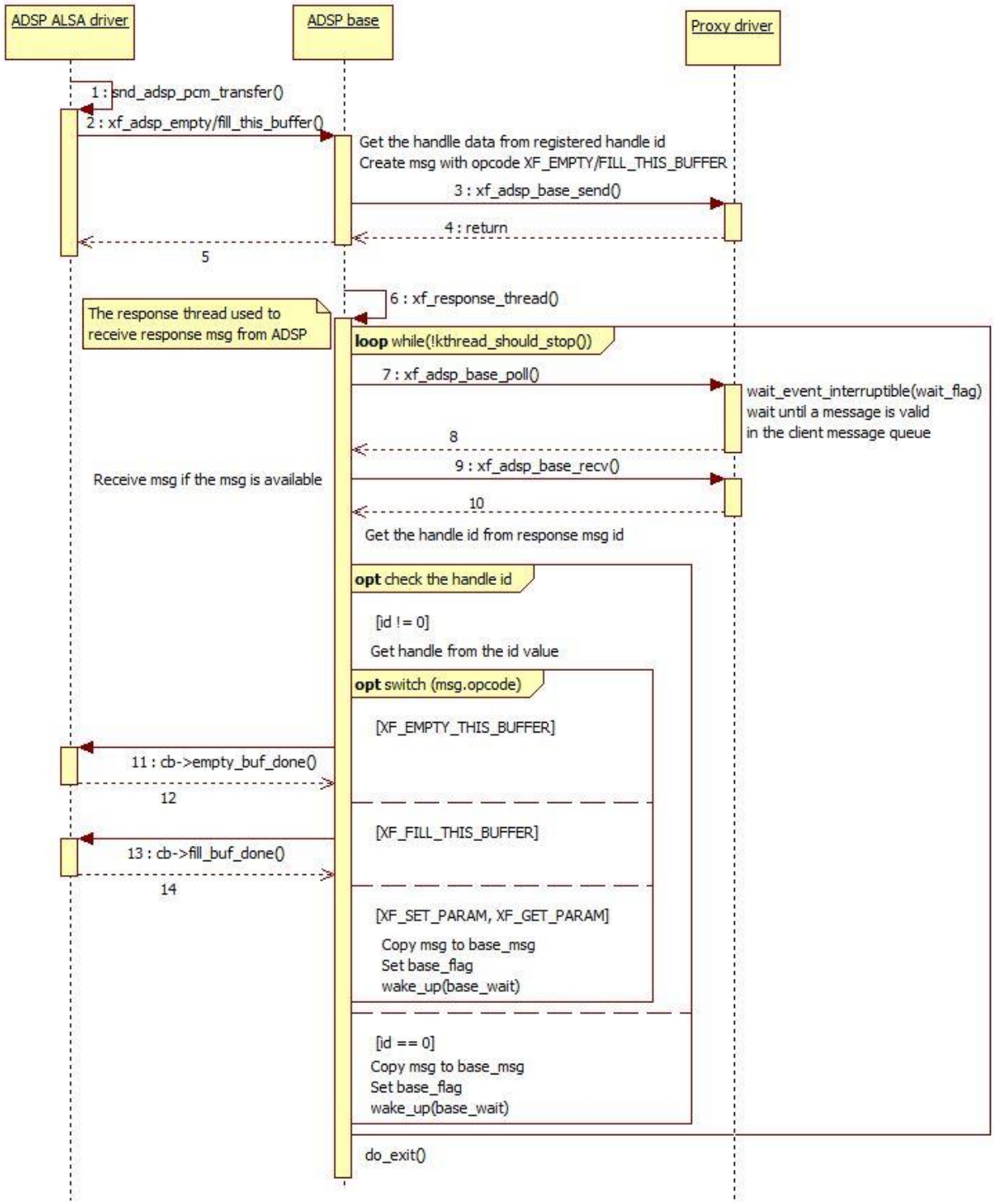

Figure 4-10 Equalizer execution flow chart

4.4.3 Equalizer Destruction

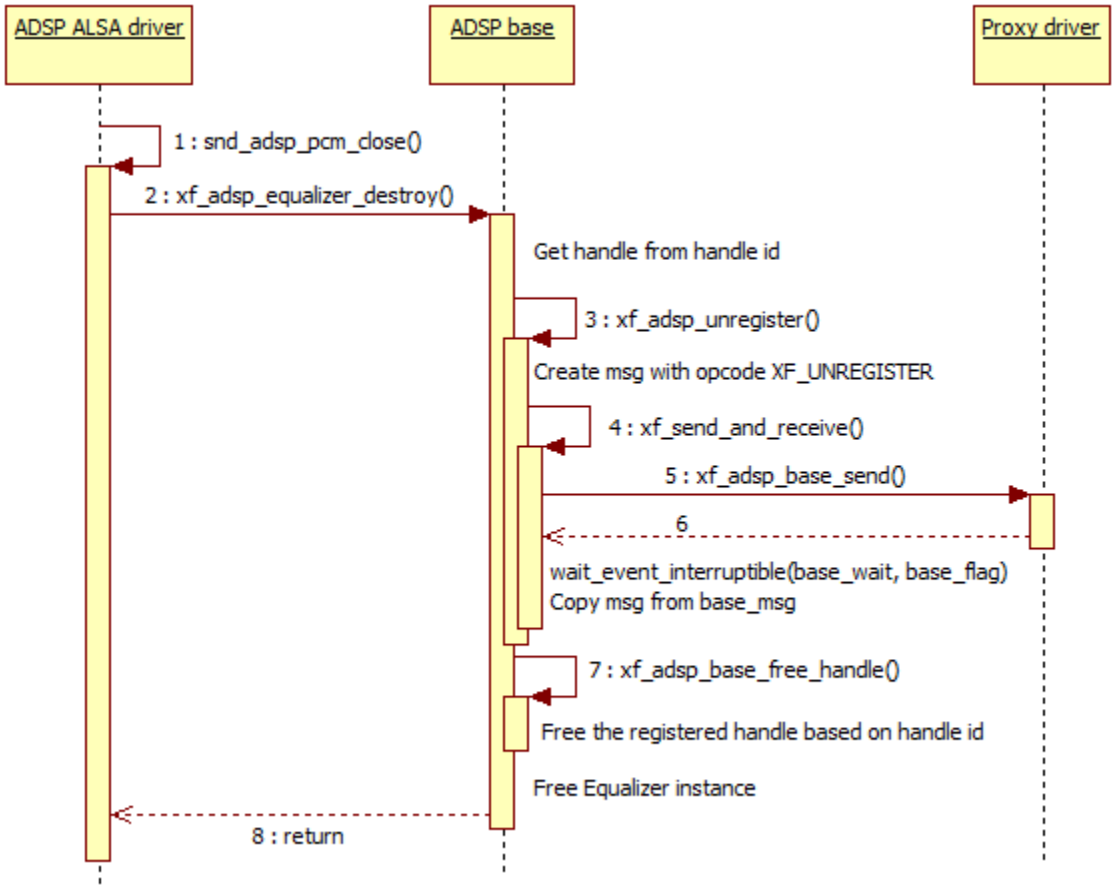

Figure 4-11 Equalizer destruction flow chart

4.5 TDM Renderer Flow

4.5.1 TDM Renderer Creation

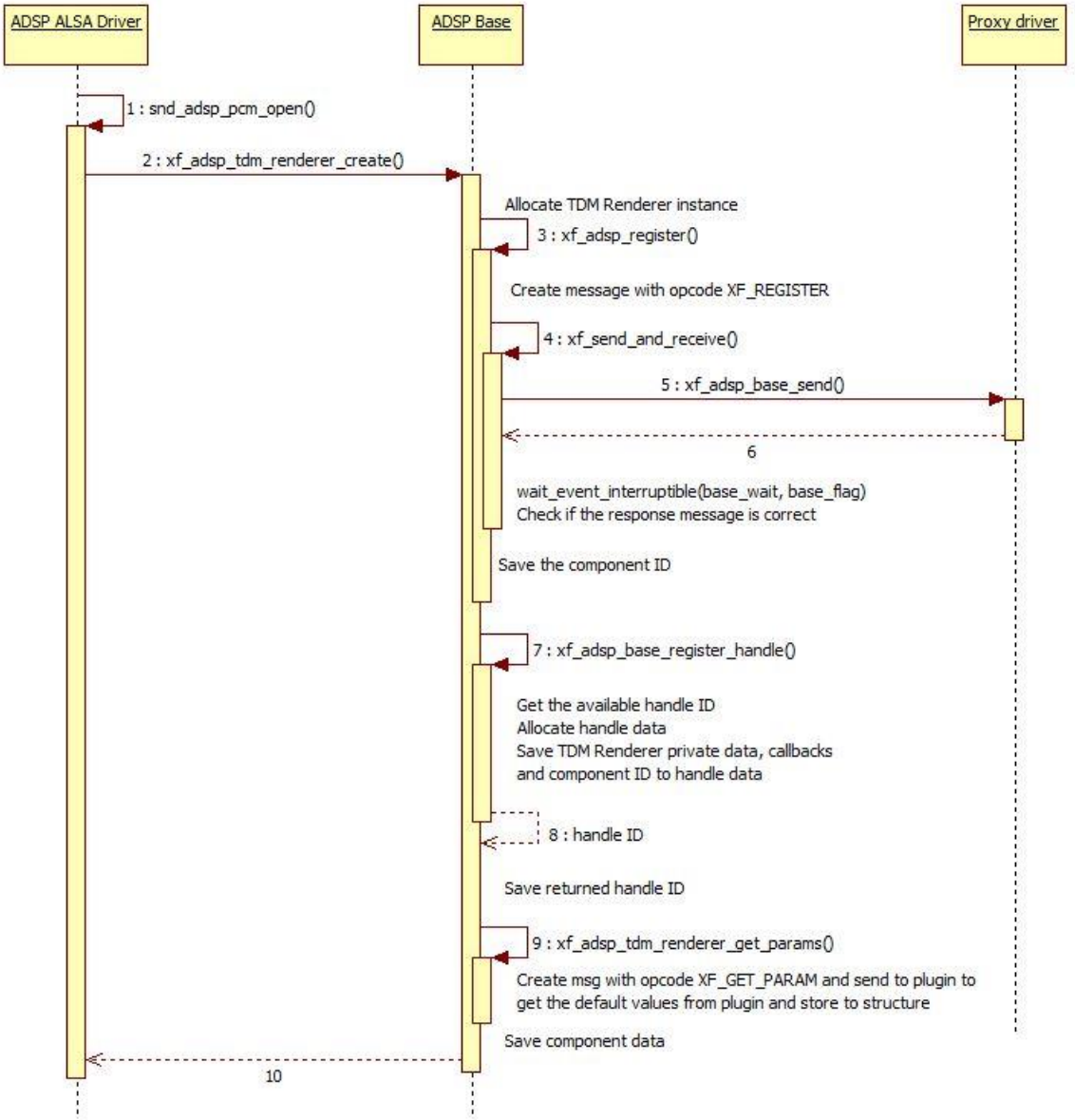

Figure 4-12 TDM Renderer creation flow chart

4.5.2 TDM Renderer Execution

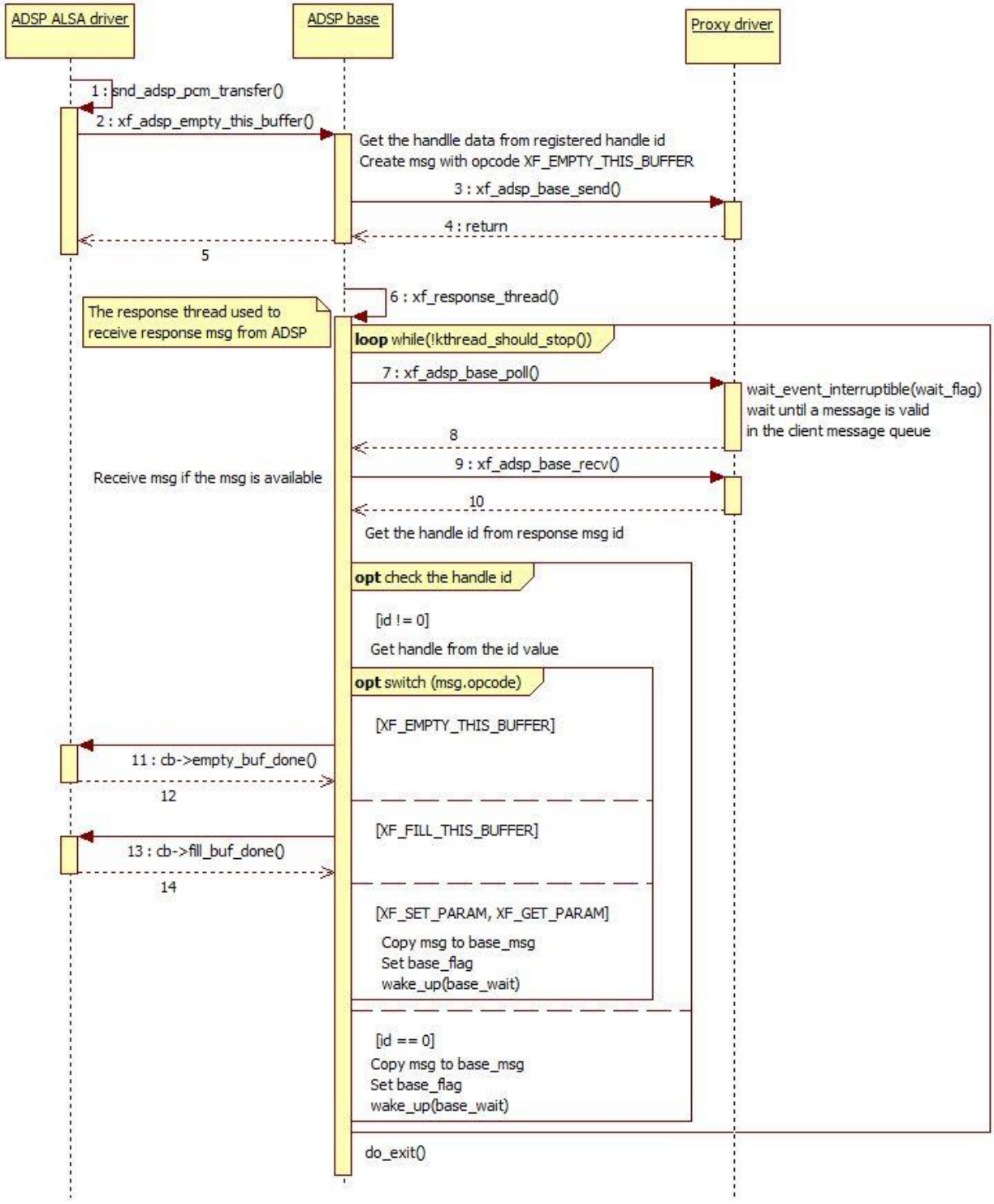

Figure 4-13 TDM Renderer execution flow chart

4.5.3 TDM Renderer Destruction

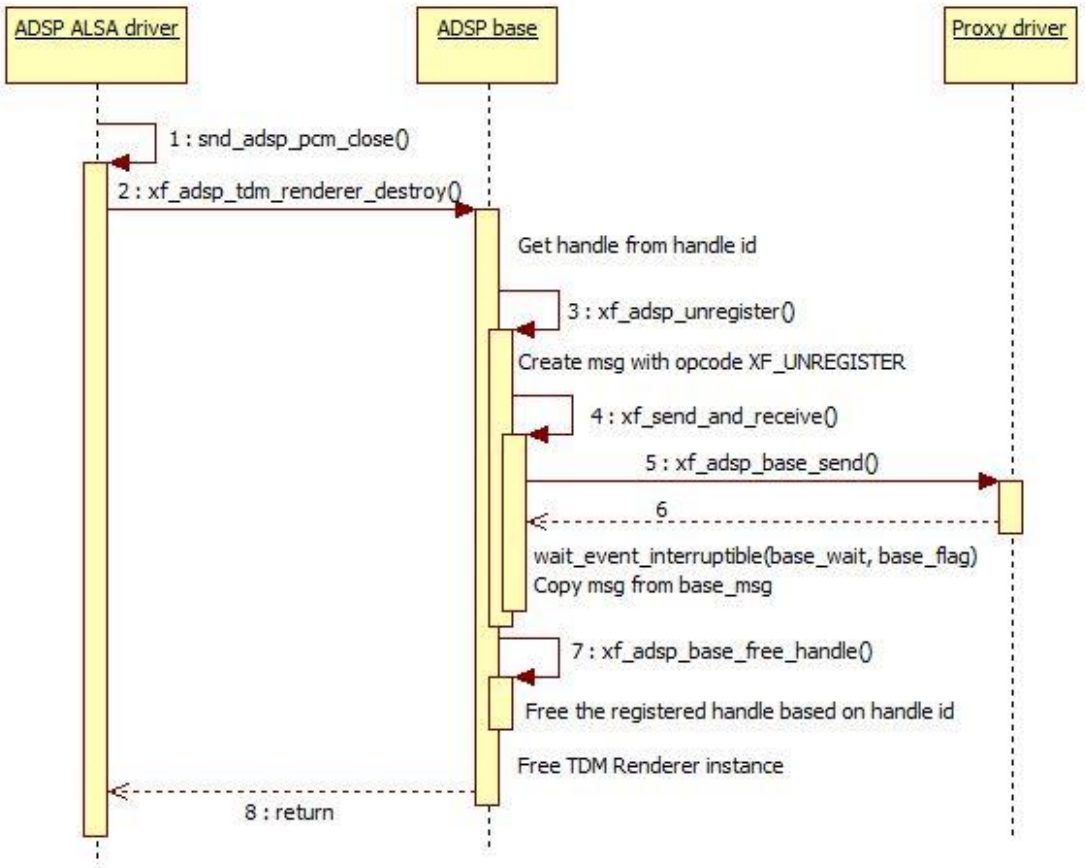

Figure 4-14 TDM Renderer destruction flow chart

4.6 TDM Capture Flow

4.6.1 TDM Capture Creation

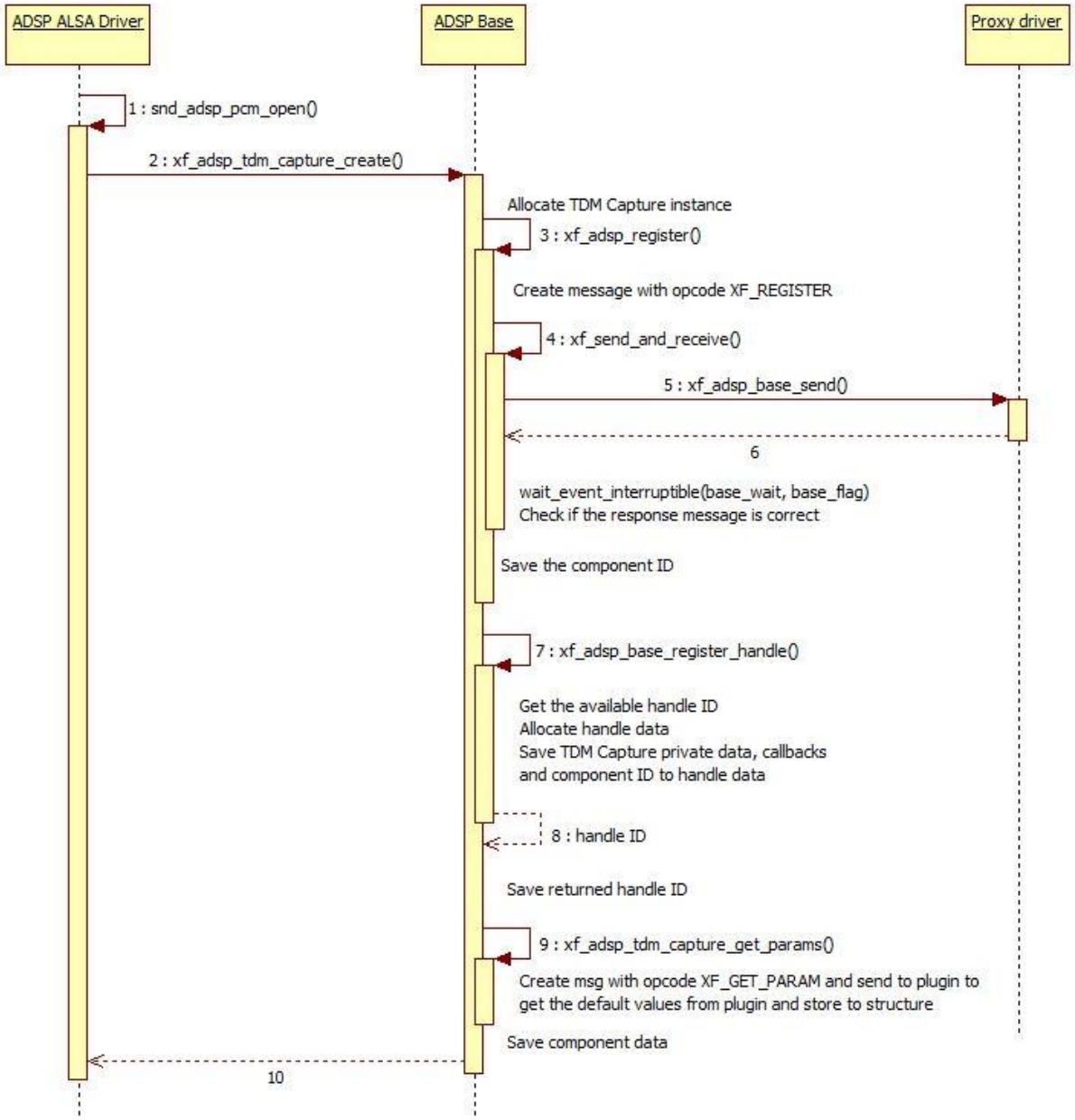

Figure 4-15 TDM Capture creation flow chart

4.6.2 TDM Capture Execution

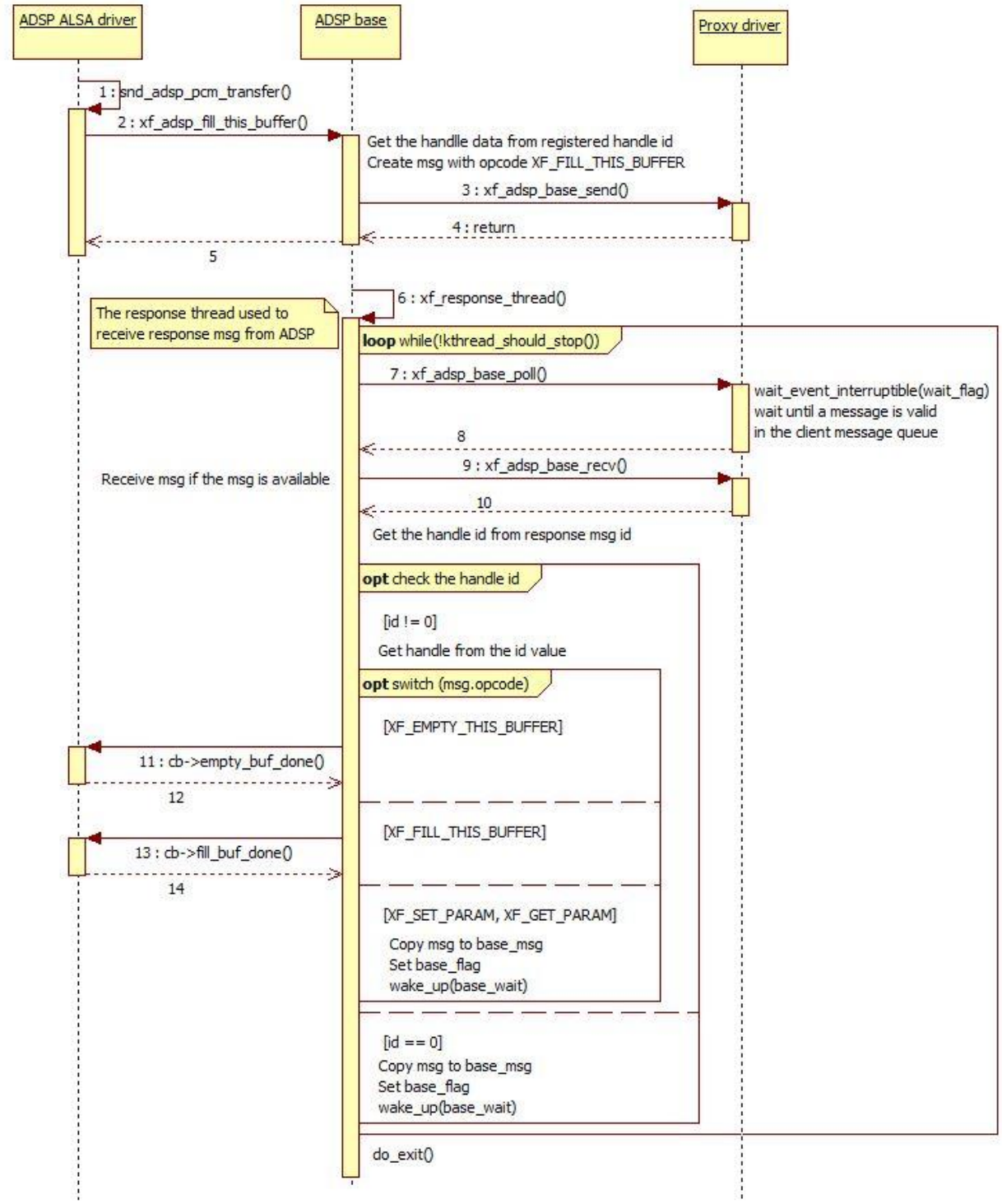

Figure 4-16 TDM Capture execution flow chart

4.6.3 TDM Capture Destruction

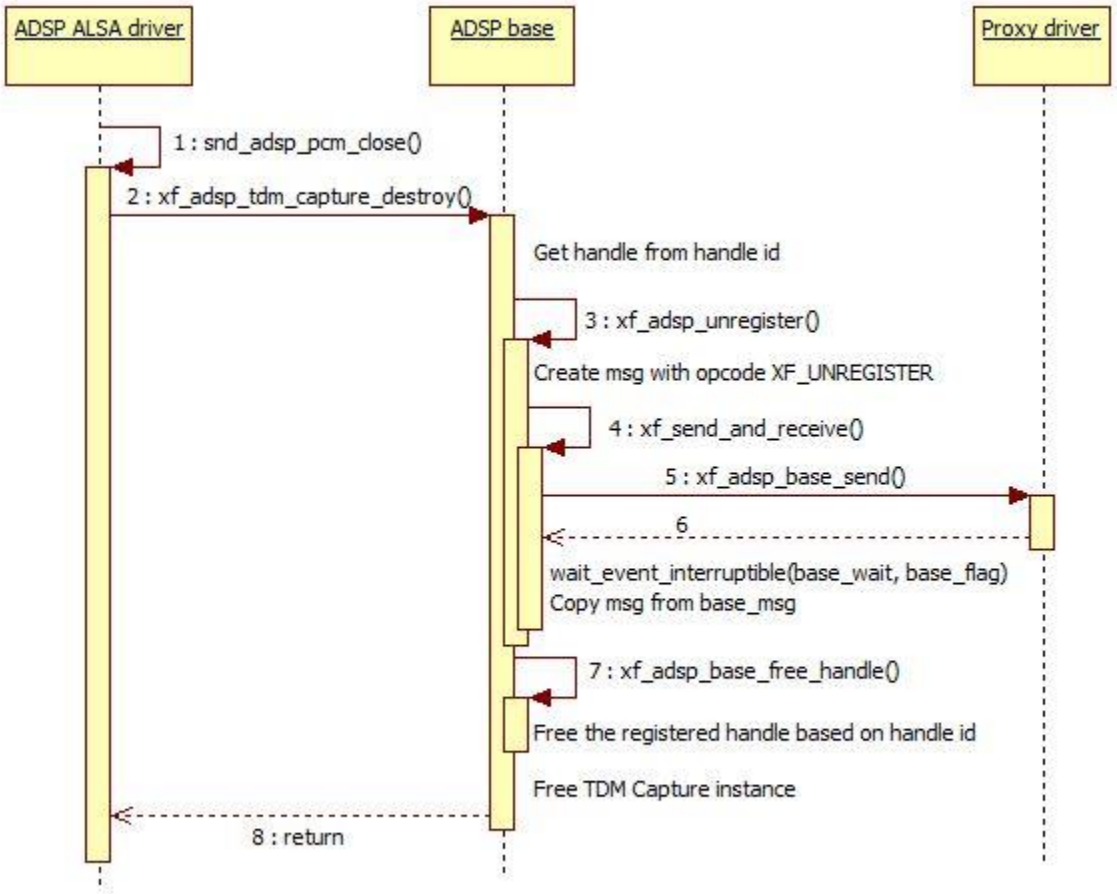

Figure 4-17 TDM Capture destruction flow chart

5. Appendix

5.1 Error Code

Error code	Description	Reference
ENOMEM	Out of memory	https://elixir.free-electrons.com/linux/v4.0/source/include/uapi/asm-generic/errno-base.h
EINVAL	Invalid argument	
ENODEV	No such device	
EBUSY	Device or resource busy	

Table 5-1 Generic error code definition

5.2 Structures

Structure	Description	Reference
struct xf_pool	Data pool type	Defined in the ADSP Interface for Linux document
struct xf_message	Message type	Defined in the ADSP framework document
struct task_struct	Task process structure	http://elixir.free-electrons.com/linux/latest/source/include/linux/sched.h
wait_queue_head_t	Waiting queue structure	https://elixir.free-electrons.com/linux/latest/source/include/linux/wait.h

Table 5-2 External structure definition

Revision History	ADSP Interface for Android Application Note - Driver -

Rev.	Date	Description	
		Page	Summary
1.00	May. 24, 2019	-	New Create

ADSP Driver for Android Application Note - Driver -

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