Basic Development Guide for Open AT® V4.10

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Basic Development Guide for Open AT® V4.10

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Overview

This User's Guide describes the Open AT® facility and provides guidelines for developing an Embedded Application. It applies to V4.10 and higher (until next version of this document).

Document History

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001	May 16, 2006	Document creation	
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III. Open AT® ADL User guide (for Open AT® V4.10: ref WM_DEV_OAT_UGD_019)

1.2 Glossary

Application Mandatory API	Mandatory software interfaces to be used by the Embedded Application.
AT commands	Set of standard modem commands.
AT function	Software that processes the AT commands and AT subscriptions.
Embedded API layer	Software developed by Wavecom, containing the Open AT® APIs (Application Mandatory API, AT Command Embedded API, OS API, Standard API, FCM API, IO API, and BUS API).
Embedded Application	User application sources to be compiled and run on a Wavecom product.
Embedded OS	Software that includes the Embedded Application and the Wavecom library.
Embedded software	User application binary: set of Embedded Application sources + Wavecom library.
External Application	Application external to the Wavecom product that sends AT commands through the serial link.
Target	Open AT® compatible product supporting an Embedded Application.
Target Monitoring Tool	Set of utilities used to monitor a Wavecom product.
Receive command pre–parsing	Process for intercepting AT responses.
Send command pre–parsing	Process for intercepting AT commands.
Standard API	Standard set of “C” functions.
Wavecom library	Library delivered by Wavecom to interface Embedded Application sources with Wavecom OS functions.
Wavecom OS	Set of GSM and open functions supplied to the User.

1.3 Abbreviations

API	Application Programming Interface
CPU	Central Processing Unit
DAC	Digital Analog Converter
IR	Infrared
KB	Kilobyte
OS	Operating System
OSA	Open SIM Access
PDU	Protocol Data Unit
RAM	Random-Access Memory
ROM	Read-Only Memory
RTK	Real-Time Kernel
SCTU	System Controller Timer Unit
SIM	Subscriber Identity Module
SMA	SMall Adapter
SMS	Short Message Services
SDK	Software Development Kit

1.4 Open AT® General Introduction

For more information about Open AT®, please refer to the ADL User Guide.

2 API

2.1 Data Types

The available data types are described in the wm_types.h file. They ensure compatibility with the data types used in the functional prototypes and are used for both Target and Visual C++ generation.

2.2 Mandatory Functions

The API described below include a set of mandatory functions and constants that an Embedded software must provide.

This is located in the wm_apm.h file.

2.2.1 Required Header

An Open AT® application must include the wm_apm.h header file.
This file includes all other API header files.

2.2.2 Tasks & Execution Context Identifiers

An embedded application tasks & execution contexts are defined by the identifiers, based on the following type:

```
typedef enum
{
    WM_OS_TASK_1,     // Task 1
    WM_OS_TASK_2,     // Task 2
    WM_OS_TASK_3,     // Task 3

    WM_OS_TASK_MAX,   // Maximum number of tasks

    // Context identifier for low level interruption handlers
    WM_OS_CTX_LOW_LEVEL_IRQ_HANDLER = 0xFD,

    // Context identifier for high level interruption handlers
    WM_OS_CTX_HIGH_LEVEL_IRQ_HANDLER = 0xFE,

    WM_OS_TASK_WAVECOM=0xFF // for the messages coming from
                                Wavecom OS
} wm_osTask_e;
```

2.2.3 Task Table

The task table is used to define an embedded application task parameters. It uses the following type:

```
typedef struct
{
    u32 StackSize;                      /* Stack Size (in bytes)    */
    s32 (*Init) ( wm_apmInitType_e );   /* Initialisation function */
    s32 (*Parser) ( wm_apmMsg_t * );    /* Parser function          */
} wm_apmTask_t;
```

The table must be defined by the following applications:

```
const wm_apmTask_t wm_apmTask [] =
{
     { StackSize1, Init1, Parser1 },
     { StackSize2, Init2, Parser2 },
     { StackSize3, Init3, Parser3 },
     { 0, NULL, NULL }
};
```

The last line of the **wm_apmTask** table must be filled with the 0 (zero) value, so as to inform the Wavecom OS of how many tasks must be started. A maximum of three tasks can be declared and started by the Wavecom OS (additional task declaration is ignored).

2.2.4 Call Stack Initialization

The following constants are used to define each task with its stack size:

```
#define StackSize1 1024 // The '1024' value is an example
#define StackSize2 1024 // The '1024' value is an example
#define StackSize3 1024 // The '1024' value is an example
```

The size represents the amount of memory needed by each task for its call stack.

2.2.5 Interruption Handlers Context Call Stacks

If the application is configured to handle interruptions (see. IRQ API), this must be defined by the required context (low level and/or high level) call stack sizes.

The constant used for low level interruption handler execution context is given below.

```
const u16 wm_apmIRQLowLevelStackSize = 1024;  // Example value
```

The constant used for high level interruption handler execution context is given below.

```
const u16 wm_apmIRQHighLevelStackSize = 1024;  // Example value
```

Note:
These definitions are optional: If the application either does not provide one or both of these call stack sizes or set them to 0, the associated context(s) are not available at runtime.

2.2.6 The Init Functions

The **Init** functions are called once during initialization of each embedded application task.

The prototype is:

```
s32 Init ( wm_apmInitType_e  InitType );
```

2.2.6.1 Parameter

InitType:

This works on the item that triggered the initialization. The corresponding values are:

```
typedef enum
{
  WM_APM_POWER_ON, // normal Power-On has occurred
  WM_APM_REBOOT_FROM_EXCEPTION, // the Wireless CPU has restarted
                                   after an exception.
  WM_APM_DOWNLOAD_SUCCESS, // an install process launched by the
                              wm_adInstall API has succeeded.
  WM_APM_DOWNLOAD_ERROR // an install process launched by the
                           wm_adInstall API has failed.
} wm_apmInitType_e;
```

The following events may cause an exception:

- a call to the wm_osDebugFatalError() function,
- unauthorized RAM access,
- a customer task watchdog.

2.2.6.2 Returned Values

The returned value is not relevant.

2.2.7 The Parser Functions

The Parser functions are called whenever a message is received by an embedded application task from the Wavecom OS.

The prototype is:

```
s32 Parser ( wm_apmMsg_t * Message );
```

2.2.7.1 Parameter

Message:

The *Message* structure depends on its type:

```
typedef struct
{
     s16            MsgTyp;    /* Type of the received message:
                                  works out the associated structure of
                                  the  message body part*/

     wm_apmBody_t   Body;       /* Specific message body */
} wm_apmMsg_t;
```

MsgTyp may have the following values:

MsgTyp value	Description
WM_AT_RESPONSE	The message includes an AT command response sent by the Embedded Application.
WM_AT_UNSOLICITED	The message includes an unsolicited AT response.
WM_AT_INTERMEDIATE	The message includes an intermediate AT response.
WM_AT_CMD_PRE_PARSER	The message includes an AT command sent by the External Application.
WM_AT_RSP_PRE_PARSER	The message includes a response processed by a Wavecom OS AT function.
WM_OS_TIMER	The message is sent when the timer expires.
WM_OS_RELEASE_MEMORY	The message includes the address of a released pointer.
WM_FCM_RECEIVE_BLOCK	The message includes data received by the Embedded Application.
WM_FCM_OPEN_FLOW	The requested flow opening operation is successful.
WM_FCM_CLOSE_FLOW	The requested flow closing operation is successful.

MsgTyp value	Description
WM_IO_PORT_UPDATE_INFO	Informs the Open AT® application that either a new port has been opened, or an existing port has been closed.
WM_FCM_RESUME_DATA_FLOW	The Embedded Application may resume its data sending operations.
WM_IO_SERIAL_SWITCH_STATE_RSP	Includes the response to the serial link mode switching request.
WM_IO_UPDATE_INFO	The message informs the Open AT® application that a feature multiplexed with some GPIO has been enabled or disabled.

The structure of the body is given below:

```
typedef union
{
     /* Includes herein the different specific structures
     associated to    MsgTyp */
     /* WM_AT_RESPONSE      */
     wm_atResponse_t                ATResponse;
     /* WM_AT_UNSOLICITED   */
     wm_atUnsolicited_t              ATUnsolicited;
     /* WM_AT_INTERMEDIATE  */
     wm_atIntermediate_t             ATIntermediate;
     /* WM_AT_CMD_PRE_PARSER        */
     wm_atCmdPreParser_t             ATCmdPreParser;
     /* WM_AT_RSP_PRE_PARSER    */
     wm_atRspPreParser_t             ATRspPreParser
     /* WM_OS_TIMER                 */
      wm_osTimer_t                   OSTimer;
     /* WM_OS_RELEASE_MEMORY        */
     wm_osRelease_t                  OSRelease;
     /* WM_FCM_RECEIVE_BLOCK         */
     wm_fcmReceiveBlock_t            FCMReceiveBlock;
     /* WM_FCM_OPEN_FLOW             */
     wm_fcmOpenFlow_t                FCMOpenFLow
     /* WM_FCM_CLOSE_FLOW            */
     u32 FCMCloseFlow

     /* WM_FCM_RESUME_DATA_FLOW */
     u32 FCMResumeFlow

     /* WM_IO_SERIAL_SWITCH_STATE_RSP */
     wm_ioSerialSwitchStateRsp_t     IOSerialSwitchStateRsp
     /* WM_IO_PORT_UPDATE_INFO */
     wm_ioPortUpdateInfo_t           IOPortUpdateInfo
     /* WM_IO_UPDATE_INFO   */
     wm_ioUpdateInfo_t               IOUpdateInfo;
} wm_apmBody_t;
```

The sub-structures of the message body are given below:

Body for WM_AT_RESPONSE:

```
typedef struct
{
   wm_atSendRspType_e Type;
   wm_ioPort_e        Dest;
   u16                Ti;
   u16                TiToKill;
   u16                StrLength;  /* Length of StrData[] */
   ascii              StrData[1]; /* AT response */
} wm_atResponse_t;
```

The **Dest** field, is the destination port where the response must be sent (please refer to the Input/Output API for more information).

```
typedef enum
{
   WM_AT_SEND_RSP_TO_EMBEDDED,
   WM_AT_SEND_RSP_TO_EXTERNAL,
   WM_AT_SEND_RSP_BROADCAST
} wm_atSendRspType_e;
```

(See §2.3.3 for wm_atSendRspType_e description).

The **Type** field should be a bitwise operator OR combined with the **WM_AT_SEND_RSP_HIGH_PRIORITY** flag. In this case, and if the response must be forwarded to any external application, this flag must also be forwarded to the **wm_atSendRspExternalAppExt** function.

The **Ti** field is the transaction identifier of the executed command. This TI was generated when the **wm_atSendCommandExt** function was called (it was the function returned value); it allows the application to associate a given response with the command previously sent.

The **TiToKill** field is the transaction identifier of a command which was canceled by the execution of another one (if not set to 0; TI are always different from 0). This case occurs when two commands are sent through the **wm_atSendCommandExt** function, and the second one cancels the execution of the first one (Eg. an ATH command sent before an ATD command sends a response back).

Body for WM_AT_UNSOLICITED:

```
typedef struct    {
   wm_atUnsolicited_e  Type;
   wm_ioPort_e         Dest;
   u16                 StrLength;
   ascii               StrData[1];
} wm_atUnsolicited_t;
```

The Dest field, is the destination port where the unsolicited response must be sent (please refer to the Input/Output API for more information). If *this parameter is set to WM_IO_NO_PORT, the unsolicited response is broadcasted on all ports.*

```
typedef enum {
  WM_AT_UNSOLICITED_TO_EXTERNAL,
  WM_AT_UNSOLICITED_TO_EMBEDDED,
  WM_AT_UNSOLICITED_BROADCAST
} wm_atUnsolicited_e;
```

(See §2.3.5 for wm_atUnsolicited_e description).

Body for WM_AT_INTERMEDIATE:

```
typedef struct
{
  wm_atIntermediate_e Type;
  wm_ioPort_e         Dest;
  u16                 Ti; u16     StrLength;
  ascii               StrData[1];
} wm_atIntermediate_t;
```

The **Dest** field, is the destination port where the intermediate response must be sent (please refer to the Input/Output API for more information).

```
typedef enum
{
  WM_AT_INTERMEDIATE_TO_EXTERNAL,
  WM_AT_INTERMEDIATE_TO_EMBEDDED,
  WM_AT_INTERMEDIATE_BROADCAST
} wm_atIntermediate_e;
```

(See §2.3.6 for wm_atIntermediate_e description).

The Ti field is the transaction identifier of the executed command. This is generated when the wm_atSendCommandExt function is called (it is the returned value for the function); it allows the application to associate a given intermediate response with the command previously sent.

Body for WM_AT_CMD_PRE_PARSER:

```
typedef struct    {
  wm_atCmdPreSubscribe_e   Type;
  wm_ioPort_e              Source;
  u16                      Ti;
  u16                      StrLength;
  ascii                    StrData[1];
} wm_atCmdPreParser_t;
```

The **Dest** field, is the source port from which the command is emitted (please refer to the Input/Output API for more information).

```
typedef enum      {
  WM_AT_CMD_PRE_WAVECOM_TREATMENT,
  WM_AT_CMD_PRE_EMBEDDED_TREATMENT,
  WM_AT_CMD_PRE_BROADCAST,
  WM_AT_CMD_PRE_APP_CONTROL_WAVECOM,
  WM_AT_CMD_PRE_APP_CONTROL_EMBEDDED
} wm_atCmdPreSubscribe_e;
```

(See §2.3.7 for wm_atCmdPreSubscribe_e description).

Body for WM_AT_RSP_PRE_PARSER:

```
typedef struct {
  wm_atRspPreSubscribe_e Type;
  wm_ioPort_e              Dest;
  u16                      Ti;
  u16                      TiToKill; u16
    StrLength;
  ascii                    StrData[1];
} wm_atRspPreParser_t;
```

The **Dest** field, is the destination port where the response must be sent (please refer to the Input/Output API for more information).

```
typedef enum {
  WM_AT_RSP_PRE_WAVECOM_TREATMENT, /* Default value */
  WM_AT_RSP_PRE_EMBEDDED_TREATMENT,
  WM_AT_RSP_PRE_BROADCAST
} wm_atRspPreSubscribe_e;
```

See wm_atRspPreParserSubscribe function for wm_atRspPreSubscribe_e description; The **Type** field should be a bitwise operator OR combined with the **WM_AT_SEND_RSP_HIGH_PRIORITY** flag. In this case, and if the response is forwarded to any external application, this flag must also be forwarded to the wm_atSendRspExternalAppExt function.

The **Ti & TiToKill** fields are reserved for future use.

```
typedef enum
{
  WM_IO_UART1,
  WM_IO_UART2,
  WM_IO_USB
} wm_ioPort_e;
```

(See §2.3.8 for wm_atRspPreSubscribe_e description).

Body for WM_OS_TIMER:

```
typedef struct    {
  u8          Ident;          /* Timer identifier */
} wm_osTimer_t;
```

(See § 2.5.2 for timer identifier description).

Body for WM_OS_RELEASE_MEMORY:

```
typedef struct    {
  void        *pMemoryBlock;
} wm_osRelease_t;
```

(See §2.2.7 for this message description).

Body for WM_FCM_RECEIVE_BLOCK:

```
typedef struct    {
u32     Reserved3;
u16  DataLength;  /* number of bytes received */
u8 Reserved1[2];
wm_fcmFlow_e FlowId;        /* IO flow ID */
u8 Reserved2[7];
u8 Data[1];        /* data received */
} wm_fcmReceiveBlock_t;
```

(See §2.6.7 for wm_fcmReceiveBlock_t description and §2.6.2 for wm_fcmFlow_e description).

Body for WM_FCM_OPEN_FLOW:

```
typedef struct    {
u32  FlowId;      /* opened IO flow ID */
u16  DataMaxToSend; /* max length of sent data */
} wm_fcmOpenFlow_t;
```

(See §2.6.4 for wm_fcmOpenFlow_t description and §2.6.2 for wm_fcmFlow_e description).

Body for WM_FCM_CLOSE_FLOW:

(See §2.6.2 for wm_fcmFlow_e description).

Body for WM_FCM_RESUME_DATA_FLOW:

(See §2.6.2 for wm_fcmFlow_e description).

Body for WM_IO_SERIAL_SWITCH_STATE_RSP:

```
typedef struct        {
  wm_ioSerialSwitchState_e   SerialMode; /* mode requested */
  s8                         RequestReturn; /* <0 means error
*/
} wm_ioSerialSwitchStateRsp_t;
```

(See §2.7.2.2 for wm_ioSerialSwitchStateRsp_t description).

***Body for** `WM_IO_SERIAL_SWITCH_STATE_RSP:`*

```
typedef struct
{
  wm_ioSerialSwitchState_e  SerialMode;     // mode requested
  s8                        RequestReturn;  // <0 means error
  wm_ioPort_e               Port;           // required port
} wm_ioSerialSwitchStateRsp_t;
```

(See § 2.7.2.2 for wm_ioSerialSwitchStateRsp_t description).

***Body for** `WM_IO_PORT_UPDATE_INFO:`*

```
typedef struct
{
  wm_ioPort_e           Port;    // Port identifier
  wm_ioPortUpdateType_e Update;  // Update type (Opened/Closed)
} wm_ioPortUpdateInfo_t;
```

(See §2.7.2.1 for more information about wm_ioPort_e description).
The wm_ioPortUpdateType_e type is described below:

```
typedef enum
{
    WM_IO_PORT_UPDATE_OPENED,    // The New opened port
    WM_IO_PORT_UPDATE_CLOSED     // The port is now closed
} wm_ioPortUpdateType_e;
```

***Body for** `WM_IO_UPDATE_INFO:`*

```
typedef struct
{
    wm_ioUpdateType_e   UpdateType;
    u8                  FeaturesNb;
    wm_ioFeature_e      UpdatedFtrList[1];
} wm_ioUpdateInfo_t;
```

`UpdateType` field informs the application if the feature has been allocated or released, using the type below.

```
typedef enum
{
    WM_IO_UPDATE_TYPE_ALLOCATION,   // The feature has been
                                    allocated (linked GPIO are
                                    no more available)
    WM_IO_UPDATE_TYPE_RELEASE       // The feature has been
                                    released (linked GPIO are
                                    now available again)
} wm_ioUpdateType_e;
```

`FeaturesNb` field is the ***`UpdatedFtrList`*** table size.

`UpdatedFtrList` field is a table of feature identifiers which have just been updated (please refer to GPIO API description for more information).

2.2.7.2 Returned Values

The returned parameter indicates whether the message has been taken into account

- **OK** if it returns a value 0.
- else **ERROR** with a value -1.

2.2.7.3 Notes

- any S*trData[]* or *Data[]* parameter present in the body sub-structure is automatically released at the end of the function.
- any *StrData[]* data is ended with a 0x00 character and any associated *StrLength* includes the 0x00 character.

2.3 AT Command API

2.3.1 Required Header

This API is defined in the wm_at.h header file.
This file is included by wm_apm.h.

2.3.2 The wm_atSendCommand Function

This function is a shortcut to wm_atSendCommandExt, with the Dest parameter always set to the WM_IO_OPEN_AT_VIRTUAL_BASE value. Please refer to this function description for more information.

2.3.3 The wm_atSendCommandExt Function

The wm_atSendCommand function allows to send AT commands on a required port.

The prototype is:

```
u16 wm_atSendCommandExt (     u16                   AtStringSize,
                              wm_atSendRspType_e    ResponseType,
                              ascii                 *AtString,
                              wm_ioPort_e           Dest );
```

2.3.3.1 Parameters

AtString
Any AT command string in ASCII character (ending with a 0x00 chararcter). Several strings can be sent at the same time, depending on the type of AT command.

AtStringSize
Size of the previous *AtString* parameter. It equals the length + 1 and includes the 0x00 character.

ResponseType:
Indicates which application receives the AT responses. The corresponding values are:

```
typedef enum          {
    WM_AT_SEND_RSP_TO_EMBEDDED,      /* Default value */
    WM_AT_SEND_RSP_TO_EXTERNAL,
    WM_AT_SEND_RSP_BROADCAST
} wm_atSendRspType_e;
```

WM_AT_SEND_RSP_TO_EMBEDDED means that all AT responses are sent back to the Embedded Application (default mode).

WM_AT_SEND_RSP_TO_EXTERNAL means that all AT responses are sent back to the External Application (PC).

WM_AT_SEND_RSP_BROADCAST means that all the AT responses are broadcasted to both the Embedded and External Applications (PC).

Dest:

Specifies the port on which the AT command must be executed. Available ports may be opened and closed dynamically by any application (an external or an Open AT® one).
Each time a port is opened or closed, the Open AT® application receives a WM_IO_PORT_UPDATE message. The Open AT® application may also use the wm_ioIsPortAvailable function to detect whether a specific port is currently available.

Available values for this parameter are listed in the wm_ioPort_e type. All opened ports (ie. the ones on which the wm_ioIsPortAvailable returns TRUE) may be used to send an AT command, except the GSM & GPRS based ones (ie. the ones which have their four MSB set to WM_IO_ GSM_VIRTUAL_BASE or WM_IO_GPRS_VIRTUAL_BASE).

Used with the product physical outputs based ports (ie. all ports except the WM_IO_OPEN_AT_VIRTUAL_BASE based ones), this parameter also:

- indicates on which port responses must be sent, in **`WM_AT_SEND_RSP_TO_EXTERNAL`** or **`WM_AT_SEND_RSP_BROADCAST`** mode.
- selects the current port in order to set-up specific parameters (speed with AT+IPR, character framing with AT+ICF, etc.).

In **`WM_AT_SEND_RSP_TO_EMBEDDED`** or **`WM_AT_SEND_RSP_BROADCAST`** modes, this Dest parameter is copied in the Dest field of the WM_AT_RESPONSE & WM_AT_INTERMEDIATE message body structures, for each answer received in response to the AT command sent.

2.3.4 Returned alues

The returned value is a generated command transaction identifier (always greater than 0). TI Commands must be used by applications to associate sent commands with incoming terminal & intermediate responses.

2.3.4.1 Notes

- As described in the “AT Commands Interface” document, AT commands sent by **`wm_atSendCommandExt()`** begin with the “AT” string, and end with a “\r” character (carriage return), except in some cases (“A/” command, SMS writing commands (“test\x1A”), ...)

- AT Command responses are received by the Embedded Application through a message. This message is available as a parameter of the **`wm_apmAppliParser()`** function with the *MsgTyp* parameter set to WM_AT_RESPONSE.

- A response sent to an External Application cannot be pre-parsed .If an Embedded Application must filter or spy responses, it must set the *ResponseType* parameter to WM_AT_SEND_RSP_TO_EMBEDDED or WM_AT_SEND_RSP_BROADCAST.

2.3.4.2 Example: Sending AT Commands and Receiving the Corresponding Responses

The Embedded Application sends an AT command and receives the response from the AT functionality of the Wavecom OS using the wm_atSendCommand (see § 2.3.2) and the wm_atSendRspExternalApp (see § 2.3.9) functions.

- Example of sending an AT command:

```
wm_atSendCommand( 16, WM_AT_SEND_RSP_TO_EMBEDDED,
"ATD0146290800\r" );
```

- Example of receiving an AT response:

```
s32 wm_apmAppliParser (wm_apmMsg_t * Message)
{
   ascii *     strBuffer;
   u16    nLenBuffer;

   switch (Message->MsgTyp)
   {
      ….
      case WM_AT_SEND_RSP:

         strBuffer    = &(Message->Body.AT_Response.StrData);
         nLenBuffer = Message->Body. AT_Response.StrLength;

         /* Receive AT response for filtering    */
         if (Message->Body.ATResponse.Type == AT_RESPONSE_TO_EMBEDDED)
                        {
          if (wm_strnicmp(strBuffer, "CONNECT", 7) == 0)
          {
                /* Local processing */
                ….
                wm_atSendRspExternalApp("CONNECT\r", 9);
          }
          else
          {
                /* Don't modify other responses */
                wm_atSendRspExternalApp ( wm_strlen(strBuffer),
                                          strBuffer);
          }
         }
         /*  Receive AT response for spying      */
         else if (Message->Body.ATResponse.Type ==
                     WM_AT_SEND_RSP_BROADCAST)
                {  ...
          }
          /*  ERROR   */
           else
           { ..
           }
      …
   }
   return OK;
}
```

2.3.5 The wm_atUnsolicitedSubscription Function

If the Embedded Application is configured to receive an unsolicited AT response (incoming call, etc.), the wm_atUnsolicitedSubscription function is used to subscribe to the corresponding service.

The prototype is:

```
void  wm_atUnsolicitedSubscription (
                          wm_atUnsolicited_e  Unsolicited);
```

2.3.5.1 Parameter

Unsolicited:

Indicates which application receives the unsolicited AT response. The corresponding values are:

```
typedef enum          {
  WM_AT_UNSOLICITED_TO_EXTERNAL,    /* Default value */
  WM_AT_UNSOLICITED_TO_EMBEDDED,
  WM_AT_UNSOLICITED_BROADCAST
} wm_atUnsolicited_e;
```

WM_AT_UNSOLICITED_TO_EXTERNAL means any unsolicited AT response are sent back to the External Application (PC). This is the default mode.
WM_AT_UNSOLICITED_TO_EMBEDDED means any unsolicited AT response are sent back to the Embedded Application.
WM_AT_UNSOLICITED_BROADCAST means any unsolicited AT response are broadcasted to both the Embedded and External Applications (PC).

2.3.5.2 Note

An unsolicited AT response is received by the Embedded Application through a message. This message is available as a parameter of the `wm_apmAppliParser()` function with *MsgTyp* parameter set to WM_AT_UNSOLICITED.

2.3.5.3 Example: Receiving Unsolicited AT Responses

The following example deals with the wm_atUnsolicitedSubscription function.

The two stages used to receive unsolicited AT responses are:

1) Subscribing to an Embedded Application to receive unsolicited AT responses. Three types of subscriptions are available:
   - default (WM_AT_UNSOLICITED_TO_EXTERNAL),
   - filtering (WM_AT_UNSOLICITED_TO_EMBEDDED) and
   - spying (WM_AT_UNSOLICITED_BROADCAST).

   An example of a filter subscription is given below:

```
/* Unsolicited responses are process by Embedded Application */
wm_atUnsolicitedSubscription (WM_AT_UNSOLICITED_TO_EMBEDDED);
```

2) Receiving unsolicited AT responses:

```
s32 wm_apmAppliParser (wm_apmMsg_t * Message)
{
   ascii *     strBuffer;
   u16    nLenBuffer;

   switch (Message->MsgTyp)
   {
      ….
      case WM_AT_UNSOLICITED:
         strBuffer    = &(Message->Body.ATUnsolicited.StrData);
         nLenBuffer = Message->Body.ATUnsolicited.StrLength;

         /*  Process unsolicited AT response for filtering     */
         if (Message->Body.ATUnsolicited.Type ==
               WM_AT_UNSOLICITED_TO_EMBEDDED)
         {
           /* Embedded processings */
         }

         /*  Process unsolicited AT response for spying   */
         else if (Message->Body.ATUnsolicited.Type ==
               WM_AT_UNSOLICITED_BROADCAST)
         {
           /* Embedded processings */
         }
      …
   }
   return OK;
}
```

2.3.6 The wm_atIntermediateSubscription Function

If the Embedded Application is configured to receive an intermediate AT response (alerting the remote party during a mobile-originated call, SMS reading responses, etc.), the wm_atIntermediateSubscription function is used to subscribe to the corresponding service.

The prototype is:

```
void  wm_atIntermediateSubscription (
                          wm_atIntermediate_e  Intermediate );
```

2.3.6.1 Parameter

Intermediate:

Indicates which application receives the intermediate AT response. The corresponding values are:

```
typedef enum          {
  WM_AT_INTERMEDIATE_TO_EXTERNAL,   /* Default value */
  WM_AT_INTERMEDIATE_TO_EMBEDDED,
  WM_AT_INTERMEDIATE_BROADCAST
} wm_atIntermediate_e;
```

WM_AT_INTERMEDIATE_TO_EXTERNAL means any intermediate AT response are sent back to the External Application (PC). This is the default mode.
WM_AT_INTERMEDIATE_TO_EMBEDDED means any intermediate AT response are sent back to the Embedded Application.
WM_AT_INTERMEDIATE_BROADCAST means any intermediate AT response are broadcasted to both the Embedded and External Applications (PC).

2.3.6.2 Note

An intermediate AT response is received by the Embedded Application through a message. This message is available as a parameter of the `wm_apmAppliParser()` function with *MsgTyp* parameter set to WM_AT_INTERMEDIATE.

2.3.6.3 Example: Receiving Intermediate AT Responses

The following example deals with the **wm_atIntermediateSubscription** function. The two stages which are used to receive intermediate AT responses are:

1) Subscribing to an Embedded Application to receive intermediate AT responses. Three types of subscriptions are available: default (WM_AT_INTERMEDIATE_TO_EXTERNAL), filtering (WM_AT_INTERMEDIATE_TO_EMBEDDED) and spying (WM_AT_INTERMEDIATE_BROADCAST).

   An example of a filter subscription is given below:

```
/* Intermediate responses are processed by Embedded Application
*/
wm_atIntermediateSubscription (WM_AT_INTERMEDIATE_TO_EMBEDDED);
```

2) Receiving intermediate AT responses:

```
s32 wm_apmAppliParser (wm_apmMsg_t * Message)
{
   ascii *     strBuffer;
   u16    nLenBuffer;

   switch (Message->MsgTyp)
   {
      ….
      case WM_AT_INTERMEDIATE:
         strBuffer    = &(Message->Body.ATIntermediate.StrData);
         nLenBuffer = Message->Body.ATIntermediate.StrLength;

         /*  Process intermediate AT response for filtering     */
         if (Message->Body.ATIntermediate.Type ==
               WM_AT_INTERMEDIATE_TO_EMBEDDED)
         {
          /* Embedded processing */
         }

         /*  Process intermediate AT response for spying   */
         else if (Message->Body.ATIntermediate.Type ==
               WM_AT_INTERMEDIATE_BROADCAST)
         {
          /* Embedded processing */
         }
      …
   }
   return OK;
}
```

2.3.7 The wm_atCmdPreParserSubscribe Function

If the Embedded Application is configured to perform AT command pre-parsing, it must subscribe to the corresponding services, using the wm_atCmdPreParserSubscribe function.
The AT messages received from the External Application are forwarded to the Pre-parser and sent to the Embedded Application through a WM_AT_CMD_PRE_PARSER type message, the associated structure of which is wm_atCmdPreParser_t.

Note that, by default, the "AT+WDWL" and "AT+WOPEN" AT commands cannot be pre-parsed, so that users can download a new Embedded software or stop the embedded application whenever they want.
The wm_atCmdPreParserSubscribe function may also be used to pre-parse these commands, using the WM_AT_CMD_PRE_APP_CONTROL_EMBEDDED option.

The prototype of this function is:

```
void  wm_atCmdPreParserSubscribe  (
                    wm_atCmdPreSubscribe_e   SubscribeType);
```

2.3.7.1 Parameter

SubscribeType:

Indicates what happens when an AT command arrives. The corresponding values are:

```
typedef enum          {
    WM_AT_CMD_PRE_WAVECOM_TREATMENT, /* Default value */
    WM_AT_CMD_PRE_EMBEDDED_TREATMENT,
    WM_AT_CMD_PRE_BROADCAST,

/* Open-AT control commands processing */
    WM_AT_CMD_PRE_APP_CONTROL_WAVECOM, /* Default value */
    WM_AT_CMD_PRE_APP_CONTROL_EMBEDDED
} wm_atCmdPreSubscribe_e;
```

WM_AT_CMD_PRE_WAVECOM_TREATMENT means the Embedded Application does not require filtering or spying the commands sent by an External Application (default mode).
WM_AT_CMD_PRE_EMBEDDED_TREATMENT means the Embedded Application requires filtering of the AT commands sent by an External Application.
WM_AT_CMD_PRE_BROADCAST means the Embedded Application requires spying the AT commands sent by an External Application.
WM_AT_CMD_PRE_APP_CONTROL_WAVECOM means the +WOPEN and +WDWL commands are always processed by the Wavecom OS ; they cannot be filtered by the embedded application (default mode)
WM_AT_CMD_PRE_APP_CONTROL_EMBEDDED means +WDWL and +WOPEN commands are processed as other ones, and may be pre-parsed by the embedded application.

2.3.7.2 Notes

- Filtered or spied AT commands are received by the Embedded Application through a message. This message is available as a parameter of the **wm_apmAppliParser()** function with the *MsgTyp* parameter set to WM_AT_CMD_PRE_PARSER. The source part of the message is the port on which the command has been received.
- The Embedded Application processes the received command and may send it back (either in full or not) to the **wm_atSendCommand()** function. Therefore, responses may be forwarded to the Wavecom OS.
- When a command is pre-parsed for filtering, the User has the responsibility to send the response to the External Application.
- When +WDWL or +WOPEN commands are pre-parsed for filtering, the application has the responsability to maintain an interface for other applications download and Open AT® start/stop mode. For exemple, it should filter +WDWL or +WOPEN command and require a password for download or application stop.

2.3.7.3 Example: Filtering or Spying AT Commands Sent by an External Application

The following example deals with the `wm_atCmdPreParserSubscribe()` function.

The two stages which are used to filter or spy AT commands sent by an External Application are:

1) Subscribing to a command pre–parsing mechanism to filter or spy the AT commands sent by the External Application.

   An example of a filtering subscription is given below:

```
/* Filter subscription */
wm_atCmdPreParserSubscribe (WM_AT_CMD_PRE_EMBEDDED_TREATMENT);
```

   An example of a spying subscription is given below:

```
/* Spy subscription */
wm_atCmdPreParserSubscribe(WM_AT_CMD_PRE_BROADCAST);
```

2) Receiving and processing the pre-parsed commands (an AT command sent by the External Application) in the Embedded Application:

```
s32 wm_apmAppliParser (wm_apmMsg_t * Message)
{
   ascii *     strBuffer;
   u16    nLenBuffer;

   switch (Message->MsgTyp)
   {
      ….
      case WM_AT_CMD_PRE_PARSER:
         strBuffer    = &(Message->Body.ATCmdPreParser.StrData);
         nLenBuffer = Message->Body. ATCmdPreParser.StrLength;

         /*  Process pre-parsed AT command for filtering   */
         if     (Message->Body.ATCmdPreParser.Type ==
                WM_AT_CMD_PRE_EMBEDDED_TREATMENT)
         {
          /* Filtering Embedded processings */
          …
         }
         else if (Message->Body.ATCmdPreParser.Type ==
                  WM_AT_CMD_PRE_BRAODCAST)
           {
            /* Spying Embedded processing */
           …
           }
      …
   }
   return OK;
}
```

2.3.8 The wm_atRspPreParserSubscribe Function

If the Embedded Application is configurede to perform an AT response pre-parsing, it should then subscribe to the corresponding services, using the wm_atRspPreParserSubscribe function.
An AT message sent by an External Application and processed by the Wavecom OS generates a response. Depending on the subscription type, this response may be forwarded to the Embedded Application through a message of the WM_AT_RSP_PRE_PARSER type of which the associated structure is wm_atRspPreParser_t.

The prototype is:

```
void  wm_atRspPreParserSubscribe (
                    wm_atRspPreSubscribe_e    SubscribeType );
```

2.3.8.1 Parameter

SubscribeType:

Indicates what happens when an AT response arrives. The corresponding values are as follows:

```
typedef enum          {
    WM_AT_RSP_PRE_WAVECOM_TREATMENT, /* Default value */
    WM_AT_RSP_PRE_EMBEDDED_TREATMENT,
    WM_AT_RSP_PRE_BROADCAST
} wm_atRspPreSubscribe_e;
```

WM_AT_RSP_PRE_WAVECOM_TREATMENT means the Embedded Application is not configured to filter or spy responses sent to an External Application (default mode).

WM_AT_RSP_PRE_EMBEDDED_TREATMENT means the Embedded Application is configured to filter the AT responses sent to an External Application.

WM_AT_RSP_PRE_BROADCAST means the Embedded Application is configured to spy the AT responses sent to an External Application.

2.3.8.2 Notes

- Filtered or spied AT responses are received by the Embedded Application through a message. This message is available as a parameter of the **wm_apmAppliParser()** function with the *MsgTyp* parameter set to WM_AT_RSP_PRE_PARSER.
- If the Embedded Application subscribes to WM_AT_RSP_PRE_EMBEDDED_TREATMENT, it processes the response and sends it to the External Application, using the **wm_atSendRspExternalApp()** function .
- The response pre-parser is only active when the AT command has not been sent through **wm_atSendCommand()**. In this case, the response is processed as described in the *ResponseType* parameter .

2.3.8.3 Example: Filtering or Spying AT Responses Sent to the External Application

The following example deals with the wm_atRspPreParserSubscribe() function.

The two stages used to filter or spy the AT response sent to the External Application are:

1) Subscribing to the response pre–parsing mechanism in order to filter or spy the AT response sent to the External Application.

   An example of a filter subscription is given below:

```
/* Filter subscription */
wm_atRspPreParserSubscribe (WM_AT_RSP_PRE_EMBEDDED_TREATMENT);
```

   An example of a spying subscription is given below:

```
/* Spy subscription */
wm_atRspPreParserSubscribe(WM_AT_RSP_PRE_BROADCAST);
```

2) Processing the pre-parsed response in the Embedded Application:

```
s32 wm_apmAppliParser (wm_apmMsg_t * Message)
{
   ascii * strBuffer;
   u16     nLenBuffer;

   switch (Message->MsgTyp)
   {
      ….
      case WM_AT_RSP_PRE_PARSER:
         strBuffer = &(Message->Body.ATRspPreParser.StrData);
         nLenBuffer = Message->Body.ATRspPreParser.StrLength;

         /*  Process pre-parsed AT command for filtering   */
            if(Message>Body.ATRspPreParser.Type ==
            WM_AT_RSP_PRE_EMBEDDED_TREATMENT)
         {
            /* Filtering Embedded processing */
            …
         }
         else if (Message->Body.ATRspPreParser.Type ==
                  WM_AT_RSP_PRE_BRAODCAST)      {
            /* Spying Embedded processing */
            …
         }
      …
   }
   return OK;
}
```

2.3.9 The wm_atSendRspExternalApp Function

This function is a shortcut to the wm_atSendRspExternalAppExt one, with the Dest parameter always set to the WM_IO_UART1 value. Please refer to this function description for more information.

The response is sent to the UART 1 physical port (if this port is not opened, the response is not be displayed anywhere).
It is strongly not recommended not to use this function ; the wm_atSendRspExternalAppExt one must be used instead.

2.3.10 The wm_atSendRspExternalAppExt Function

The **wm_atSendRspExternalAppExt** function sends an AT response to the External Application, in case of AT command pre-parsing.
The response is sent to the required port.

The prototype is:

```
void wm_atSendRspExternalAppExt ( u16           AtStringSize,
                                  ascii         *AtString,
                                  wm_ioPort_e   Dest );
```

Note: This function must be used to transmit the responses received by the Embedded Application to the External Application through a WM_AT_RESPONSE message.

2.3.10.1 Parameters

AtString
: Any AT response string in ASCII characters (ending with a 0x00 character). This string is sent on the serial link without any change: it must also include "\r\n" characters at the end and/or at the beginning of the string.

AtStringSize
: Size of the previous *AtString* parameter. It equals the length + 1 since it includes the 0x00 character.

Dest
: Port where to send the provided response.
Available ports may be opened and closed dynamically by any application (an external or an Open AT® one).
Each time a port is opened or closed, the Open AT® application receives a WM_IO_PORT_UPDATE message. The Open AT® application may also use the wm_ioIsPortAvailable function to check whether a specific port is currently available.
Available values for this parameter are listed in the wm_ioPort_e type.
All opened ports (ie. the ones on which the wm_ioIsPortAvailable returns TRUE) may be used to send an AT response, except the GSM, GPRS & Open AT® based ones (ie. the ones which have their four MSB set to WM_IO_ GSM_VIRTUAL_BASE, WM_IO_GPRS_VIRTUAL_BASE or WM_IO_OPEN_AT_VIRTUAL_BASE ; in this case the response is not displayed anywhere).

If the function is used to forward a response received from the WavecomOS to any external application, and if the

WM_AT_SEND_RSP_HIGH_PRIORITY flag is set in the received response, then this flag must be provided (through a bitwise operator OR combination) in the Dest parameter, in order to abide by the response priority level. This flag is mainly used for the "CONNECT" response, issued just when a port is switched in data mode during a GSM data call (if this port is not used by the Open AT® application with the FCM API).

2.3.11 The wm_atSendUnsolicitedExternalApp Function

The wm_atSendUnsolicitedExternalApp function sends an AT unsolicited response to the External Application.
The Unsolicited response is sent to all ports.

The prototype is:

```
void wm_atSendUnsolicitedExternalApp (    u16          AtStringSize,
                                          ascii        *AtString );
```

2.3.11.1 Parameters

AtString

Any AT unsolicited response string in ASCII characters (ending with a 0x00 character). This string is sent on the serial link without any change: it must also include "\r\n" characters at the end and/or at the beginning of the string.

AtStringSize

Size of the previous *AtString* parameter. It equals the length + 1 since it includes the 0x00 character.

2.3.11.2 Notes

- An unsolicited response string sent by the **wm_atSendUnsolicitedExternalApp** function is only displayed on the serial link when the Wavecom AT task is not busy with command processing. If it is busy in such processing, the unsolicited response string is stored, and displayed at the end of the process (after the terminal AT response).
- Sending an AT response by the wm_atSendRspExternalApp function displays all previously stored unsolicited responses (after this response display).
- This function should be used to transmit the unsolicited responses received by the Embedded Application to the External Application through the WM_AT_UNSOLICITED message.

2.3.12 The wm_atSendUnsolicitedExternalAppExt Function

This function behaves exactly as the wm_atSendUnsolicitedExternalApp one, but provides an additional parameter in order to send the unsolicited response on one specific port, instead of broadcasting it to all ports.

The prototype is:

```
void wm_atSendUnsolicitedExternalAppExt (  u16         AtStringSize,
                                           ascii       *AtString,
                                           wm_ioPort_e     Dest );
```

Please note that if the Dest parameter is set to **WM_IO_NO_PORT** value, the unsolicited response is broadcasted on all ports.

2.3.13 The wm_atSendIntermediateExternalApp Function

This function is a shortcut to the wm_atSendIntermediateExternalAppExt one, with the Dest parameter always set to the WM_IO_UART1 value. Please refer to this function description for more information.

The wm_atSendIntermediateExternalApp function sends an AT intermediate response to the External Application. The response is sent to the UART 1 physical port (if this port is not opened, the response is not displayed anywhere).
It is strongly not recommended not to use this function ; the wm_atSendIntermediateExternalAppExt one must be used instead.

2.3.14 The wm_atSendIntermediateExternalAppExt Function

The **wm_atSendIntermediateExternalApp** function sends an AT intermediate response to the External Application.
The intermediate response is sent to the required port.

The prototype is:

```
void wm_atSendIntermediateExternalAppExt
                                  (u16          AtStringSize,
                                  ascii         *AtString,
                                  wm_ioPort_e   Dest );
```

2.3.14.1 Parameters

AtString

Any AT intermediate response string in ASCII characters (ending with a 0x00 character). This string is sent on the serial link without any change: it must also include "\r\n" characters at the end and/or at the beginning of the string.

AtStringSize

Size of the previous *AtString* parameter. It equals the length + 1 and includes the 0x00 character.

Dest

Port where to send the provided intermediate response.
Available ports may be opened and closed dynamically by any application (an external or an Open AT® one).

Each time a port is opened or closed, the Open AT® application receives a WM_IO_PORT_UPDATE message. The Open AT® application may also use the wm_ioIsPortAvailable function to check whether a specific port is currently available.
Available values for this parameter are listed in the wm_ioPort_e type.
All opened ports (ie. the ones on which the wm_ioIsPortAvailable returns TRUE) may be used to send an AT intermediate response, except the GSM, GPRS & Open AT® based ones (ie. the ones which have their four MSB set to WM_IO_ GSM_VIRTUAL_BASE, WM_IO_GPRS_VIRTUAL_BASEor WM_IO_OPEN_AT_VIRTUAL_BASE; in this case the intermediate response is not displayed anywhere).

2.3.14.2 Notes

- An intermediate response string sent by the **`wm_atSendIntermediateExternalAppExt`** function always displays this string on the serial link, whether the Wavecom AT task is busy on a command processing or not.

- Previously stored unsolicited responses are not be displayed after a call to the wm_ atSendIntermediateExternalApp function.

- This function should be used to transmit the intermediate responses received by the Embedded Application to the External Application through the WM_AT_INTERMEDIATE message.

2.4 Debug API

2.4.1 Required Header

This API is defined in the wm_dbg.h header file.
This file is included by wm_apm.h.

2.4.2 The wm_osDebugTrace Function

The **wm_osDebugTrace** function allows the application to send a debug trace to the Target Monitoring Tool.

The prototype is:

```
s32  wm_osDebugTrace ( u8  Level, ascii *Format, ... );
```

2.4.2.1 Parameters

Level:

Used to differentiate the traces. The Target Monitoring Tool software gives access to level configuration.

Format:

Used to specify a string and the corresponding formats (like the printf function), as far as the data to trace is concerned. Supported formats are '%c', '%x', '%X', '%u', '%d'.
Up to 6 parameters may be included in the *Format* string.
As the '%s' format is not supported, the way to display an ascii * string is to replace the *Format* string by this character, without any other parameters.

...:

Represents the list of data to be traced.

2.4.2.2 Returned values

This function always returns OK

2.4.2.3 Example: Inserting Debug Information

Debug information is included in the Embedded Application, and therefore uses ROM space and CPU resources.
The Target Monitoring Tool is used to display the Debug information.

An example of tracing an informational message is given below:

```
wm_osDebugTrace ( 1, "This is an informational message on level 1" );
/* To visualise this, the Target Monitoring Tool must be configured
to extract level 1 traces */

/* The result string using the Target Monitoring Tool should be:
 "This is an informational message on level 1" */
```

Example of tracing an informational message using a decimal parameter:

```
u8 param =12;

wm_osDebugTrace ( 2, "This is an informational message on level 2
with 1 parameter =%d", param );
/* To visualise this, the Target Monitoring Tool must be configured
to extract level 2 traces */

/* The result string using the Target Monitoring Tool should be:
 "This is an informational message on level 2 with 1 parameter =12"
*/
```

Example of tracing a string:

```
ascii String[]="Hello World";

wm_osDebugTrace ( 3, String );
/* To visualise this, the Target Monitoring Tool must be configured
to extract level 3 traces */

/* The result string on Target Monitoring Tool should be:
 "Hello World" */
```

2.4.3 The wm_osDebugFatalError Function

The **wm_osDebugFatalError** function allows the application to store a "backtrace" in the product memory, and to reset it. A backtrace is composed of the provided message, and a call stack "footprint" taken at function call time. It is readable by the Target Monitoring Tool (Please refer to the Tools Manual for more information).

The prototype is:

```
s32    wm_osDebugFatalError ( const ascii * Message );
```

2.4.3.1 Parameters

Message:

String to be displayed whenever an error occurs, and to be stored with the backtrace in the product memory.
Please note that only the string address is stored in the backtrace, so this parameter must not be a pointer on a RAM buffer, but a constant string pointer. Moreover, the string is correctly displayed only when the current application is still present in the Wireless CPU's flash memory. If the application is erased or modified, the string is not correctly displayed when retrieving backtraces.

2.4.3.2 Returned Value

None: this function resets the product.

2.4.3.3 Note

On a reset due to an exception, the Open AT® application restarts. Moreover, if the product reset is due to a fatal error (from Open AT® application, or from

Wavecom OS), the Init function's InitType parameter is set to the **WM_APM_REBOOT_FROM_EXCEPTION** value.

2.4.4 The wm_osDebugEraseAllBacktraces Function

The **wm_osDebugEraseAllBacktraces** function allows the application to re-initialize the product backtrace storage place. All currently stored backtraces are erased.

The prototype is:

```
void    wm_osDebugEraseAllBacktraces ( void );
```

2.4.5 The wm_osDebugInitBacktracesAnalysis Function

In order to start backtrace analysis, the **wm_osDebugInitBacktracesAnalysis** function must be called before the first **wm_osDebugRetrieveBacktrace** function call. Each time a full backtrace analysis must be started, this function must be called first.

The prototype is:

```
s32     wm_osDebugInitBacktracesAnalysis ( void );
```

2.4.5.1 Returned Value

OK on success.
A negative internal error value if an unexpected error occurred.

2.4.6 The wm_osDebugRetrieveBacktrace Function

This function retrieves the next stored backtrace in the product's memory. Before the first call to this function, the **wm_osDebugInitBacktracesAnalysis** function must be called in order to initialize the analysis. Successive calls to the **wm_osDebugRetrieveBacktrace** function allows to retrieve all backtraces, until the function returns a negative value.

The prototype is:

```
s32    wm_osDebugRetrieveBacktrace ( u8 * BacktraceBuffer, u16 Size );
```

2.4.6.1 Parameters

BacktraceBuffer:

Buffer where the backtrace content are copied. The buffer content is not modified if it is not large enough. This parameter may be set to **NULL** in order to know the next backtrace buffer required size.

Size:

Backtrace buffer size. The buffer content is not modified if it is not large enough. A backtrace buffer size consists of at least 550 bytes, + the stored message size.

2.4.6.2 Returned Value

OK on success.

A negative internal error value if there is no more backtrace stored in the product's memory, or if the **wm_osDebugInitBacktracesAnalysis** function has not been called yet.

A positive size value, if the BacktraceBuffer argument was set to **NULL**: the next backtrace buffer required size is returned (at least 550 bytes, + the stored message size).

2.5 OS API

2.5.1 Required Header

This API is defined in the **wm_os.h** header file.
This file is included by **wm_apm.h**.

2.5.2 The wm_osStartTimer Function

The wm_osStartTimer function sets up a timer (in 100ms steps) and is associated to an existing *TimerId*.

The prototype is:

```
s32    wm_osStartTimer     ( u8      TimerId,
                             bool     bCyclic,
                             u32 TimerValue  );
```

2.5.2.1 Parameters

TimerId:
Timer identifier: the range 0 to WM_OS_MAX_TIMER_ID is accepted.

BCyclic:
This parameter may have one of the following values:

- **TRUE**: the timer is cyclic and is automatically set up when a cycle is over,
- **FALSE**: the timer has only one cycle.

TimerValue:
Numerical value of timer unit (the timer unit is 100 ms).

2.5.2.2 Returned Values

- The returned parameter is positive or null if the timer is successfully set
- and negative in case of failure.

2.5.2.3 Notes

- The timer expiry indication is received by an Embedded Application through a message. This message is available as a parameter of the **wm_apmAppliParser()** function with the *MsgTyp* parameter set to WM_OS_TIMER.
- Since the Wavecom® product time granularity is 18.5 ms, 100 ms steps are emulated, reaching a value as close as possible to the requested one (modulo 18.5). For example, if a 20 * 100ms timer is required, the real time value is 1998 ms (108 * 18.5ms).

2.5.2.4 Example: Managing a Timer

The range 0 to WM_OS_MAX_TIMER_ID is accepted for the timer Id. A timer may or may not be cyclic.

An example of setting up a timer is given below:

```
/* Timer start, not cyclic, value = 1second */
wm_osStartTimer( 1, FALSE, 10 );
```

An example of receiving a timer expiry event is given below:

```
s32 wm_apmAppliParser (wm_apmMsg_t * Message)
{
   ascii * strBuffer;
   u16     nLenBuffer;

   switch (Message->MsgTyp)
   {
      ….
      case WM_OS_TIMER:

      …
   }
   return OK;
}
```

2.5.3 The wm_osStopTimer Function

The wm_osStopTimer function stops the timer identified by TimerId.

The prototype is:

```
s32   wm_osStopTimer  ( u8   TimerId );
```

2.5.3.1 Parameter

TimerId:

Timer identifier: the range 0 to WM_OS_MAX_TIMER_ID is accepted.

2.5.3.2 Returned Values

- The returned parameter is the remaining time, (in 100 ms steps) if the timer was still running
- if not, it returns a negative value.

2.5.4 The wm_osStartTickTimer Function

The wm_osStartTickTimer function sets up a timer (in 18.5 ms tick steps) associated to an existing *TimerId*.

The prototype is:

```
s32   wm_osStartTickTimer     ( u8      TimerId,
                                bool      bCyclic,
                                u32       TimerValue  );
```

2.5.4.1 Parameters

TimerId:
Timer identifier: the range 0 to WM_OS_MAX_TIMER_ID is accepted.

BCyclic:
This parameter may have one of the following values:

- **TRUE**: the timer is cyclic and is automatically set up when a cycle is over,
- **FALSE**: the timer has only one cycle.

TimerValue:
Number of ticks (18.5 ms steps).

2.5.4.2 Returned Values

- **OK** if the returned parameter is positive or null, if the timer is successfully set up.
- **ERROR** with a negative value if it is unsuccessful.

2.5.4.3 Note

The timer expiry indication is received by an Embedded Application through a message. This message is available as a parameter of the **wm_apmAppliParser()** function with the *MsgTyp* parameter set to WM_OS_TIMER.

2.5.4.4 Example: Managing a Timer

The range 0 to WM_OS_MAX_TIMER_ID is accepted. A timer may or may not be cyclic.

An example to set up a timer is given below:

```
/* Timer start, not cyclic, value = 37 ms */
wm_osStartTickTimer( 1, FALSE, 2 );
```

2.5.5 The wm_osStopTickTimer Function

The wm_osStopTickTimer function stops the timer identified by TimerId.

The prototype is:

```
s32  wm_osStopTimer ( u8  TimerId );
```

2.5.5.1 Parameter

TimerId:
Timer identifier: the range 0 to WM_OS_MAX_TIMER_ID is accepted.

2.5.5.2 Returned Values

- The returned parameter is the remaining time (in 18.5 ms tick steps) if the timer was still running.
- **ERROR** with a negative value.

2.5.6 Important Note on Data Flash Management

A single flash object may use up to 30 Kbytes of data.

Identifiers use an u16 value: any value from 0 to 0xFFFF is valid for an object identifier.
However, due to the internal storage implementation, a maximum of 2000 object identifiers can exist at the same time.

2.5.7 The wm_osWriteFlashData Function

The wm_osWriteFlashData function is used to write data into Flash ROM. The corresponding identifier is assigned to the stored data.

The prototype is:

```
s32  wm_osWriteFlashData  ( u16  Id, u16  DataLen, u8  *Data );
```

2.5.7.1 Parameters

Id:
Identifier assigned to the stored data.

DataLen:
Length of the data to be stored (in bytes).

Data:
Pointer to the data to be stored.

2.5.7.2 Returned Values

- `OK` on success
- `ERROR` if the following conditions occur:
  - There is no free space
  - The object size exceeds 30 Kbytes
  - There is no free identifier (2000 objects limit reached)

2.5.8 The wm_osReadFlashData Function

The wm_osReadFlashData function is used to read the data identified by an Id from the Flash ROM.

The prototype is:

```
s32  wm_osReadFlashData  ( u16  Id, u16  DataLen, u8  *Data );
```

2.5.8.1 Parameters

Id:
Identifier assigned to the stored data.

DataLen:
Length of the data to be read (in bytes).

Data:
Pointer to the data to be read.

2.5.8.2 Returned Values

- **OK** if the returned parameter is the length to read and copied to **Data* on success.
- **ERROR** if the object does not exist.

2.5.9 The wm_osGetLenFlashData Function

The wm_osGetLenFlashData function supplies the length of the data stored in Flash ROM and identified by an Id.

The prototype is:

```
s32  wm_osGetLenFlashData  ( u16  Id );
```

2.5.9.1 Parameter

Id:
Identifier assigned to the stored data.

2.5.9.2 Returned Values

- **OK** if the returned parameter is the byte length of the data identified by Id.
- **ERROR** if the object does not exist.

2.5.10 The wm_osDeleteFlashData Function

The wm_osDeleteFlashData function deletes the data stored in Flash ROM and identified by an Id.

The prototype is:

```
s32  wm_osDeleteFlashData  ( u16  Id );
```

2.5.10.1 Parameter

Id:

Identifier assigned to the stored data.

2.5.10.2 Returned Values

- **OK** on success
- **ERROR** if the object does not exist.

2.5.11 The wm_osGetAllowedMemoryFlashData Function

The wm_osGetAllowedMemoryFlashData function returns the quantity of allocated memory in Flash ROM.

The prototype is:

```
s32  wm_osGetAllowedMemoryFlashData ( void );
```

The returned parameter is the quantity of allocated memory in Flash ROM (Unit: bytes).

2.5.12 The wm_osGetFreeMemoryFlashData Function

The wm_osGetFreeMemoryFlashData function returns the quantity of available memory in Flash ROM.

The prototype is:

```
s32  wm_osGetFreeMemoryFlashData ( void );
```

The returned parameter is the quantity of free memory (expressed in bytes) in Flash ROM.

2.5.13 The wm_osGetUsedMemoryFlashData Function

The wm_osGetUsedMemoryFlashData function returns the quantity of used memory by flash objects between the start & end IDs provided.

The prototype is:

```
s32  wm_osGetUsedMemoryFlashData ( u16 StartId, u16 EndId );
```

2.5.13.1 Parameters

StartId:
Range to browse first Id

EndId:
Range to browse last Id

2.5.13.2 Returned Values

- The returned parameter is the quantity of memory used (expressed in bytes) by the provided Id range in Flash ROM.
- ERROR is the returned parameter if StartId is greater or equal to Enid.

2.5.14 The wm_osDeleteAllFlashData Function

The wm_osDeleteAllFlashData function deletes all the data previously stored in flash memory by an Embedded Application.

The prototype is:

```
s32  wm_osDeleteAllFlashData ( void );
```

The returned value is the total data size of the deleted flash objects (0 if there is no object to delete).

2.5.15 The wm_osDeleteRangeFlashData Function

The wm_osDeleteRangeFlashData function deletes all the flash objects between the start & end IDs provided .

The prototype is:

```
s32  wm_osDeleteRangeFlashData ( u16 StartId, u16 EndId );
```

2.5.15.1 Parameters

StartId:
Range to browse first Id

EndId:
Range to browse last Id

2.5.15.2 Returned Values

- The returned value is the total data sizes of the deleted flash objects (0 if there is no objects to delete).
- ERROR is the returned parameter if StartId is greater or equal to Enid.

2.5.16 The wm_osGetHeapMemory Function

The wm_osGetHeapMemory function gets memory from an Embedded Application heap.

The prototype is:

```
void  * wm_osGetHeapMemory  ( u32  MemorySize);
```

2.5.16.1 Parameter

MemorySize:
Requested size.

2.5.16.2 Returned Values

- **OK** if the returned parameter returns the memory address.
- if not, **ERROR** with a NULL value.

2.5.17 The wm_osReleaseHeapMemory Function

The wm_osReleaseHeapMemory function releases a previously reserved memory buffer.

The prototype is:

```
s32  wm_osReleaseHeapMemory  ( void * ptrData );
```

2.5.17.1 Parameter

PtrData:
Points to the reserved memory.

2.5.17.2 Returned Values

The returned parameter is positive or null if the reserved memory has been released, and negative if not. An exception should also occur on unrecoverable errors (Please refer to the ADL User Guide for more information on generated errors).

2.5.18 The wm_osGetRamInfo Function

The **wm_osGetRamInfo** function retrieves information about the Open AT® RAM areas sizes.

The prototype is:

```
s32 wm_osGetRamInfo ( wm_osRamInfo_t * Info );
```

2.5.18.1 Parameter

Info:

Open AT® RAM information structure, using the following type:

```
typedef struct
{
    u32 TotalSize;
    u32 StackSize;
    u32 HeapSize;
    u32 GlobalSize;
} wm_osRamInfo_t;
```

- **TotalSize**
  Total RAM size for an Open AT® application (in bytes).
- **StackSize**
  Open AT® application call stack area size (in bytes).
- **HeapSize**
  Open AT® application total heap memory area size (in bytes).
- **GlobalSize**
  Open AT® application global variables area size (in bytes).

2.5.18.2 Returned Values

- **OK** on success.
- **ERROR** on parameter error.

2.5.19 The wm_osSuspend Function

The wm_osSuspend function suspends the execution of an Open AT® embedded application. All the application's tasks (except interruption handlers) are suspended as soon as the function is called. To resume the application, the **wm_osResume** function must be called from an interruption handler.

The prototype is:

```
void wm_osSuspend(void)
```

An Open AT® application running in Remote Task Environment cannot be suspended (the function has no effect).

2.5.20 The wm_osSuspendExt Function

The **wm_osSuspendExt** function suspends the execution of an Open AT® application task. This task's process is suspended as soon as the function is called. To resume the task, the **wm_osResumeExt** function must be called from any other task, or form an interruption handler.
An Open AT® application running in Remote Task Environment cannot be suspended (the function has no effect).

The prototype is:

```
void wm_osSuspendExt ( wm_osTask_e Task );
```

2.5.20.1 Parameters

Task

Task identifier to be suspended. This ID must be a real Open AT® task identifier; using an undefined value or an interruption handler context identifier leads to an error.

2.5.20.2 Returned Values

- **OK** on success; please note that if this function is used to suspend the current task, the function will not return but suspend immediately the task process. The OK value is returned once the task resumes.
- **ERROR** on parameter error.

2.5.21 The wm_osResume Function

The **wm_osResume** function resumes the execution of all the Open AT® application's tasks, previously suspended by the **wm_osSuspend** or **wm_osSuspendExt** functions.

The prototype is:

```
void wm_osResume ( void );
```

2.5.22 The wm_osResumeExt Function

The **wm_osResumeExt** function resumes the execution of an Open AT® application task, previously suspended by the **wm_osSuspend** or **wm_osSuspendExt** functions.

The prototype is:

```
void wm_osResumeExt ( wm_osTask_e Task );
```

2.5.22.1 Parameters

Task

Task identifier to be resumed. This ID must be a real Open AT® task identifier; using an undefined value or an interruption handler context identifier leads to an error.

2.5.22.2 Returned Values

- **OK** on success: the required task has been resumed.
- **ERROR** on parameter error

2.5.23 The wm_osGetTaskCount Function

The **wm_osGetTaskCount** function returns the running Open AT® tasks count, as declared in the **wm_apmTask** table.

The prototype is:

```
u8 wm_osGetTaskCount ( void );
```

2.5.23.1 Returned Values

- The returned value is the running Open AT® task count.

2.5.24 The wm_osGetTask Function

The wm_osGetTask function returns the current task ID. Please note that the returned value depends on the current execution context:

- If the function is called within an Open AT® task context, the returned value is the current task identifier.
- If the function is called within the high level interruption handler context, the returned value is the **WM_OS_CTX_HIGH_LEVEL_IRQ_HANDLER** identifier.
- If the function is called within a low level interruption handler context, the returned value depends on the active task on interruption raise:
  - If a Wavecom OS task is active, the returned value is the **WM_OS_TASK_WAVECOM** identifier.
  - If an Open AT® task is active, the returned value is the current task identifier.
  - If a high level interruption handler is active, the returned value is the **WM_OS_CTX_HIGH_LEVEL_IRQ_HANDLER** identifier.

The prototype is:

```
wm_osTask_e wm_osGetTask ( void );
```

2.5.24.1 Returned Values

The returned parameter is the current embedded application task or execution context ID. (see. **wm_osTask_e** type definition).

2.5.25 The wm_osSendMsg Function

The wm_osSendMsg function behaves as the **wm_osSendMsgExt** one, except that the message source mailbox automatically set, according to the current execution context (if the function is called from an Open AT® task or from a high level interruption handler context). If the function is called from a low level interruption handler execution context, the source mailbox is set to the active context identifier one, when the interruption occurs (see. **wm_osGetTask** function description).

2.5.26 The wm_osSendMsgExt Function

The **wm_osSendMsgExt** function allows an embedded application to send a user-defined message to one of the application tasks, and to specify the source mailbox.

The prototype is:

```
s8 wm_osSendMsgExt (            wm_osTask_eDestination,
                    wm_osTask_e Source,
                    u8          MsgID,
                    u16         MsgLength,
                    u8 *        MsgBody );
```

Notes:

- The sent message is received by the destination task as a parameter of the **Parser** function.
- The received message ID is (**WM_USER_MSG_BASE** + the **MsgID** parameter).
- The received message body is accessed through the **UserMsg** member of the **wm_apmBody_t** union.

2.5.26.1 Parameters

Destination
Destination task ID. This ID must be a real Open AT® task identifier; use of an undefined value or an interruption handler context identifier leads to an error.

Source
Source execution context ID. This ID can be freely set by the application.

MsgID
User-defined message ID; allowed values are from 0 to 0x7F.

MsgLength
Message body length.

MsgBody
Message body data pointer.

2.5.26.2 Returned Values

- **OK** on success
- **ERROR** on parameter error

2.5.27 The wm_osGetDiagnostic Function

The **wm_osGetDiagnostic** function allows the application to retrieve information about the current binary behavior.

The prototype is:

```
u32 wm_osGetDiagnostic ( void );
```

2.5.27.1 Returned Values

Bit mask where one or several of the following values are set (with a bitwise operator OR combination).

- **WM_OS_DIAG_NO_IRQ_PROCESSING**
  An Open AT® IRQ processing mechanism has not been started (low level handler stack size has not been supplied).
- **WM_OS_DIAG_BAD_IRQ_PARAM**
  There is an error in Open AT® IRQ processing mechanism parameters (low level handler stack size is not supplied when high level handler's one is supplied).
- **WM_OS_DIAG_NO_HIGH_LEVEL_IRQ_HANDLER**
  High level interruption handlers are not supported (high level handler stack size is not supplied).

2.5.28 Example: Managing Data Flash Objects

5KB of Data Flash objects are available for an Embedded Application. Data Flash objects are organized in Ids and managed by Embedded Applications.

An example related to Data Flash reading/writing is given below:

```
s32 LengthRead;
s32 Length;
u8* Ptr;
u16 Id;
s32 Writen;

FlashId = 112;

/* Get the len */
Length = wm_osGetLenFlashData (FlashId);
if ( Length > 0 )
{
    Ptr = wm_osGetHeapMemory (Length);

    /* Read the Flash Id item */
    LengthRead  = wm_osReadFlashData  (FlashId, Length, Ptr);

    Ptr[3] = 0x10; /* Change something */

   /* Write the modified Flash Id item */
    Writen = wm_osWriteFlashData  (FlashId, Length, Ptr);
}
```

2.5.29 Example: RAM Management

32 or 128 Kbytes (according to product type) of RAM are available for Embedded Applications and the provided Wavecom library manages this RAM.

An example of the RAM request function is given below:

```
void *ptr;
ptr = wm_osGetHeapMemory (1000);/* 1000 bytes are requested */
```

An example of the RAM release function is given below:

```
wm_osReleaseHeapMemory (ptr);
```

2.6 Flow Control Manager API

The Flow Control Manager API provides IO flows to the Embedded Application:

- Serial link based flows (UART 1, UART 2 physical outputs, or associated logical 27.010 protocol channels, if any);
- Data Communication (through the GSM or GPRS network);
- Connected Bluetooth peripheral data access (Serial Port Profile only).

By default, these flows are closed to transmit all data directly between the V24 serial links and GSM, GPRS or Bluetooth flows. The Embedded Application can use the functions **`wm_fcmOpen()`** (see §2.6.4) and **`wm_fcmClose()`** (see §2.6.5) to open or close these flows.

Important note
GPRS provides only **packet** mode transmission. This means that you can only send **IP packets to the GPRS flow.**

2.6.1 Required Header

This API is defined in the `wm_fcm.h` header file.
This file is included by `wm_apm.h`.

2.6.2 The wm_fcmFlow_e Type

This type is the same as the **`wm_ioPort_e`** one. Please refer to the IO Port API for more information about available ports. Flow identifiers defined for previous versions have been kept for backward compatibility, but the new **`wm_ioPort_e`** ones should be used instead.

```
#define WM_FCM_DATA       WM_IO_GSM_BASE      // GSM CSD FCM flow
#define WM_FCM_GPRS       WM_IO_GPRS_BASE     // GPRS FCM flow
#define WM_FCM_V24        WM_IO_UART1         // UART 1 FCM flow
#define WM_FCM_V24_UART1  WM_IO_UART1         // UART 1 FCM flow
#define WM_FCM_V24_UART2  WM_IO_UART2         // UART 2 FCM flow
#define WM_FCM_USB        WM_IO_USB           // USB flow (reserved)
```

2.6.3 The wm_fcmIsAvailable Function

This function allows to check if the required port is available and ready to handle the FCM service.
The prototype is:

```
bool wm_fcmIsAvailable ( wm_fcmFlow_e  FlowID );
```

2.6.3.1 Parameters

Flow

The flow to be checked, using the `wm_fcmFlow_e` type.

2.6.3.2 Returned Value

- TRUE if the flow is ready for the FCM service.
- FALSE if it is not ready.

2.6.3.3 Notes

All ports should be available for the FCM service, except:

- The Open AT® virtual one, which is only usable for AT commands,
- The Bluetooth virtual ones with enabled profiles other than the SPP one,
- If the port is already used to handle a feature required by an external application through the AT commands (+WLDB command, or a CSD/GPRS data session is already running)

2.6.4 The wm_fcmOpen Function

The wm_fcmOpen function opens the requested flow between the Embedded Application and a serial link port, a Data communication port, or a Bluetooth peripheral.

The prototype is:

```
s32  wm_fcmOpen (  wm_fcmFlow_e  FlowID,
                   u16           DataMaxToReceive );
```

2.6.4.1 Parameters

Flow

The flow to be opened, using the `wm_fcmFlow_e` type.

DataMaxToReceive

Maximum block size to be sent to the Embedded Application from the requested flow. This size depends on the required flow:

- **120 bytes** maximum for a serial link based flow;
- **270 bytes** maximum for the GSM CSD data flow;
- not used for the GPRS flow;
- **120 bytes** maximum for a Bluetooth based flow.

2.6.4.2 Returned value

- WM_FCM_OK if successful.
- WM_FCM_ERR_NO_LINK if the requested flow cannot be opened (the GSM and GPRS flows cannot be opened together).
- WM_FCM_KO if the required flow is unknown or not available

2.6.4.3 Notes

- The flow opening response is received by the Embedded Application through a message. This message is available as a parameter of the **`Parser()`** function of the task which has called the **`wm_fcmOpen`** function, with the **MsgTyp** parameter set to WM_FCM_OPEN_FLOW.
- The **DataMaxToSend** parameter of the WM_FCM_OPEN_FLOW message informs the Embedded Application of the maximum data block size it can send on this flow. If this parameter is 0, there is no size limitation.
- The **`wm_fcmOpen()`** function on the GSM data flow **must** be called **before** using the **"ATD"** command to set up a data call.
- The **`wm_fcmOpen()`** function on the GPRS flow **must** be called **AFTER** using the **`wm_gprsOpen()`** function, followed by **"ATD*99" or +CGACT or +CGDATA** commands to set up a GPRS session.
- After the end of a data call or GPRS session (on NO CARRIER unsolicited response, or on ATH command), the **`wm_fcmClose()`** function must be called before setting up a new data call / GPRS session.

2.6.5 The wm_fcmClose Function

The **`wm_fcmClose`** function closes the requested flow between the Embedded Application and a serial link port, a Data communication port, or a Bluetooth port.

The prototype is:

```
s32  wm_fcmClose (wm_fcmFlow_e FlowID );
```

2.6.5.1 Parameters

Flow

The flow to be closed, using the `wm_fcmFlow_e` type (see §2.6.2 for `wm_fcmFlow_e` description).

2.6.5.2 Returned Value

- WM_FCM_OK if successful.
- WM_FCM_ERR_NO_LINK if the requested flow is not opened.
- WM_FCM_KO if the closing of data flow has failed.

2.6.5.3 Notes

- The flow closing response is received by the Embedded Application through a message. This message is available as a parameter of the **`Parser()`** function of the task which has used the **`wm_fcmOpen`** function, with **MsgTyp** parameter set to WM_FCM_CLOSE_FLOW.
- The **`wm_fcmClose`** function **must** be called **after** any data call or GPRS session release.

2.6.6 The wm_fcmSubmitData Function

The wm_fcmSubmitData function submits a data block to the Flow Control Manager.

The prototype is:

```
s32  wm_fcmSubmitData (     wm_fcmFlow_e            Flow,
                            wm_fcmSendBlock_t *     fcmDataBlock );
```

2.6.6.1 Parameters

Flow

Specifies the IO flow where data is sent; See §2.6.2 for `wm_fcmFlow_e` description.

fcmDataBlock:

Pointer on a wm_fcmSendBlock_t structure, allocated (see § **2.5.16**: "**The wm_osGetHeapMemory** ") and filled by the Embedded Application before sending.
For example, to send 10 data bytes, the buffer must be allocated as follows:

fcmDataBlock = (wm_fcmSendBlock_t *) wm_osGetHeapMemory (sizeof (wm_fcmSendBlock_t) + 10);

The definition of this structure is as follows:

```
typedef struct        {
    u16  Reserved1[4];
    u32  Reserved3;
    u16  DataLength;        /* number of byte of data to send */
    u16  Reserved2[5];
    u8   Data[1];/* data buffer to send */
} wm_fcmSendBlock_t;
```

2.6.6.2 Returned Values

Returned Value	Description
WM_FCM_OK	The data block is sent, the memory allocated for fcmDataBlock is released, and the Embedded Application may go on sending more data blocks.
WM_FCM_EOK_NO_CREDIT	The data block is sent and the memory allocated for fcmDataBlock is released, but the Embedded Application must wait for the WM_FCM_RESUME_DATA_FLOW message before sending more data blocks. This message is available as a parameter of the `wm_apmAppliParser()` function.
WM_FCM_ERR_NO_CREDIT	The data block is not sent and the memory allocated for fcmDataBlock is not released. The Embedded Application must wait for the WM_FCM_RESUME_DATA_FLOW message before sending more data blocks. This message is available as a parameter of the `wm_apmAppliParser()` function.
WM_FCM_ERR_NO_LINK	The flow is not opened. The data block is not sent and the memory allocated for fcmDataBlock is not released.

Returned Value	Description
WM_FCM_ERR_UNKNOWN_FLOW	The Embedded Application used an incorrect flow ID. The data block is not sent and the memory allocated for fcmDataBlock is not released.
WM_FCM_ERR_NO_LINK	The requested flow is not opened or cannot be opened (the GSM and GPRS flows cannot be opened together).

2.6.6.3 Notes

- Successful data sent by the **wm_fcmSubmitData()** function (with WM_FCM_OK or WM_FCM_EOK_NO_CREDIT return code) results in the reception of a WM_OS_RELEASE_MEMORY message by the Embedded Application. This message is available as a parameter of the **wm_apmAppliParser()** function with the *MsgTyp* parameter set to WM_OS_RELEASE_MEMORY.
- Do not call the **wm_fcmSubmitData()** function more than once in the same message treatment. The Embedded Application should set a timer between each data block sending on the IO flows.
- Set a timer between the last data block sending on an IO flow, and this flow closing operation. Also, a timer should be set between the last data block sending on the V24 flow, and a call to the **wm_ioSwitchSerialState (WM_IO_SERIAL_AT_MODE)** function.
- In remote task mode, as the serial link is substantially used (AT commands and responses, traces and messages between the remote task and the target software), a data send operation on the V24 flow with high speed rate does not work. The Embedded Application should send data blocks on the V24 flow a very **low speed rate**, in remote task mode.

2.6.7 Receive Data Blocks

The Embedded Application may receive data blocks from an opened IO flow, through the WM_FCM_RECEIVE_BLOCK message. This message is available as a parameter of the **wm_apmAppliParser()** function.

2.6.7.1 Message Parameters

This is the WM_FCM_RECEIVE_BLOCK message structure:

```
typedef struct   {
    u32          Reserved3;
    u16          DataLength;    /* number of bytes received */
    u8           Reserved1[2];
    wm_fcmFlow_e FlowId;        /* IO flow ID */
    u8           Reserved2[7];
    u8           Data[1];       /* received data buffer */
} wm_fcmReceiveBlock_t;
```

DataLength
Number of data bytes received in **Data** parameter from this flow. This size cannot exceed the **DataMaxToReceive** parameter of the **`wm_fcmOpen()`** function (see §2.6.4).

FlowID
Specifies the opened IO flow from where the data are received. See §2.6.2 for `wm_fcmFlow_e` description.

Data
Data block received from the IO flow. The memory allocated for **Data** parameter is released at the end of the **`Parser()`** function (see § 2.2.7).

2.6.7.2 Notes

- When the Embedded Application has treated one or more data blocks, it should inform the Flow Control Manager to release credits, in order to receive more data, by using the **`wm_fcmCreditToRelease()`** function (see § 2.6.8).

2.6.8 The wm_fcmCreditToRelease Function

The `wm_fcmCreditToRelease` function informs the Flow Control Manager that the Embedded Application has treated some data blocks, and is ready to receive more data. This credit release system provides more security for data transfer.

The prototype is:

```
s32  wm_fcmCreditToRelease (   wm_fcmFlow_e     Flow,
                               u8               Credits );
```

2.6.8.1 Parameters

Flow:
Specifies the IO flow on which the Flow Control Manager may release credits. See §2.6.2 for `wm_fcmFlow_e` description.

Credits:
Specifies the number of credits the Embedded Application requests the Flow Control Manager to release. This represents the number of data blocks received and treated by the Embedded Application.
For example: when the Embedded Application has received and treated 3 data blocks (i.e. 3 WM_FCM_RECEIVE_BLOCK messages), it should inform the Flow Control Manager by calling the **`wm_fcmCreditToRelease()`** function with the Credits parameter set to 3.

2.6.8.2 Returned Values

The returned value is positive or zero if the credits are successfully released.
WM_FCM_ERR_NO_LINK if the requested flow is not opened or cannot be opened (the GSM and GPRS flows cannot be opened together).

2.6.9 The wm_fcmQuery Function

The wm_fcmQuery function informs the Embedded Application of the FCM buffers status.

The prototype is:

```
s32 wm_fcmQuery (  wm_fcmFlow_e  Flow,
                   wm_fcmWay_e   Way );
```

2.6.9.1 Parameters

Flow:

Specifies the IO flow from which the buffer status is requested. See §2.6.2for `wm_fcmFlow_e` description.

Way:

As flows have two ways (*from* the Embedded application, and *to* the Embedded application), this parameter specifies the way on which buffer status is requested. The possible values are:

```
typedef enum          {
    WM_FCM_WAY_FROM_EMBEDDED,
    WM_FCM_WAY_TO_EMBEDDED
} wm_fcmWay_e;
```

2.6.9.2 Returned Values

The returned value is WM_FCM_BUFFER_EMPTY, the requested flow & way buffer is empty.
The returned value is WM_FCM_BUFFER_NOT_EMPTY, the requested flow & way buffer is not empty; the Flow Control Manager is still processing data on this flow.
A negative returned value means that an error occurred.

2.7 Input Output API

This API manages Serial Link State and GPIO operations.

2.7.1 Required Header

This API is defined in the wm_io.h header file.
This file is included by wm_apm.h.

2.7.2 AT/FCM Ports related Functions

2.7.2.1 The wm_ioPort_e type

This type is used to identify the product IO ports, usable to send AT commands and/or with the FCM service in order to exchange data with an external peripheral. The type is detailed below.

```
typedef enum
{
    WM_IO_NO_PORT,
    WM_IO_UART1,
    WM_IO_UART2,
    WM_IO_USB,

    WM_IO_UART1_VIRTUAL_BASE = 0x10,
    WM_IO_UART2_VIRTUAL_BASE = 0x20,
    WM_IO_USB_VIRTUAL_BASE   = 0x30,
    WM_IO_BLUETOOTH_VIRTUAL_BASE = 0x40,
    WM_IO_GSM_BASE = 0x50,
    WM_IO_GPRS_BASE = 0x60,
    WM_IO_OPEN_AT_VIRTUAL_BASE = 0x80
} wm_ioPort_e;
```

The available ports are described below:

- WM_IO_NO_PORT
  Not usable
- WM_IO_UART1
  Product physical UART 1
- WM_IO_UART2
  Product physical UART 2
- WM_IO_USB
  Product physical USB port (reserved for future products)
- WM_IO_UART1_VIRTUAL_BASE
  Base ID for 27.010 protocol logical channels on UART 1
- WM_IO_UART2_VIRTUAL _BASE
  Base ID for 27.010 protocol logical channels on UART 2
- WM_IO_USB_VIRTUAL _BASE
  Base ID for 27.010 protocol logical channels on USB link (reserved for future products)
- WM_IO_BLUETOOTH_VIRTUAL_BASE
  Base ID for connected Bluetooth peripheral virtual port.
  ONLY USABLE WITH THE FCM SERVICE
- WM_IO_GSM_BASE
  GSM CSD data flow identifier for FCM API

This flow is always considered as available (no update messages)
ONLY USABLE WITH THE FCM SERVICE

- WM_IO_GPRS_BASE
  GPRS data flow identifier for FCM API
  This flow is always considered as available if the GPRS feature is enabled, or unavailable if this feature is disabled (no update messages)
  ONLY USABLE WITH THE FCM SERVICE
- WM_IO_OPEN_AT_VIRTUAL_BASE
  Base ID for AT commands contexts dedicated to Open AT® applications
  ONLY USABLE WITH AT COMMANDS

2.7.2.2 The wm_ioSerialSwitchState Function

The **wm_ioSerialSwitchState** function sets the serial link mode:

- AT command computing, or
- direct data transmission through the V24 Serial Link Flow.

The prototype is:

```
void wm_ioSerialSwitchState
                (wm_ioPort_e              Port
                 wm_ioSerialSwitchState_e SerialState);
```

2.7.2.2.1 Parameters

Port

Specifies the IO port to switch the state, using the wm_ioPort_e type.

SerialState

Specifies the requested state of the Serial Link. The possible values are defined below:

```
typedef enum          {
    WM_IO_SERIAL_AT_MODE,
    WM_IO_SERIAL_DATA_MODE,
    WM_IO_SERIAL_ATO,
    WM_IO_SERIAL_AT_OFFLINE     // Incoming message only
} wm_ioSerialSwitchState_e;
```

WM_IO_SERIAL_AT_MODE represents the AT commands computing mode. In this mode, data received from V24 serial link is parsed and treated like AT commands.
WM_IO_SERIAL_DATA_MODE represents the direct data transmission mode. In this mode, data received from V24 serial link is transmitted without treatment through the V24 Serial Link Flow.
WM_IO_SERIAL_ATO is used only if the External Application sent a "+++" string, in order to switch the V24 interface in "ONLINE" mode (see next paragraph "Notes")
WM_IO_SERIAL_AT_OFFLINE is only received in the WM_IO_SERIAL_SWITCH_STATE_RSP message, when the external application used the "+++" sequence to switch back the serial link to AT mode.

2.7.2.2.2 Notes

- The serial mode switching response is received by the Embedded Application through a message. This message is available as a parameter of the **`Parser()`** function with the MsgTyp parameter set to WM_IO_SERIAL_SWITCH_STATE_RSP (see § 2.2.7). The SerialMode parameter of this message is the requested Serial Link Mode; if the RequestReturn parameter is negative, an error occurrs, and the Serial Link Mode does not change.
- The **`wm_ioSerialSwitchState()`** function is not allowed if the V24 Serial Link and the Data Flows are not opened by the Embedded Application. In this case, the WM_IO_SERIAL_SWITCH_STATE_RSP message always returns a negative RequestReturn parameter.
- In Figure 2 (see § 2.6), the **`wm_ioSerialSwitchState()`** function controls Switch 1.

VERY IMPORTANT NOTES

- Sending the "**+++**" sequence from an External Application while the serial link is in WM_IO_SERIAL_DATA_MODE state switches it to WM_IO_SERIAL_AT_MODE state after the OK response, during or outside of a data call. The "**+++**" sequence **must** be preceded and followed by a period of one second with no character sending, in order to allow the serial link to switch to WM_IO_SERIAL_AT_MODE state.
  In this case, the Open AT® application receives a WM_IO_SERIAL_SWITCH_STATE_RSP message with the SerialMode field set to the WM_IO_SERIAL_AT_OFFLINE state.

2.7.2.3 The wm_ioSerialGetSignal Function

The wm_ioSerialGetSignal function allows to get the current values of the CTS and DSR signals of the required port.

The prototype is:

```
s32 wm_ioSerialGetSignal ( wm_ioPort_e             Port,
                           wm_ioSerialGetSignal_e  SerialSignal )
```

2.7.2.3.1 Parameters

Port:
Required port from which to query the signal state, based on the wm_ioPort_e type. Only physical output related ports (UARTX & USB ones, used as physical ports, or with the 27.010 protocol) may be used with this function.

SerialSignal:
Value designating the signal to get, using following type:

```
typedef enum
{
    WM_IO_SERIAL_CTS,
    WM_IO_SERIAL_DSR
} wm_ioSerialGetSignal_e;
```

2.7.2.3.2 Returned Values

1: The signal is on (active)
0: The signal is off

2.7.2.4 The wm_ioIsPortAvailable Function

The wm_ioIsPortAvailable function allows to query the required port state (opened or closed).

The prototype is:

```
bool wm_ioIsPortAvailable ( wm_ioPort_e Port )
```

2.7.2.4.1 Parameters

Port:
Port from which to query the state.

2.7.2.4.2 Returned Values

TRUE if the port is currently opened,
FALSE otherwise.

2.7.3 GPIO API

2.7.3.1 Types

2.7.3.1.1 The wm_ioConfig_t structure

This structure is used by the wm_ioAllocate function in order to set the reserved GPIO parameters.

```
typedef struct
{
      wm_ioLabel_u        eLabel;
      u32                 Pad;
      wm_ioDirection_e    eDirection;
      wm_ioState_e        eState;
} wm_ioConfig_t;
```

The eLabel member represents the GPIO label.
The eDirection member represents the GPIO direction.
The eState member represents the GPIO state.

2.7.3.1.2 The wm_ioLabel_u Union

This union represents the different GPIO labels, depending on the used Wireless CPU.

```
typedef union
{
      wm_ioLabel_Q2686_e      Q2686_Label;
      wm_ioLabel_Q2687_e      Q2687_Label;
} wm_ioLabel_u;
```

The Q2686_Label member must be used on Q2686 products Wireless CPU.
The Q2687_Label member must be used on Q2687 Wireless CPU.

Wismo QUIK Q2686 Gpio Labels

The GPIO labels for Wismo Quik Q2686 Wireless CPU are defined with the values of the table below. For each GPIO, it is also indicated whether it is linked to a specific feature.

GPIO identifier	Linked Feature (if any)
WM_IO_Q2686_GPIO_1	
WM_IO_Q2686_GPIO_2	
WM_IO_Q2686_GPIO_3	WM_IO_FEATURE_INT0
WM_IO_Q2686_GPIO_4	WM_IO_FEATURE_KBD
WM_IO_Q2686_GPIO_5	WM_IO_FEATURE_KBD
WM_IO_Q2686_GPIO_6	WM_IO_FEATURE_KBD
WM_IO_Q2686_GPIO_7	WM_IO_FEATURE_KBD
WM_IO_Q2686_GPIO_8	WM_IO_FEATURE_KBD
WM_IO_Q2686_GPIO_9	WM_IO_FEATURE_KBD
WM_IO_Q2686_GPIO_10	WM_IO_FEATURE_KBD
WM_IO_Q2686_GPIO_11	WM_IO_FEATURE_KBD
WM_IO_Q2686_GPIO_12	WM_IO_FEATURE_KBD
WM_IO_Q2686_GPIO_13	WM_IO_FEATURE_KBD
WM_IO_Q2686_GPIO_14	WM_IO_FEATURE_UART2
WM_IO_Q2686_GPIO_15	WM_IO_FEATURE_UART2
WM_IO_Q2686_GPIO_16	WM_IO_FEATURE_UART2

GPIO identifier	Linked Feature (if any)
WM_IO_Q2686_GPIO_17	WM_IO_FEATURE_UART2
WM_IO_Q2686_GPIO_18	WM_IO_FEATURE_SIMPRES
WM_IO_Q2686_GPIO_19	
WM_IO_Q2686_GPIO_20	
WM_IO_Q2686_GPIO_21	
WM_IO_Q2686_GPIO_22	WM_IO_FEATURE_BT_RST
WM_IO_Q2686_GPIO_23	
WM_IO_Q2686_GPIO_24	
WM_IO_Q2686_GPIO_25	WM_IO_FEATURE_INT1
WM_IO_Q2686_GPIO_26	WM_IO_FEATURE_BUS_I2C
WM_IO_Q2686_GPIO_27	WM_IO_FEATURE_BUS_I2C
WM_IO_Q2686_GPIO_28	WM_IO_FEATURE_BUS_SPI1_CLK
WM_IO_Q2686_GPIO_29	WM_IO_FEATURE_BUS_SPI1_IO
WM_IO_Q2686_GPIO_30	WM_IO_FEATURE_BUS_SPI1_I
WM_IO_Q2686_GPIO_31	WM_IO_FEATURE_BUS_SPI1_CS
WM_IO_Q2686_GPIO_32	WM_IO_FEATURE_BUS_SPI2_CLK
WM_IO_Q2686_GPIO_33	WM_IO_FEATURE_BUS_SPI2_IO
WM_IO_Q2686_GPIO_34	WM_IO_FEATURE_BUS_SPI2_I
WM_IO_Q2686_GPIO_35	WM_IO_FEATURE_BUS_SPI2_CS
WM_IO_Q2686_GPIO_36	WM_IO_FEATURE_UART1
WM_IO_Q2686_GPIO_37	WM_IO_FEATURE_UART1
WM_IO_Q2686_GPIO_38	WM_IO_FEATURE_UART1
WM_IO_Q2686_GPIO_39	WM_IO_FEATURE_UART1
WM_IO_Q2686_GPIO_40	WM_IO_FEATURE_UART1
WM_IO_Q2686_GPIO_41	WM_IO_FEATURE_UART1
WM_IO_Q2686_GPIO_42	WM_IO_FEATURE_UART1
WM_IO_Q2686_GPIO_43	WM_IO_FEATURE_UART1
WM_IO_Q2686_GPIO_44	

As soon as a multiplexed feature is used (or stopped), a **WM_IO_UPDATE_INFO** message is notified to an Open AT® application to inform whether the related GPIO is available).

```
typedef enum
{
     WM_IO_Q2686_GPIO_1 = 3,
     WM_IO_Q2686_GPIO_2,
     WM_IO_Q2686_GPIO_3,
     …
     WM_IO_Q2686_GPIO_43,
     WM_IO_Q2686_GPIO_44,
     WM_IO_Q2686_PAD    = 0x7FFFFFFF
} wm_ioLabel_Q2686_e;
```

Wismo QUIK Q2687 GPIO Labels

The GPIO labels for Wismo Quik Q2687 Wireless CPU are defined with the values of the table below. For each GPIO, it is also indicated whether it is linked to a specific feature.

GPIO identifier	Linked Feature (if any)
WM_IO_Q2687_GPIO_1	WM_IO_FEATURE_BUS_PARALLEL_ADDR2_CS2
WM_IO_Q2687_GPIO_2	WM_IO_FEATURE_BUS_PARALLEL_ADDR1
WM_IO_Q2687_GPIO_3	WM_IO_FEATURE_INT0
WM_IO_Q2687_GPIO_4	WM_IO_FEATURE_KBD
WM_IO_Q2687_GPIO_5	WM_IO_FEATURE_KBD
WM_IO_Q2687_GPIO_6	WM_IO_FEATURE_KBD
WM_IO_Q2687_GPIO_7	WM_IO_FEATURE_KBD
WM_IO_Q2687_GPIO_8	WM_IO_FEATURE_KBD
WM_IO_Q2687_GPIO_9	WM_IO_FEATURE_KBD
WM_IO_Q2687_GPIO_10	WM_IO_FEATURE_KBD
WM_IO_Q2687_GPIO_11	WM_IO_FEATURE_KBD
WM_IO_Q2687_GPIO_12	WM_IO_FEATURE_KBD
WM_IO_Q2687_GPIO_13	WM_IO_FEATURE_KBD
WM_IO_Q2687_GPIO_14	WM_IO_FEATURE_UART2
WM_IO_Q2687_GPIO_15	WM_IO_FEATURE_UART2
WM_IO_Q2687_GPIO_16	WM_IO_FEATURE_UART2
WM_IO_Q2687_GPIO_17	WM_IO_FEATURE_UART2
WM_IO_Q2687_GPIO_18	WM_IO_FEATURE_SIMPRES
WM_IO_Q2687_GPIO_19	
WM_IO_Q2687_GPIO_20	
WM_IO_Q2687_GPIO_21	
WM_IO_Q2687_GPIO_22	WM_IO_FEATURE_BT_RST
WM_IO_Q2687_GPIO_23	
WM_IO_Q2687_GPIO_24	
WM_IO_Q2687_GPIO_25	WM_IO_FEATURE_INT1
WM_IO_Q2687_GPIO_26	WM_IO_FEATURE_BUS_I2C
WM_IO_Q2687_GPIO_27	WM_IO_FEATURE_BUS_I2C
WM_IO_Q2687_GPIO_28	WM_IO_FEATURE_BUS_SPI1_CLK
WM_IO_Q2687_GPIO_29	WM_IO_FEATURE_BUS_SPI1_IO
WM_IO_Q2687_GPIO_30	WM_IO_FEATURE_BUS_SPI1_I
WM_IO_Q2687_GPIO_31	WM_IO_FEATURE_BUS_SPI1_CS
WM_IO_Q2687_GPIO_32	WM_IO_FEATURE_BUS_SPI2_CLK
WM_IO_Q2687_GPIO_33	WM_IO_FEATURE_BUS_SPI2_IO
WM_IO_Q2687_GPIO_34	WM_IO_FEATURE_BUS_SPI2_I
WM_IO_Q2687_GPIO_35	WM_IO_FEATURE_BUS_SPI2_CS
WM_IO_Q2687_GPIO_36	WM_IO_FEATURE_UART1
WM_IO_Q2687_GPIO_37	WM_IO_FEATURE_UART1
WM_IO_Q2687_GPIO_38	WM_IO_FEATURE_UART1
WM_IO_Q2687_GPIO_39	WM_IO_FEATURE_UART1
WM_IO_Q2687_GPIO_40	WM_IO_FEATURE_UART1
WM_IO_Q2687_GPIO_41	WM_IO_FEATURE_UART1
WM_IO_Q2687_GPIO_42	WM_IO_FEATURE_UART1
WM_IO_Q2687_GPIO_43	WM_IO_FEATURE_UART1
WM_IO_Q2687_GPIO_44	

As soon as a multiplexed feature is used (or not used), a **WM_IO_UPDATE_INFO** message is notified to an Open AT application to inform that related GPIO are no more available (or made available again).

```
typedef enum
{
      WM_IO_Q2687_GPIO_1 = 2,
      WM_IO_Q2687_GPIO_2,
      WM_IO_Q2687_GPIO_3,
      …
      WM_IO_Q2687_GPIO_43,
      WM_IO_Q2687_GPIO_44,
      WM_IO_Q2687_PAD    = 0x7FFFFFFF
} wm_ioLabel_Q2687_e;
```

2.7.3.1.3 The wm_ioDirection_e Type

This type represents the direction used for a GPIO.

```
typedef enum
{
      WM_IO_OUTPUT,
      WM_IO_INPUT,
      WM_IO_NORMAL   // for GPIO only, deprecated
} wm_ioDirection_e;
```

The WM_IO_OUTPUT constant is used to set a GPIO as an output.
The WM_IO_INPUT constant is used to set a GPIO as an input.

2.7.3.1.4 The wm_ioState_e type

This type represents the state of a GPIO.

```
typedef enum
{
      WM_IO_LOW,
      WM_IO_HIGH
} wm_ioState_e;
```

The WM_IO_LOW constant represents the low state of a GPIO.
The WM_IO_HIGH constant represents the high state of a GPIO.

2.7.3.1.5 The wm_ioSetDirection_t structure

This type is used by the wm_ioSetDirection function to set a GPIO to the new direction.

```
typedef struct
{
      wm_ioLabel_u       eLabel;
      wm_ioDirection_e   eDirection;
} wm_ioSetDirection_t;
```

The eLabel member represents the GPIO label.
The eDirection member represents the new GPIO direction.

2.7.3.1.6 The wm_ioRead_t Structure

This type is used by the wm_ioRead function to read one or morel GPIO values.

```
typedef struct
{
      wm_ioLabel_u   eLabel;
      wm_ioState_e   eState;
} wm_ioRead_t;
```

The eLabel member represents the GPIO label.
The eState member is set by the function to the GPIO read value.

2.7.3.1.7 The wm_ioWrite_t Structure

This type is used by the wm_ioWrite function to write one or more GPIO values.

```
typedef struct
{
      wm_ioLabel_u   eLabel;
      wm_ioState_e   eState;
} wm_ioWrite_t;
```

The eLabel member represents the GPIO label.
The eState member represents the GPIO value to be set on the output.

2.7.3.1.8 The wm_ioFeature_e Type

This type enumerates the Wireless CPU features which are multiplexed with one or more GPIO.

```
typedef enum
{
    WM_IO_FEATURE_NONE,
    WM_IO_FEATURE_BUS_SPI1_CLK,             // SPI 1 bus clock pin
    WM_IO_FEATURE_BUS_SPI1_IO,              // SPI 1 bus
                                            bi-directional data pin
    WM_IO_FEATURE_BUS_SPI1_I,               // SPI 1 bus
                                            uni-directional input pin
    WM_IO_FEATURE_BUS_SPI1_CS,              // SPI 1 bus hardware chip
                                            select pin
    WM_IO_FEATURE_BUS_SPI2_CLK,             // SPI 2 bus clock pin
    WM_IO_FEATURE_BUS_SPI2_IO,              // SPI 2 bus
                                            bi-directional data pin
    WM_IO_FEATURE_BUS_SPI2_I,               // SPI 2 bus
                                            uni-directional input pin
    WM_IO_FEATURE_BUS_SPI2_CS,              // SPI 2 bus hardware chip
                                            select pin
    WM_IO_FEATURE_BUS_I2C,                  // I2C bus
    WM_IO_FEATURE_BUS_PARALLEL_ADDR1,       // Parallel bus Address
                                            pin
    WM_IO_FEATURE_BUS_PARALLEL_ADDR2_CS2,   // parallel bus chip
                                            select 2 / Address pin
    WM_IO_FEATURE_KBD,                      // Keypad
    WM_IO_FEATURE_SIMPRES,                  // SIM presence signal
    WM_IO_FEATURE_UART1,                    // UART 1 port
    WM_IO_FEATURE_UART2,                    // UART 2 port
    WM_IO_FEATURE_INT0,                     // External interrupt 0
    WM_IO_FEATURE_INT1,                     // External interrupt 1
    WM_IO_FEATURE_BT_RST,                   // Bluetooth reset signal
    WM_IO_FEATURE_LAST
} wm_ioFeature_e;
```

2.7.3.1.9 Returned Value Definition

Returned Value	Definition
WM_IO_PROC_DONE	The function processing is successful.
WM_IO_UNKNOWN_TYPE	A direction parameter has an incorrect value.
WM_IO_INPUT_CANT_BE_SET	The function failed to set an Input pin.
WM_IO_OUTPUT_CANT_BE_READ	The function failed to read an Output pin.
WM_IO_NO_MORE_HANDLES_LEFT	No more free handles available for the requested GPIOs.
WM_IO_EXCEED_MAX_NUMBER	A parameter exceeded the allowed range value.
WM_IO_UNALLOCATED_HANDLE	A handle parameter has an incorrect value.
WM_IO_INCOHERENCE_BETWEEN_HANDLE_AND_MASK	The function tried to use a GPIO mask with an incorrect handle.
WM_IO_INCOHERENCE_BETWEEN_DIRECTION_AND_MASK	The function tried to set an input pin direction to output, or an output pin direction to input.
WM_IO_IO_ALREADY_USED	The function tried to allocate a GPIO already allocated on another handle.
WM_IO_INCOHERENCE_BETWEEN_HANDLE_AND_IO_NUMBER	The function tried to use a GPIO value with an incorrect handle.

2.7.3.2 The wm_ioAllocate Function

The wm_ioAllocate function reserves one or more GPIO(s) for Embedded Application use.

The prototype is:

```
s32 wm_ioAllocate ( u32 NbGpioToAllocate,
                    wm_ioConfig_t * GpioCustomerConfig );
```

2.7.3.2.1 Parameters

NbGpioToAllocate:

Size of the GpioCustomerConfig array.

GpioCustomerConfig:

Array of values, defined by the wm_ioConfig_t structure.
For each member of this array:

- eLabel represents the label of the requested GPIO, depending on the used Wireless CPU.
- eDirection represents the required direction for this GPIO.
- State represents the state of the requested GPIO.

2.7.3.2.2 Returned Values

- If the GPIO allocation operation is successful, the returned value is positive or null handle, which must be used in all further operations on one of the reserved GPIO.
- A negative returned value represents an error.

Notes:

- The eState member of the wm_ioConfig_t structure is only significant for the pins set as an output by the eDirection parameter. Otherwise, the eState parameter is not taken into account.
- After a successful allocation, any GPIO allocated by an Embedded Application is no longer available for AT commands (AT+WIOR, AT+WIOW, AT+WIOM) or linked features (see. **wm_ioFeature_e** type definition).

2.7.3.3 The wm_ioRelease Function

The wm_ioRelease function allows to release one or more GPIO reserved by the wm_ioAllocate function.

The prototype is:

```
s32 wm_ioRelease (  s32 Handle,
                    u32 NbGpioToRelease,
                    wm_ioLabel_u * GpioCustomerLabel );
```

2.7.3.3.1 Parameters

Handle:

Handle returned by the wm_ioAllocate function. All GPIOs of GpioCustomerLabel parameter must be related to this Handle.

NbGpioToRelease:

Size of the GpioCustomerLabel array.

GpioCustomerLabel:

Array of values, defined by the wm_ioLabel_u union.
Each member of this array represents the label of one GPIO to release.

2.7.3.3.2 Returned Values

- **OK** on successful completion
- **ERROR** with a negative returned value.

Notes:

- If one of the given GPIO labels is not related to the given Handle, the `wm_ioRelease` function fails.
- After a successful release, GPIO released control is resumed by AT commands (AT+WIOR, AT+WIOW, AT+WIOM), and GPIO is available again for any linked feature.

2.7.3.4 The wm_ioSetDirection Function

The wm_ioSetDirection function allows to change the direction of an allocated GPIO.

The prototype is:

```
s32 wm_ioSetDirection (  s32 Handle,
                         u32 NbGpioToChangeDir,
                         wm_ioSetDirection_t * GpioDirection );
```

2.7.3.4.1 Parameters

Handle:

Handle returned by the wm_ioAllocate function. All GPIOs of GpioDirection parameter must be related to this Handle.

NbGpioToChangeDir:

Size of the GpioDirection array.

GpioDirection:

Array of values, defined by the wm_ioSetDirection_t structure.

For each member of this array:

- eLabel represents the label of the GPIO to change direction, depending on the Wireless CPU used.
- eDirection represents the new direction to use for this GPIO.

2.7.3.4.2 Returned Values

- **OK** on successful completion
- **ERROR** with a negative returned value.

Note:

- If one of the given GPIO labels is not related to the given Handle, the wm_ioSetDirection function fails.

2.7.3.5 The wm_ioRead Function

The wm_ioRead function allows to read the current state of one or more allocated GPIO(s).

The prototype is:

```
s32 wm_ioRead (   s32 Handle,
                  u32 NbGpioToRead,
                  wm_ioRead_t * GpioToRead );
```

2.7.3.5.1 Parameters

Handle:

Handle returned by the wm_ioAllocate function. All GPIOs of "Gpio" parameter must be related to this Handle.

NbGpioToRead:

Size of the GpioToRead array.

GpioToRead:
Array of values, defined by the wm_ioRead_t structure.
For each member of this array:
- eLabel represents the label of the GPIO to read.
- The Read value is copied in the eState field.

2.7.3.5.2 Returned Values

- **OK** on successful completion
- **ERROR** with a negative returned value.

Note:
- If one of the given GPIO labels is not related to the given Handle, the wm_ioRead function fails.

2.7.3.6 The wm_ioSingleRead Function

The wm_ioSingleRead function allows to read the current state of one single allocated GPIO.

The prototype is:
```
s32 wm_ioSingleRead (   s32 Handle,
                        u32 Gpio );
```

2.7.3.6.1 Parameters

Handle:
Handle returned by the wm_ioAllocate function. The "Gpio" parameter must be related to this Handle.

Gpio:
Value designating the GPIO to read, member of the wm_ioLabel_u union.

2.7.3.6.2 Returned Values

- If the read operation is successful, the function returns the GPIO state, as defined in wm_ioState_e type.
- A negative returned value represents an error.

Note:
If the given GPIO label is not related to the given Handle, the wm_ioSingleRead function fails.

2.7.3.7 The wm_ioWrite Function

The wm_ioWrite function allows to define a new state for one or more allocated GPIO(s).

The prototype is:
```
s32 wm_ioWrite (  s32 Handle,
                  u32 NbGpioToWrite,
                  wm_ioWrite_t*  GpioToWrite );
```

2.7.3.7.1 Parameters

Handle:
Handle returned by the wm_ioAllocate function. All GPIOs of "Gpio" parameter must be related to this Handle.

NbGpioToWrite:
Size of the GpioToWrite array.

GpioToWrite:
Array of values, defined by the wm_ioWrite_t structure.

For each member of this array:
- eLabel represents the label of the GPIO to write.
- eState represents the value to set on the output.

2.7.3.7.2 Returned Values

- **OK** on successful completion.
- **ERROR** with a negative returned value.

Note:
- If one of the given GPIO labels is not related to the given Handle, the wm_ioWrite function fails.

2.7.3.8 The wm_ioSingleWrite Function

The wm_ioSingleWrite function allows to define a new state for one single allocated GPIO.

The prototype is:
```
s32 wm_ioSingleWrite (  s32 Handle,
                        u32 Gpio
                        u32 State );
```

2.7.3.8.1 Parameters

Handle:
Handle returned by the wm_ioAllocate function. The "Gpio" parameter must be related to this Handle.

Gpio:
Value designating the GPIO to write, member of the wm_ioLabel_u union.

State:
Value designating the State to write (as defined by the wm_ioState_e type).

2.7.3.8.2 Returned Values

- **OK** on successful completion.
- **ERROR** with a negative returned value.

Note:
- If the given GPIO label is not related to the given Handle, the wm_ioSingleWrite function fails.

2.7.3.9 The wm_ioGetGPIOListForFeature Function

This function allows to dynamically get a GPIO list associated to the feature.

The prototype is:
```
s32 wm_ioGetGPIOListForFeature ( wm_ioFeature_e Feature,
                                 u8 * GpioTab,
                                 u8 GpioNumber );
```

2.7.3.9.1 Parameters

Feature:
Feature from which to get the multiplexed GPIO list.

GpioTab:
Returned list of GPIO identifier associated to the required feature.
If set to NULL, the GPIO number is returned by the function.

GpioNumber:
Size of the GpioTab array.

2.7.3.9.2 Returned Values

- **ERROR** if the feature is unknown.
  - **WM_IO_EXCEED_MAX_NUMBER** if the provided GpioNumber parameter does not match the required array size.
  - GPIO number associated to the feature on success (if the GpioTab is not NULL, it is updated with the GPIO list associated to the required feature).

2.7.3.10 The wm_ioIsFeatureEnabled Function

This function allows to check whether a feature is currently enabled.

The prototype is:

```
bool wm_ioIsFeatureEnabled ( wm_ioFeature_e Feature );
```

2.7.3.10.1 Parameters

Feature:
Feature to be checked.

2.7.3.10.2 Returned Values

- **FALSE:** if the feature is disabled, or if it is unknown, all associated GPIOs are available for allocation.
- **TRUE:** if the feature is enabled,, the associated GPIOs are not available for allocation.

Note:
Each time a feature is enabled or disabled, a WM_IO_UPDATE_INFO message is notified to an Open AT® application.

2.7.3.11 The wm_ioGetProductType Function

This function allows to retrieve the current Wireless CPU type.

The prototype is:

```
wm_ioProductType_e wm_ioGetProductType ( void );
```

2.7.3.11.1 Returned Values

The function returns the Wireless CPU type, using the following defined values.

Identifier	Product Type
WM_IO_PRODUCT_TYPE_Q2686	Q2686 Wireless CPU
WM_IO_PRODUCT_TYPE_Q2687	Q2687 Wireless CPU

2.8 Open SIM Access API

The Open SIM Access (OSA) API allows the application to control a remote SIM card. Please note that this feature must be enabled on the Wireless CPU in order to make the API accessible.

2.8.1 Required Header

This API is defined in the **wm_osa.h** header file.

This file is included by **wm_apm.h**.

2.8.2 Open SIM Access Incoming Messages

Incoming OSA related messages are described in the following sections.

2.8.2.1 Messages types

An incoming OSA message type has one of the following values:

MsgTyp value	Description
WM_OSA_SWITCH_INFO	The message informs the application if the required switch (from local SIM card connection to the remote one, or reverse) was successful or not.
WM_OSA_ERROR_INFO	The message informs the application that an error occurred in the remote SIM connection (response timeout has ran out, or a received SIM response is corrupted. The local SIM connection is resumed.
WM_OSA_DATA_REQUEST	The message provides the application with a SIM data request (APDU or ATR) to be forwarded to the remote SIM card. The SIM response buffer must then be posted back to the Wavecom firmware.

2.8.2.2 Messages Structure

The structure of the body is given below:

```
typedef union
{
     /* Includes herein the different specific structures
     associated to MsgTyp */
…
     /* WM_OSA_SWITCH_INFO  */
     wm_osaSwitchInfo_t              OSASwitchInfo;
     /* WM_OSA_ERROR_INFO   */
     wm_osaErrorInfo_t               OSAErrorInfo;
     /* WM_OSA_DATA_REQUEST */
     wm_osaDataRequest_t             OSADataRequest;
…
} wm_apmBody_t;
```

2.8.2.2.1 WM_OSA_SWITCH_INFO Message Type

Global structure:

```
typedef struct
{
     wm_osaSwitchInfo_e      Info;
     wm_osaSwitchRequest_e   Request;
     u8                      Pad[2];
} wm_osaSwitchInfo_t;
```

The ***Info*** field informs the application of the previously posted request result, using the following type.

```
typedef enum
{
     WM_OSA_SWITCH_OK,               // The switch to the remote
                                     or local SIM was
                                     successfully performed.
     WM_OSA_SWITCH_ERROR_SAP_RUNNING // The switch to the remote
                                     SIM was not performed since
                                     a Bluetooth SAP connection
                                     is already running.
} wm_osaSwitchInfo_e;
```

Request field is the previously posted request type, through the **wm_osaSendSwitchRequest** function.

```
typedef enum
{
     WM_OSA_SWITCH_LOCAL,    // Request to be sent to the
                             Wavecom firmware in order to switch
                             back to the local SIM connection.
     WM_OSA_SWITCH_REMOTE    // Request to be sent to the
                             Wavecom firmware in order to switch
                             to the remote SIM connection.
} wm_osaSwitchRequest_e;
```

2.8.2.2.2 WM_OSA_ERROR_INFO Message Type

Global structure:

```
typedef struct
{
    wm_osaResponseStatus_e  Info;
    u8                      Pad[3];
} wm_osaErrorInfo_t;
```

The ***Info*** field informs the application of the reason why the remote SIM connection was closed.

```
typedef enum
{
    WM_OSA_RSP_STATUS_OK,                    // SIM response
                                             status is OK
    WM_OSA_RSP_STATUS_CARD_NOT_ACCESSIBLE,   // Card is not
                                             accessible (Timeout
                                             problem)
    WM_OSA_RSP_STATUS_CARD_REMOVED,          // Card is removed
    WM_OSA_RSP_STATUS_CARD_UNKNOWN_ERROR     // Generic card
                                             error code
} wm_osaResponseStatus_e;
```

2.8.2.2.3 WM_OSA_DATA_REQUEST Message Type

Global structure:

```
typedef struct
{
    wm_osaRequestType_e     Request;
    u8                      Pad;
    u16                     Length;
    u8                      Data [ 1 ];
} wm_osaDataRequest_t;
```

The ***Request*** field informs the application of the request type (APDU or ATR):

```
typedef enum
{
    WM_OSA_REQUEST_ATR,     // Answer To Reset request: the SIM
                            card must be reset, and the Answer
                            To Reset data must be posted back
                            to the Wavecom firmware.
    WM_OSA_REQUEST_APDU     // APDU request, to be forwarded to
                            the remote SIM; relevant response
                            must be posted back to the Wavecom
                            firmware.
} wm_osaRequestType_e;
```

The ***Length*** field is the APDU request buffer length

The ***Data*** field is the APDU request data buffer, to be forwarded to the remote SIM.

2.8.3 The wm_osaSwitchRequest Function

The **wm_osaSwitchRequest** function controls the remote SIM connection, and must be used by the application to make the Wavecom firmware either disconnect or connect back to the local SIM, in order to send requests to a remote SIM.

The prototype is:

```
s32 wm_osaSwitchRequest ( wm_osaSwitchRequest_e Request );
```

2.8.3.1 Parameters

Request:

Open SIM mode switch request, using the following type

```
typedef enum
{
    WM_OSA_SWITCH_LOCAL,     // Request to be sent to the
                             Wavecom firmware in order to switch
                             back to the local SIM connection.
    WM_OSA_SWITCH_REMOTE     // Request to be sent to the
                             Wavecom firmware in order to switch
                             to the remote SIM connection.
} wm_osaSwitchRequest_e;
```

2.8.3.2 Returned Value

- **OK** on success
  Note: a **WM_OSA_SWITCH_INFO** message is received by the application to inform whether switching was performed correctly.
- **ERROR** on parameter error.
- **WM_OSA_NOT_SUPPORTED** if the OSA feature is not enabled on the Wireless CPU.

2.8.4 The wm_osaSendResponse Function

The **wm_osaSendResponse** function allows the application to send back ATR or APDU request responses to the Wavecom firmware. It must be used each time a **WM_OSA_DATA_REQUEST** message is received by the application, a request is then forwarded to the SIM card to get back the response buffer.

The prototype is:

```
s32 wm_osaSendResponse ( wm_osaResponseType_e          Type,
                         wm_osaResponseStatus_e        Status
                         u16                           Length,
                         u8 *                          Data );
```

2.8.4.1 Parameters

Type:

Input. SIM response type, using the following defined values:

```
typedef enum
{
    WM_OSA_RESPONSE_ATR,     // Answer To Reset response, to be
                             sent back on WM_OSA_REQUEST_ATR
                             request type.
    WM_OSA_RESPONSE_APDU     // APDU response, to be sent back
                             on WM_OSA_REQUEST_APDU request
                             type.
} wm_osaResponseType_e;
```

Status:

SIM status, in response to a previously sent request. This parameter must be used to notify the firmware of the SIM status, according to the type below.

```
typedef enum
{
    WM_OSA_RSP_STATUS_OK,                  // SIM response
                                           status is OK
    WM_OSA_RSP_STATUS_CARD_NOT_ACCESSIBLE, // Card is not
                                           accessible (Timeout
                                           problem)
    WM_OSA_RSP_STATUS_CARD_REMOVED,        // Card is removed
    WM_OSA_RSP_STATUS_CARD_UNKNOWN_ERROR   // Generic card
                                           error code
} wm_osaResponseStatus_e;
```

Length:

Input. SIM response buffer length, in bytes.

Data:

Input. SIM response buffer, to be copied and sent to the Wavecom firmware.

2.8.4.2 Returned Values

- **OK** on success.
- **ERROR** on parameter error

2.9 GPRS API

A set of AT commands to manage the GPRS is provided.
These commands are described in the AT Command Interface Guide.

2.9.1 GPRS Overview

2.9.1.1 Introduction

The General Packet Radio Service (GPRS) is a set of GSM services that provides **packet** mode transmission within the Public Land Mobile Network (PLMN) and **interworks** with **external networks**. GPRS allows the subscriber to send and receive data in an end-to-end packet transfer mode, without using network resources in circuit-switched mode. GPRS enables the cost-effective and efficient use of network resources for **packet data applications** such as:

- application with intermittent, non periodic data transmission,
- frequent transmissions of small volumes of data,
- infrequent transmissions of larger volumes of data.

Based on standardized network protocols supported by the GPRS bearer services, a GPRS network operator may offer a set of additional services including:

- Retrieval services that provide the capability of accessing information stored in database centers. The information is sent to the user on demand only. Web is a good example of such services.
- Messaging services which offer communication between individual users via storage units with store and forward mailbox as e-mail client.
- Conversational services which provide bi-directional communication by means of real time end-to-end information transfer such as telnet application (download of melodies, games and more).
- Tele-action services which are characterized by low data volume transactions, such as credit card validation, bank account transaction, stock trading, electronic monitoring, utility meter reading and surveillance system.

GPRS provides cost optimization (the user is billed for the volume of data transferred and not for the duration of the connection) and best interworking with external packet network.

Wavecom Mobile Equipment is GPRS class B compliant.

2.9.1.2 Definition of a PDP Context

Before transferring any data packet between the mobile and the network, a PDP context (Packet Data Protocol) must be defined and activated by the mobile. These activation and deactivation procedures over the GPRS network are considered as signaling phases.

A PDP context is a structure which identifies a PDP (IP or X25 type, but Wavecom uses the IP context only). It operates as a virtual channel between the mobile and the GGSN (the GPRS Gateway which provides access to an external network). We typically call a"GPRS session" an activated PDP.

Note that a PDP context is a logical channel which does not cost anything when idle (unlike GSM data calls). It allows permanent data connection.

A PDP context is associated with a specific Quality Of Service.

A set of AT commands are available in order to activate, accept, deactivate and abort PDP contexts.

PDP context activation may be initiated by the mobile or may be requested by the Network.

The mobile user can define more than one PDP contexts (up to 4 simultaneously) but can only activate one at a time.

The parameters which define a PDP context are:

- Cid is the identifier of the defined PDP context (ie 1 to 4)
- PDP Type organization: IETF (IP type)
- PDP Address Information: Mobile address (static or dynamic) that identifies the ME in the address space applicable for the PDP
- QOS Profile requested: QOS requested by the user (mobile equipment)
- QOS Profile Minimum: QOS minimum accepted by the ME
- DCOMP: Data compression (or not)
- HCOMP: Header compression (or not)
- Access Point Name: Access Point Name of the External Network. This is a logical name used to select the GGSN or the external packet data network (ex web.sfr.fr). Provided by the GPRS operator.

Please refer to the definitions of GPRS AT commands for more information.

IMPORTANT NOTE:
The **`wm_fcmOpenGPRSAndV24()`** function **must** be called **AFTER** using the **`wm_gprsOpen()`** function followed by **"ATD*99"** or **+CGACT** or **+CGDATA** commands to set up a GPRS session.

2.9.2 The wm_gprsAuthentification Function

This command sets the authentication parameters login/password to use with a particular Cid during PDP activation.

The prototype is:

```
s32 wm_gprsAuthentification(u8 Cid, ascii *login, ascii *password)
```

2.9.2.1 Parameters

Cid:

(PDP Context Identifier) a numeric parameter (1-4) which specifies a particular PDP context definition (see AT Commands Interface Guide).

Login and Password:

Authentification parameters, which allow the application to supply the PDP context login and password strings.
The maximum length of each authentication string is limited to 50 characters (including the terminal 0x00 character). The string is truncated if its length is more than 25 characters.

Note

- These parameters must be set before each PDP activation.
- They are optional and depend on your subscription setup.

2.9.2.2 Required Header

```
Wm_gprs.h
```

2.9.2.3 Returned Value

0 if successful
WM_GPRS_CID_NOT_DEFINED If the Cid is not defined
WM_NO_GPRS_SERVICE if the GPRS service is not supported

2.9.3 The wm_gprsIPCPInformation Function

This command gets the current IPCP information to use with a particular Cid after PDP activation.
These parameters are not saved in memory, and are only available during the life of the PDP context.

The prototype is:

```
s32 wm_gprsIPCPInformation (
      u8 Cid,
      u32* DNS1,
      u32* DNS2,
      u32* Gateway)
```

2.9.3.1 Parameters

Cid:

(PDP Context Identifier) a numeric parameter (1-4) which specifies a particular PDP context definition (see AT Commands Interface Guide).

DNS1 and DNS2 and Gateway:

Returned values in native u32 format which are IPV4 addresses provided by the network. If the network does not provide them, the values are equal to 0.

Note
These parameters are optional and depend on the operator setup.

2.9.3.2 Required Header

```
Wm_gprs.h
```

2.9.3.3 Returned Value

0 if successful
WM_GPRS_CID_NOT_DEFINED If the Cid is not defined
WM_NO_GPRS_SERVICE if the GPRS service is not supported

2.9.4 The wm_gprsOpen Function

This command sets Open AT® as the user of the GPRS bearer associated with the parameter Cid.

The prototype is:

```
s32 wm_gprsOpen(u8 Cid)
```

Note
This interface **must be used before each PDP activation and before opening the FCM flows**.

2.9.4.1 Parameters

Cid:

(PDP Context Identifier) a numeric parameter (1-4) which specifies a particular PDP context definition (see AT Commands Interface Guide).

2.9.4.2 Required Header

```
Wm_gprs.h
```

2.9.4.3 Returned Value

0 if successful
WM_GPRS_CID_NOT_DEFINED If the Cid is not defined
WM_NO_GPRS_SERVICE if the GPRS service is not supported

2.9.5 The wm_gprsClose Function

This command unsets Open AT® as the user of the GPRS bearer associated with the parameter Cid.

The prototype is:

```
s32 wm_gprsClose(u8 Cid)
```

Note
This interface **must be used after closing the PDP context and closing the FCM flows**.

2.9.5.1 Parameters

Cid:

(PDP Context Identifier) a numeric parameter (1-4) which specifies a particular PDP context definition (see AT Commands Interface Guide).

2.9.5.2 Required Header

```
Wm_gprs.h
```

2.9.5.3 Returned Value

0 if successful
WM_GPRS_CID_NOT_DEFINED If the cid is not defined
WM_NO_GPRS_SERVICE if the GPRS is not supported

2.10 BUS API

This API manages I2C and SPI bus operations.

2.10.1 Required Header

This API is defined in the `wm_bus.h` header file.
This file is included by `wm_apm.h`.

2.10.2 Returned Value Definition

Returned Value	Description
WM_BUS_PROC_DONE (0)	Function processing is successful.
WM_BUS_MODE_UNKNOWN_TYPE (-1)	Unknown open mode type.
WM_BUS_UNKNOWN_TYPE (-11)	Unknown bus type.
WM_BUS_BAD_PARAMETER (-12)	A parameter has an incorrect value.
WM_BUS_SPI_ALREADY_USED (-13)	The SPI bus is already opened.
WM_BUS_I2C_HARD_ALREADY_USED (-14)	The I2C bus is already opened.
WM_BUS_PARALLEL_ALREADY_USED (-16)	The Parallel bus is already opened
WM_BUS_UNKNOWN_HANDLE (-21)	The handle used has an incorrect value.
WM_BUS_HANDLE_NOT_OPENED (-22)	No existing handle for this bus.
WM_BUS_NO_MORE_HANDLE_FREE (-23)	No more handles available for this bus.
WM_BUS_NOT_CONNECTED_ON_I2C (-31)	No peripheral connected on I2C bus.
WM_BUS_NOT_ALLOWED_ADDRESS (-32)	Unknown address.
WM_BUS_SPI_GPIO_CS_NOT_GPIO (-36)	The considered chip select pin is not a GPIO or a GPO.
WM_BUS_SPI_GPIO_CS_NOT_FREE (-37)	The considered chip selected GPIO is not free.
WM_BUS_SPI1_CS_HARD_NOT_FREE (-48)	The selected hardware chip is already used for SPI1 bus
WM_BUS_SPI2_CS_HARD_NOT_FREE (-49)	The selected hardware chip is already used for SPI2 bus

2.10.3 The wm_busOpen Function

The wm_busOpen function allows to allocate a Handle on the required bus, and to open it for further read/write operations.

The prototype is:

```
s32 wm_busOpen (    u32 BusType,
                    u32 Mode
                    wm_busSettings_u * Settings );
```

2.10.3.1 Parameters

BusType:

Type of the bus to open. Defined values are:

- **WM_BUS_SPI1** for SPI 1 bus;
- **WM_BUS_SPI2** for SPI 2 bus;
- **WM_BUS_HARD_I2C** for I2C bus.
- **WM_BUS_PARALLEL** for Parallel bus.

Mode:

Bus mode: the only defined value is WM_BUS_MODE_STANDARD.

Settings:

Pointer on settings union, defined as below.

```
typedef union
{
    wm_busSPISettings_t              SPI;
    wm_busI2CHardSettings_t      I2C_Hard;
    wm_busPARALLELSettings_t     Parallel;
} wm_busSettings_u;
```

2.10.3.1.1 SPI Bus Settings

To open the SPI bus, the application must use the SPI member of this union. It is defined below.

```
typedef struct
{
     u32       Clk_Speed;
     u32       Clk_Mode;
     u32       ChipSelect;
     u32       ChipSelectPolarity;
     u32       LsbFirst;
     u32       GpioChipSelect;
     u32       WriteByteHandling;
     u32       DataLinesConf;

} wm_busSPI1Settings_t;
```

- The "*Clk_Speed*" parameter is the SPI clock speed. The allowed values are in the range of 0 – 127. The output data rate is reckoned using the formula given below.

  Pclk / ((2 * Clk_Speed) + 2)

  Where **Pclk** is the Wireless CPU Peripheral Clock speed.
  On the Q2686 Wireless CPU and the **Pclk**, the rate is 26 MHz.

- The "*Clk_Mode*" parameter is the SPI clock mode. Defined values are:

WM_BUS_SPI_SCK_MODE_0	rest state 0, data valid on rising edge
WM_BUS_SPI_SCK_MODE_1	rest state 0, data valid on falling edge
WM_BUS_SPI_SCK_MODE_2	rest state 1, data valid on rising edge
WM_BUS_SPI_SCK_MODE_3	rest state 1, data valid on falling edge

- The "*ChipSelect*" parameter selects the valid pin. The defined values are:

WM_BUS_SPI_ADDRESS_CS_GPIO	Use a GPIO as ChipSelect, the *GpioChipSelect* parameter must be used
WM_BUS_SPI_ADDRESS_CS_HARD	Use the reserved hardware chip selected pin for the required bus.
WM_BUS_SPI_ADDRESS_CS_NONE	This Chip Select signal is not handled by an Open AT® BUS API. An application should allocate a GPIO to handle the Chip Select signal.

- The "*ChipSelectPolarity*" parameter sets the polarity of the ChipSelect. Defined values are:
  - **WM_BUS_SPI_CS_POL_LOW** (active low) ;
  - **WM_BUS_SPI_CS_POL_HIGH** (active high) ;

- The "*LsbFirst*" parameter sets whether the data sent/received through the SPI bus is LSB or MSB. This parameter applies only to data, the opcode and address sent are always MSB first. Defined values are:
  - **WM_BUS_SPI_LSB_FIRST** ;
  - **WM_BUS_SPI_MSB_FIRST** ;

- The "*GpioChipSelect*" parameter is used only when the "*ChipSelect*" parameter is set to the WM_BUS_SPI_ADDRESS_CS_GPIO value. It is the GPIO label to use as a chip select. It must be a member of the wm_ioLabel_u union (see the GPIO API description).

- The "*WriteByteHandling*" parameter defines the chip select signal behavior. Defined values are:
  - **WM_BUS_SPI_WORD_HANDLING** (chip select signal state changes on each word written or read. word size is defined on the read or write process request, in the AccessMode configuration structure);
  - **WM_BUS_SPI_FRAME_HANDLING** (Chip select signal is enabled at the beginning of the read/write process, and it is disabled at the end of this process).

Note:
This mode is not available with the **WM_BUS_SPI_ADDRESS_CS_HARD** Chip Select configuration.

- The "*DataLinesConf*" parameter defines if the SPI bus uses one single pin to handle both input and output data signals, or two pins to handle them separately. Defined values are:
  - **WM_BUS_SPI_DATA_BIDIR** (One bi-directional pin is used to handle both input & output data signals);
  - **WM_BUS_SPI_DATA_UNIDIR** (Two pins are used to handle separately input & output data signals).

2.10.3.1.2 I2C Bus

To open the I2C bus, an application must use the "*I2C_Hard*" parameter of the union, defined below:

```
typedef struct
{
     u32       ChipAddress;
     u32       Clk_Speed;

} wm_busI2CHardSettings_t;
```

- The *ChipAddress* parameter is the remote chip address on the bus. Only the bits from b1 to b7 are used to define this address.

- The *Clk_Speed* parameter sets the required I2C bus speed. Defined values are:
  - **WM_BUS_I2CHARD_CLK_STD** (standard I2C bus speed, 100 Kbit/s)
  - **WM_BUS_I2CHARD_CLK_FAST** (fast I2C bus speed, 400 Kbit/s)

2.10.3.1.3 Parallel Bus Settings

The wm_busParallelCs_t structure

This type defines the Parallel bus chip select.

```
typedef struct
{
     u8        Type;
     u8        Id;
     u8        pad[2]

} wm_busParallelCs_t;
```

- The *Type* parameter defines the Chip Select signal type. The only available value is **WM_BUS_PARA_CS_TYPE_CS**. All other values are reserved for future use.
- The *Id* parameter defines the used Chip Select identifier; available values are 2 (for CS2 pin) and 3 (for CS3 pin).

The wm_busParallelTimingCfg_t structure

This type defines the Parallel bus timings.

```
typedef struct
{
          u8 AccessTime;
          u8 SetupTime;
          u8 HoldTime;
          u8 TurnaroundTime;
          u8 OpToOpTurnaroundTime;
          u8 pad[3]
} wm_busParallelTimingCfg_t
```

- The *OpToOpTurnaroundTime* parameter is reserved for future use.
- The configuration of other parameters defines the parallel bus timing, in 26 MHz cycles number (one cycle duration is 1/26 MHz = ~38.5 ns), according to the bus mode required at subscription time.
- Please refer to ADL documentation for more information on these parameters.

The wm_busParallelSettings_t structure

This type defines the Parallel bus settings for subscription.

```
typedef struct
{
   union
   {
     struct
     {
            u8                          Width;
            u8                          Mode;
            u8                          pad[2]
            wm_busParallelTimingCfg_t   ReadCfg;
            wm_busParallelTimingCfg_t   WriteCfg;
            wm_busParallelCs_t          Cs;
            u8                          NbAddNeeded;
     } In;
     struct
     {
            volatile void *  PrivateAddress;
            u32              MaskValidAddress;
     } Out;
   } u;
} wm_busParallelSettings_t;
```

- The structure is usable:
  - before the subscription function call, in order to set the required parallel bus configuration (using the `In` union member)
  - after the subscription function call, in order to retrieve the address mask to be set at read/write process time (using the `Out` union member)
- Please refer to ADL documentation for more information on these parameters.

2.10.3.2 Returned Values

- On successful completion, the function returns a positive or null BUS Handle, to use for further Read/Write/Close operations on this bus.
- Otherwise, the function returns a negative error value (see Returned Value Definition above).

2.10.3.3 Notes

A bus is available only when the GPIO multiplexed with the corresponding feature (according to the required configuration) have not been allocated by an Open AT® application yet. Concerned features depend on the bus type and configuration.

Bus Type & Configuration	Multiplexed Features
WM_BUS_HARD_I2C bus	**WM_IO_FEATURE_BUS_I2C**
WM_BUS_SPI1 bus, not using the hardware chip select pin, using one bi-directional data pin	**WM_IO_FEATURE_BUS_SPI1_CLK,** **WM_IO_FEATURE_BUS_SPI1_IO**
WM_BUS_SPI1 bus, using the hardware chip select pin, using one bi-directional data pin	**WM_IO_FEATURE_BUS_SPI1_CLK,** **WM_IO_FEATURE_BUS_SPI1_IO,** **WM_IO_FEATURE_BUS_SPI1_CS**
WM_BUS_SPI1 bus, not using the hardware chip select pin, using two data pin	**WM_IO_FEATURE_BUS_SPI1_CLK,** **WM_IO_FEATURE_BUS_SPI1_IO,** **WM_IO_FEATURE_BUS_SPI1_I**
WM_BUS_SPI1 bus, using the hardware chip select pin, using two data pin	**WM_IO_FEATURE_BUS_SPI1_CLK,** **WM_IO_FEATURE_BUS_SPI1_IO,** **WM_IO_FEATURE_BUS_SPI1_I,** **WM_IO_FEATURE_BUS_SPI1_CS**
WM_BUS_SPI2 bus, not using the hardware chip select pin, using one bi-directional data pin	**WM_IO_FEATURE_BUS_SPI2_CLK,** **WM_IO_FEATURE_BUS_SPI2_IO**
WM_BUS_SPI2 bus, using the hardware chip select pin, using one bi-directional data pin	**WM_IO_FEATURE_BUS_SPI2_CLK,** **WM_IO_FEATURE_BUS_SPI2_IO,** **WM_IO_FEATURE_BUS_SPI2_CS**
WM_BUS_SPI2 bus, not using the hardware chip select pin, using two data pin	**WM_IO_FEATURE_BUS_SPI2_CLK,** **WM_IO_FEATURE_BUS_SPI2_IO,** **WM_IO_FEATURE_BUS_SPI2_I**
WM_BUS_SPI2 bus, using the hardware chip select pin, using two data pin	**WM_IO_FEATURE_BUS_SPI2_CLK,** **WM_IO_FEATURE_BUS_SPI2_IO,** **WM_IO_FEATURE_BUS_SPI2_I,** **WM_IO_FEATURE_BUS_SPI2_CS**

Bus Type & Configuration	Multiplexed Features
WM_BUS_PARALLEL bus, using one hardware chip select CS3, using one address pin	**None**
WM_BUS_PARALLEL bus, using one hardware chip select CS3, using two address pin	**WM_IO_FEATURE_BUS_PARALLEL_ADDR1**
WM_BUS_PARALLEL bus, using one hardware chip select CS3, using three address pin	**WM_IO_FEATURE_BUS_PARALLEL_ADDR1** **WM_IO_FEATURE_BUS_PARALLEL_ADDR2_CS2**
WM_BUS_PARALLEL bus, using one hardware chip select CS2, using one address pin	**WM_IO_FEATURE_BUS_PARALLEL_ADDR2_CS2**
WM_BUS_PARALLEL bus, using one hardware chip select CS2, using two address pin	**WM_IO_FEATURE_BUS_PARALLEL_ADDR1** **WM_IO_FEATURE_BUS_PARALLEL_ADDR2_CS2**

Once the bus is opened, the features corresponding to the required configuration are enabled, and the multiplexed GPIO are no more available for allocation by an Open AT® application, or through the standard AT commands.

2.10.4 The wm_busClose Function

The wm_busClose function allows to close a bus which has been previously allocated by the wm_busOpen function.

The prototype is:

```
s32 wm_busClose (   s32 Handle );
```

2.10.4.1 Parameters

Handle:

Handle of the bus to close, returned by wm_busOpen function.

2.10.4.2 Returned Values

- On successful completion, the function returns 0.
- Otherwise, the function returns a negative error value (see Returned Value Definition above).

Note:

- Once a bus is closed, the features corresponding to the required configuration are disabled, and the multiplexed GPIO are available again for allocation by the Open AT® application, or through the standard AT commands.

2.10.5 The wm_busWrite Function

The wm_busWrite function allows to write on a bus which has been previously allocated by the wm_busOpen function. This function is not usable with the Parallel bus.

The prototype is:

```
s32 wm_busWrite (   s32 Handle
                    wm_busAccess_t * pAccessMode,
                    void * pDataToWrite,
                    u32 Size );
```

2.10.5.1 Parameters

Handle:

Handle of the bus device to write on, returned by wm_busOpen function.

pAccessMode:

Mode used to access the device.
This parameter is defined using the following type:

```
typedef struct
{
    u32 Address;
    u32 Opcode;
    u8 OpcodeLength;
    u8 AddressLength;
   wm_busSize_e AccessSize;
} wm_busAccess_t;
```

This structure parameter usage depends on the bus type.

	SPI bus	I2C bus
Address	Up to 32 bits to be sent on the bus before writing the data buffer. If less than 32 bits are required, only the most significant bits are sent.	Up to 32 bits to be sent on the bus before writing the data buffer. If less than 32 bits are required, only the most significant bits are sent.
AddressLength	Length of the Address parameter. Value range is [0-32].	Length of the Address parameter. Allowed values are 8, 16, 24, 32.
Opcode	Up to 32 bits to be sent on the bus before writing the data buffer. If less than 32 bits are required, only the most significant bits are sent.	Ignored.
OpcodeLength	Length of the Opcode parameter; values range is [0-32].	Ignored.
AccessSize	Data format of the provided data buffer (from 1 to 16 bits), using the **wm_busSize_e** type.	Always set to the **WM_BUS_SIZE_BYTE** value (data buffer always contains whole bytes).

pDataToWrite:

Buffer containing data to write on the requested bus.
According to AccessSize configuration, this parameter must use the following types:

- 1 <= AccessSize <= 8: the data buffer must use the u8 * type
- 9 <= AccessSize <= 16: the data buffer must use the u16 * type

If the AccessSize parameter is not the 8 or 16 value, only the less significant bits are written.

Size:

Size of the pDataToWrite buffer (according to the AccessSize configuration).

2.10.5.2 Returned Values

- On successful completion, the function returns the number of bytes written.
- Otherwise, the function returns a negative error value (see Returned Value Definition above).

2.10.6 The wm_busRead Function

The wm_busRead function allows to read on a bus previously allocated by the wm_busOpen function. This function is not usable with the Parallel bus.

The prototype is:

```
s32 wm_busRead (    s32 Handle
                    wm_busAccess_t * pAccessMode,
                    void * pDataToRead,
                    u32 Size );
```

2.10.6.1 Parameters

Handle:

Handle of the bus device to read from, returned by wm_busOpen function.

pAccessMode:

Mode used to access the device.
This parameter is defined using the following type:

```
typedef struct
{
    u32 Address;
    u32 Opcode;
    u8 OpcodeLength;
    u8 AddressLength;
   wm_busSize_e AccessSize;
} wm_busAccess_t;
```

This structure parameter usage depends on the bus type.

	SPI bus	I2C bus
Address	Up to 32 bits to be sent on the bus before reading the data buffer. If less than 32 bits are required, only the most significant bits are sent.	Up to 32 bits to be sent on the bus before reading the data buffer. If less than 32 bits are required, only the most significant bits are sent.
AddressLength	Length of the Address parameter. Values range is [0-32].	Length of the Address parameter. Allowed values are 8, 16, 24, 32.
Opcode	Up to 32 bits to be sent on the bus before reading the data buffer. If less than 32 bits are required, only the most significant bits are sent.	Ignored.
OpcodeLength	Length of the Opcode parameter; values range is [0-32].	Ignored.
AccessSize	Data format of the provided data buffer (from 1 to 16 bits), using the **wm_busSize_e** type.	Always set to the **WM_BUS_SIZE_BYTE** value (data buffer always contains whole bytes).

If required, "Address" and/or "Opcode" data are written on the bus, prior to reading data from the remote chip.
For I2C bus, using the "Address" data allows to send data to the chip and then read from it without sending a STOP instruction on the bus between the read and write processes.

pDataToRead:

Buffer containing data read from the requested bus.
According to AccessSize configuration, this parameter must use the following types:

- 1 <= AccessSize <= 8: the data buffer must use the u8 * type
- 9 <= AccessSize <= 16: the data buffer must use the u16 * type

If the AccessSize parameter has not the 8 or 16 value, only the less significant bits are written.

Size:

Size of the pDataToRead buffer (according to the AccessSize configuration).

2.10.6.2 Returned Values

- On successful completion, the function returns the number of bytes read.
- Otherwise, the function returns a negative error value (see Returned Value Definition above).

2.10.7 The wm_busDirectWrite Function

This function writes on a previously subscribed bus. This function is not usable with an SPI or I2C bus.

The prototype is:

```
s32  wm_busDirectWrite ( s32      Handle,
                         u32      ChipAddress,
                         u32      DataLen,
                         void *   Data );
```

2.10.7.1 Parameters

Handle:
Handle previously returned by the **wm_busOpen** function.

ChipAddressMode:
Chip address configuration. This address must be a combination of the desired address bits to set. Available address bits are returned in a mask at subscription time.

DataLen:
Number of items to write on the bus.

Data:
Data buffer to write on the bus (items bit size (8 or 16 bits) is defined at subscription time in the configuration structure).

2.10.7.2 Returned Values

- On successful completion, the function returns the number of bytes read.
- OK on success.
- Otherwise, the function returns a negative error value (see Returned Value Definition above).

2.10.8 The wm_busDirectRead Function

This function reads data a previously subscribed Parallel bus type. This function is not usable with SPI or I2C bus.

The prototype is:

```
s32  wm_busDirectRead  ( s32      Handle,
                         u32      ChipAddress,
                         u32      DataLen,
                         void *   Data );
```

2.10.8.1 Parameters

Handle:
Handle previously returned by the **wm_busOpen** function.

ChipAddressMode:
Chip address configuration. This address must be a combination of the desired address bits to set. Available address bits are returned in a mask at subscription time.

DataLen:
Number of items to read from the bus.

Data:
Buffer where the read items are copied (items bit size (8 or 16 bits) is defined at subscription time in the configuration structure).

2.10.8.2 Returned Values

- OK on success.
- Otherwise, the function returns a negative error value (see Returned Value Definition above).

2.11 List Management API

2.11.1 Required Header

This API is defined in the `wm_list.h` header file.
This file is included by `wm_apm.h`.

2.11.2 Type Definition

2.11.2.1 The wm_lst_t Type

This type is used to handle a list created by the list API.

```
typedef void * wm_lst_t;
```

2.11.2.2 The wm_lstTable_t Structure

This structure is used to define a comparison callback and an Item destruction callback:

```
typedef struct
{
 s16  ( * CompareItem ) ( void *, void * );
 void ( * FreeItem ) ( void * );
} wm_lstTable_t;
```

The `CompareItem` callback is called every time the list API needs to compare two items.
It returns:

- OK when the two provided elements are considered similar.
- –1 when the first element is considered smaller than the second one.
- 1 when the first element is considered greater than the second one.

If the `CompareItem` callback is set to NULL, the `wm_strcmp` function is used by default.

The `FreeItem` callback is called each time the list API needs to delete an item. It should then perform its specific processing before releasing the provided pointer.
If the `FreeItem` callback is set to NULL, the `wm_osReleaseMemory` function is used by default.

2.11.3 The wm_lstCreate Function

The wm_lstCreate function allows to create a list, using the provided attributes and callbacks.

The prototype is:

```
wm_lst_t wm_lstCreate (   u16 Attr,
                          wm_lstTable_t * funcTable );
```

2.11.3.1 Parameters

Attr:

List attributes, which can be combined by a logical OR among the following defined values:

- WM_LIST_NONE: no specific attribute ;
- WM_LIST_SORTED: this list is a sorted one (see wm_lstAddItem and wm_lstInsertItem descriptions for more details);
- WM_LIST_NODUPLICATES: this list does not allow duplicate items (see wm_lstAddItem and wm_lstInsertItem descriptions for more details).

funcTable:

Pointer on a structure containing the comparison and the item destruction callbacks.

2.11.3.2 Returned Values

This function returns a list pointer corresponding to the created list. This must be used in all further operations on this list.

2.11.4 The wm_lstDestroy Function

The wm_lstDestroy function allows to clear and then destroy the provided list.

The prototype is:

```
void wm_lstDestroy ( wm_lst_t list );
```

list:

The list to destroy.

Note

This function calls the `FreeItem` callback (if defined) on each item to delete it, before destroying the list.

2.11.5 The wm_lstClear Function

The wm_lstClear function allows to clear all the provided list items, without destroying the list itself (please refer to wm_lstDeleteItem() function for notes on item deletion).

The prototype is:

```
void wm_lstClear ( wm_lst_t list );
```

list: the list to clear.

Note
This function calls the `FreeItem` callback (if defined) on each item to delete it.

2.11.6 The wm_lstGetCount Function

The wm_lstGetCount function returns the current item count.

The prototype is:

```
u16 wm_lstGetCount ( wm_lst_t list );
```

2.11.6.1 Parameters

list:
The list from which to get the item count.

2.11.6.2 Returned Values

The number of items of the provided list. The function returns 0 if the list is empty.

2.11.7 The wm_lstAddItem Function

The wm_lstAddItem function allows to add an item to the provided list.

The prototype is:

```
s16 wm_lstAddItem (    wm_lst_t list
                       void * item );
```

2.11.7.1 Parameters

list: The list to add an item to.

item: The item to add to the list.

2.11.7.2 Returned Values

The position of the added item, or ERROR if an error occured.

Notes:

- The `item` pointer should not point on a `const` or local buffer, as it is released in any item destruction operation.
- If the list has the WM_LIST_SORTED attribute, the item is inserted in the appropriate place after calling of the `CompareItem` callback (if defined). Otherwise, the item is appended at the end of the list.
- If the list has the WM_LIST_NODUPLICATES, the item is not inserted when the `CompareItem` callback (if defined) returns 0 on any previously added item. In this case, the returned index is the existing item index.

2.11.8 The wm_lstInsertItem Function

The `wm_lstInsertItem` function allows to insert an item to the provided list at the given location.
The prototype is:

```
s16 wm_lstInsertItem (  wm_lst_t list
                        void * item
                        u16 index );
```

2.11.8.1 Parameters

list: The list to add an item to.

item: The item to add to the list.

index: The location where to add the item.

2.11.8.2 Returned Values

The position of the added item, or ERROR if an error occured.

2.11.8.3 Notes

- The item pointer should not point on a const or local buffer, as it is released in any item destruction operation.
- This function does not take list attributes into account and always inserts the provided item in the given index.

2.11.9 The wm_lstGetItem Function

The `wm_lstGetItem` function allows to read an item from the provided list, in the given index.

The prototype is:

```
void * wm_lstGetItem (  wm_lst_t list
                        u16 index );
```

2.11.9.1 Parameters

list:
The list from which to get the item.

index:
The location where to get the item.

2.11.9.2 Returned Values

A pointer on the requested item, or NULL if the index is not valid.

2.11.10 The wm_lstDeleteItem Function

The wm_lstDeleteItem function allows to delete an item of the provided list in the given indices.

The prototype is:

```
s16 wm_lstDeleteItem (  wm_lst_t list
                        u16 index );
```

2.11.10.1 Parameters

list:
The list to delete an item from.

index:
The location where to delete the item.

2.11.10.2 Returned Values

The number of remaining items in the list, or ERROR if an error did occur.

Note
This function calls the `FreeItem` callback (if defined) on the requested item to delete it.

2.11.11 The wm_lstFindItem Function

The wm_lstFindItem function allows to find an item in the provided list.

The prototype is:

```
s16 wm_lstFindItem (   wm_lst_t list
                       void * item );
```

2.11.11.1 Parameters

list: The list where to search.

item: The item to find.

2.11.11.2 Returned Values

The index of the found item if any, ERROR otherwise.

Note
This function calls the CompareItem callback (if defined) on each list item, until it returns 0.

2.11.12 The wm_lstFindAllItem Function

The wm_lstFindAllItem function allows to find all items matching the provided one, in the given list.

The prototype is:

```
s16 * wm_lstFindAllItem ( wm_lst_t list
                          void * item );
```

2.11.12.1 Parameters

list: The list where to search.

item: The item to find.

2.11.12.2 Returned Values

A s16 buffer containing the indices of all the items found, and ending with ERROR.
Important remark: this buffer should be released by the application when its processing is done.

Notes:

- This function calls the `CompareItem` callback (if defined) on each list item to get all those which match the provided item.
- This function should be used only if the list cannot be changed during the resulting buffer processing. Otherwise the `wm_lstFindNextItem` should be used.

2.11.13 The wm_lstFindNextItem Function

The wm_lstFindNextItem function allows to find the next item index of the given list, which corresponds with the provided one.

The prototype is:

```
s16 wm_lstFindNextItem (    wm_lst_t list
                            void * item );
```

2.11.13.1 Parameters

list: The list to search in.

item: The item to find.

2.11.13.2 Returned Values

The index of the next found item if any, otherwise ERROR.

Note

- This function calls the `CompareItem` callback (if defined) on each list item to get those which match with the provided item. It should be called until it returns ERROR, in order to get the index of all items corresponding to the provided one. The difference with the `wm_lstFindAllItem` function is that, even if the list is updated between two calls to `wm_lstFindNextItem`, the function does not return a previously found item. To restart a search with the `wm_lstFindNextItem`, the `wm_lstResetItem` should be called first.

2.11.14 The wm_lstResetItem Function

The wm_lstResetItem function allows to reset all previously found items by the wm_lstFindNextItem function.

The prototype is:

```
void wm_lstResetItem (  wm_lst_t list
                        void * item );
```

2.11.14.1 Parameters

list: The list to search in.

item: The item to search, in order to reset all previously found items.

Note

- This function calls the CompareItem callback (if defined) on each list item to get those which match with the provided one.

2.12 Sound API

2.12.1 Required header

This API is defined in the `wm_snd.h` header file.
This file is included by `wm_apm.h`.

2.12.2 The wm_sndTonePlay Function

This function allows a tone to be played on the current speaker or on the buzzer. Frequency, gain and duration can be specified.

The prototype is:

```
s32  wm_sndTonePlay (   wm_snd_dest_e Destination,
                        u16           Frequency,
                        u8            Duration,
                        u8            Gain );
```

2.12.2.1 Parameters

Destination:

Destination of the requested tone to play: speaker or buzzer.

```
typedef enum        {
WM_SND_DEST_BUZZER,
WM_SND_DEST_SPEAKER,
WM_SND_DEST_GSM          /* do not use */
 } wm_snd_dest_e;
```

Frequency:

For speaker: range is 1 Hz to 3999 Hz.
For buzzer: range is 1 Hz to 50000 Hz.

Duration:

This parameter sets tone duration (in unit of 20 ms).
Remark: when **<duration>** = 0, the duration is infinite, and the tone should be stopped by **wm_sndToneStop**.

Gain:

This parameter sets the tone gain.
Range of values is from 0 to 15.

<gain>	Speaker (db)	Buzzer (db)
0	0	-0.25
1	-0.5	-0.5
2	-1	-1
3	-1.5	-1.5
4	-2	-2
5	-3	-3
6	-6	-6
7	-9	-9
8	-12	-12
9	-15	-15
10	-18	-18
11	-24	-24
12	-30	-30
13	-36	-40
14	-42	-infinite
15	-infinite	-infinite

2.12.2.2 Returned values

OK on success,or negative error value

2.12.2.3 Example:

An example of playing tone:

```
wm_sndTonePlay ( WM_SND_DEST_BUZZER, 1000, 0, 9 );
```

2.12.3 The wm_sndTonePlayExt Function

This function allows a dual tone (two frequencies) to be played on the specified output. Frequencies, gains and duration can be specified.

Note: only the speaker output is able to play tones in two frequencies. The second tone parameters are ignored on the buzzer output.

The prototype is:

```
s32  wm_sndTonePlayExt ( wm_snd_dest_e     Destination,
                         u16               Frequency,
                         u16               Frequency2,
                         u8                Duration,
                         u8                Gain,
                         u8                Gain2 );
```

2.12.3.1 Parameters

Destination:

Destination of the requested tone to play: speaker or buzzer.

```
typedef enum        {
WM_SND_DEST_BUZZER,
WM_SND_DEST_SPEAKER,
WM_SND_DEST_GSM          /* do not use */
 } wm_snd_dest_e;
```

Frequency, Frequency2:

For speaker: range is from 1 Hz to 3999 Hz.
For buzzer: range is from 1 Hz to 50000 Hz.

Please remember that the Frequency2 parameter is only processed on the speaker output.

Duration:

This parameter sets tone duration (in unit of 20 ms).
Remark: when **<duration>** = 0, the duration is infinite, and the tone should be stopped by **wm_sndToneStop**.

Gain, Gain2:

This parameter sets the tones gain. Gain parameter applies to Frequency value, and Gain2 applies to the Frequency2 one.

Range of values is from 0 to 15.

<gain>	Speaker (db)	Buzzer (db)
0	0	-0.25
1	-0.5	-0.5
2	-1	-1
3	-1.5	-1.5
4	-2	-2
5	-3	-3
6	-6	-6
7	-9	-9
8	-12	-12
9	-15	-15
10	-18	-18
11	-24	-24
12	-30	-30
13	-36	-40
14	-42	-infinite
15	-infinite	-infinite

2.12.3.2 Returned values

OK on success, or a negative error value

2.12.3.3 Example:

An example of playing tone:

```
wm_sndTonePlayExt ( WM_SND_DEST_SPEAKER, 1000, 2000, 0, 9, 10 );
```

2.12.4 The wm_sndToneStop Function

This function stops playing a tone on the current speaker or on the buzzer.

The prototype is:

```
s32  wm_sndToneStop ( wm_snd_dest_e Destination );
```

2.12.4.1 Parameters

Destination:

Destination of the current playing tone to stop: speaker or buzzer.

2.12.4.2 Returned values

OK on success, or a negative error value.

2.12.4.3 Example:

An example of stopping tone:

```
wm_sndToneStop ( WM_SND_DEST_BUZZER );
```

2.12.5 The wm_sndDtmfPlay Function

This function allows a DTMF tone to be played on the current speaker or over the GSM network (in communication only). DTMF, gain (only for speaker) and duration can be specified.

Remark: it is not possible to play DTMF on the buzzer.

The prototype is:

```
s32  wm_sndDtmfPlay (   wm_snd_dest_e Destination,
                        ascii         Dtmf,
                        u8            Duration,
                        u8            Gain );
```

2.12.5.1 Parameters

Destination:

Destination of the requested DTMF tone to play: speaker or/and over the GSM network (in communication only).

```
typedef enum        {
WM_SND_DEST_BUZZER, /* do not use */
WM_SND_DEST_SPEAKER,
WM_SND_DEST_GSM
} wm_snd_dest_e;
```

Dtmf:

Value must be in { '0' - '9', '*', '#', 'A', 'B', 'C', 'D' }

Duration:

This parameter sets tone duration (in unit of 20 ms).
Remark: when **<duration>** = 0, the duration is infinite, and the tone should be stopped by **wm_sndDtmfStop**.

Gain:

Only for speaker.
This parameter sets the tone gain.
Range of values is from 0 to 15.

2.12.5.2 Returned values

OK on success, or a negative error value

2.12.5.3 Example:

An example of playing DTMF:

```
wm_sndDtmfPlay ( WM_SND_DEST_SPEAKER, 'A', 100, 9 );
```

2.12.6 The wm_sndDtmfStop Function

This function stops playing a dtmf on the current speaker or over the GSM network (in communication only).

The prototype is:

```
s32  wm_sndDtmfStop ( wm_snd_dest_e Destination );
```

2.12.6.1 Parameters

Destination:

Destination of the current playing tone to stop, this must be a speaker (GSM network DTMF cannot be stopped).

2.12.6.2 Returned values

OK on success, or a negative error value

2.12.6.3 Example:

An example of stopping DTMF:

```
wm_sndDtmfStop ( WM_SND_DEST_SPEAKER );
```

2.12.7 The wm_sndMelodyPlay Function

This function plays a melody. Destination, Melody, Tempo, Cycle and gain can be specified.

The prototype is:

```
s32  wm_melody_play (   wm_snd_dest_e Destination,
                        u16*          Melody,
                        u16           Tempo,
                        u8            Cycle,
                        u8            Gain );
```

2.12.7.1 Parameters

Destination:

Destination of the melody to play: speaker or buzzer.

```
typedef enum        {
  WM_SND_DEST_BUZZER,
  WM_SND_DEST_SPEAKER,
  WM_SND_DEST_GSM        /* do not use */
} wm_snd_dest_e;
```

Melody:

Melody to play. A melody is defined by an u16 table, where each element defines a note event, with duration and sound definition.

```
// Melody sample
const u16 MyMelody [ ]=
{
  WM_SND_E1 |  WM_SND_QUAVER  ,
  WM_SND_F1 |  WM_SND_MBLACK  ,
  WM_SND_G6S |  WM_SND_QUAVER  ,
};
```

```
typedef enum {
  WM_SND_C0 ,    // C0
  WM_SND_C0S ,   // C0#
  WM_SND_D0 ,    // D0
  WM_SND_D0S ,   // D0#
  WM_SND_E0 ,    // E0
  WM_SND_F0 ,    // F0
  WM_SND_F0S ,   // F0#
  WM_SND_G0 ,    // G0
  WM_SND_G0S ,   // G0#
  WM_SND_A0 ,    // A0
  WM_SND_A0S ,   // A0#
  WM_SND_B0 ,    // B0
  WM_SND_C1 ,    // C1
  …
  WM_SND_NO_SOUND=0xFF
} wm_sndNote_e;

#define WM_SND_ROUND       0x1000
#define WM_SND_MWHITEP     0x0C00
#define WM_SND_MWHITE      0x0800
#define WM_SND_MBLACKP     0x0600
#define WM_SND_MBLACK      0x0400
#define WM_SND_QUAVERP     0x0300
#define WM_SND_QUAVER      0x0200
#define WM_SND_MSHORT      0x0100
```

Tempo:
Tempo to apply (duration a black x 20 ms).

Cycle:
number of times that the melody should be played (0 = infinite)

Gain:
Volume to apply, range of values is 0 to 15.

2.12.7.2 Returned values

OK on success, or a negative error value

2.12.7.3 Example:

An example of playing melody:

```
wm_sndMelodyPlay ( WM_SND_DEST_SPEAKER, MyMelody, 6, 1, 9 );
```

2.12.8 The wm_sndMelodyStop Function

This function stops playing a melody on the current speaker or on the buzzer.

The prototype is:

```
s32 wm_sndMelodyStop ( wm_snd_dest_e Destination );
```

2.12.8.1 Parameters

Destination:
Destination of the current playing melody to stop: speaker or buzzer.

2.12.8.2 Returned values

OK on success, or a negative error value

2.12.8.3 Example:

An example of stopping a melody:

```
wm_sndMelodyStop ( WM_SND_DEST_SPEAKER );
```

2.13 Standard Library

2.13.1 Required Header

This API is defined in the `wm_stdio.h` header file.
This file is included by `wm_apm.h`.

2.13.2 Standard C Function Set

The available standard APIs are defined below:

```
ascii *  wm_strcpy        ( ascii * dst, ascii * src );
ascii *  wm_strncpy       ( ascii * dst, ascii * src, u32 n );
ascii *  wm_strcat        ( ascii * dst, ascii * src );
ascii *  wm_strncat       ( ascii * dst, ascii * src, u32 n );
u32      wm_strlen        ( ascii * str );
s32      wm_strcmp        ( ascii * s1, ascii * s2 );
s32      wm_strncmp       ( ascii * s1, ascii * s2, u32 n );
s32      wm_stricmp       ( ascii * s1, ascii * s2 );
s32      wm_strnicmp      ( ascii * s1, ascii * s2, u32 n );
ascii *  wm_memset        ( ascii * dst, ascii c, u32 n );
ascii *  wm_memcpy        ( ascii * dst, ascii * src, u32 n );
s32      wm_memcmp        ( ascii * dst, ascii * src, u32 n );
ascii *  wm_itoa          ( s32 a, ascii * szBuffer );
s32      wm_atoi          ( ascii * p );
u8       wm_sprintf       ( ascii * buffer, ascii * fmt, ... );
```

Important remark about GCC compiler:

When using GCC compiler, due to internal standard C library architecture, it is strongly not recommended to use the "%f" mode in the wm_sprintf function in order to convert a float variable to a string. This leads to an ARM exception (product reset).
A way around for this conversion is:

```
float MyFloat;  // float to display
ascii MyString [ 100 ];  // destination string
s16 d,f;
d = (s16) MyFloat * 1000;   // Decimal precision: 3 digits
f = ( MyFLoat * 1000 ) - d; // Decimal precision: 3 digits
wm_sprintf ( MyString, "%d.%03d", (s16)MyFloat, f ); // Decimal
precision: 3 digits
```

2.13.3 String Processing Function Set

Some string processing functions are also available in this standard API.

Note: all the following functions result as an ARM exception if a requested ascii * parameter is NULL.

```
ascii    wm_isascii          ( ascii c );
```
Returns c if it is an ascii character ('a'/'A' to 'z'/'Z'), 0 otherwise.

```
ascii    wm_isdigit          ( ascii c );
```
Returns c if it is a digit character ('0' to '9'), 0 otherwise.

```
ascii    wm_ishexa           ( ascii c );
```
Returns c if it is a hexadecimal character ('0' to '9', 'a'/'A' to 'f'/'F'), 0 otherwise.

```
bool     wm_isnumstring      ( ascii * string );
```
Returns TRUE if string is a numeric one, FALSE otherwise.

```
bool     wm_ishexastring     ( ascii * string );
```
Returns TRUE if string is a hexadecimal one, FALSE otherwise.

```
bool     wm_isphonestring    ( ascii * string );
```
Returns TRUE if string is a valid phone number (national or international format), FALSE otherwise.

```
u32      wm_hexatoi          ( ascii * src, u16 iLen );
```
If src is a hexadecimal string, converts it to a returned u32 of the given length, and 0 otherwise. As an example: wm_hexatoi ("1A", 2) returns 26, wm_hexatoi ("1A", 1) returns 1

```
u8 *     wm_hexatoibuf       ( u8 * dst, ascii * src );
```
If src is a hexadecimal string, converts it to an u8 * buffer and returns a pointer on dst, and NULL otherwise. As an example, wm_hexatoibuf (dst, "1F06") returns a 2 bytes buffer: 0x1F and 0x06

```
ascii * wm_itohexa           ( ascii * dst, u32 nb, u8 len );
```
Converts nb to a hexadecimal string of the given length and returns a pointer on dst. For example, wm_itohexa (dst, 0xD3, 2) returns "D3", wm_itohexa (dst, 0xD3, 4) returns "00D3".

```
 ascii *wm_ibuftohexa       ( ascii * dst, u8 * src, u16 len );
```
Converts the u8 buffer src to a hexadecimal string of the given length and returns a pointer on dst. Example with the src buffer filled with 3 bytes (0x1A, 0x2B and 0x3C), wm_ibuftohexa (dst, src, 3) returns "1A2B3C").

```
u16      wm_strSwitch        ( const ascii * strTest, ... );
```
This function must be called with a list of strings parameters, ending with NULL. strTest is compared with each of these strings (on the length of each string, with no matter of the case), and returns the index (starting from 1) of the string which matches if any, 0 otherwise.
Example:
wm_strSwitch ("TEST match", "test", "no match", NULL") returns 1,
wm_strSwitch ("nomatch", "nomatch a", "nomatch b", NULL) returns 0.

```
ascii * wm_strRemoveCRLF   ( ascii * dst, ascii * src, u16 size );
```
Copy in dst buffer the content of src buffer, removing CR (0x0D) and LF (0x0A) characters, from the given size, and returns a pointer on dst.

```
ascii *wm_strGetParameterString (    ascii * dst,
                                     const ascii * src,
                                     u16 Position );
```
If src is a string formatted as an AT response (for example "+RESP: 1,2,3") or as an AT command (for example "AT+CMD=1,2,3"), the function copies the parameter at Position offset (starting from 1) if it is present in the dst buffer, and returns a pointer on dst. It returns NULL otherwise.
Example:
wm_strGetParameterString (dst, "+WIND: 4", 1) returns "4",
wm_strGetParameterString (dst, "+WIND: 5,1", 2) returns "1",
wm_strGetParameterString (dst, "AT+CMGL=\"ALL\"", 1) returns "ALL".

2.14 Application & Data Storage API

This API provides storage cells, where to store data or "dwl" files in order to update the product software (a "dwl" file may be a Wavecom OS update, an Open AT® application, or an E2P configuration file).

The total Application & Data Storage volume size is configurable with the AT+WOPEN command.

2.14.1 Required Header

This API is defined in the **wm_ad.h** header file.
This file is included by **wm_apm.h**.

2.14.2 Returned Value Definition

WM_AD_ERROR_UNDEFINED	Generic error code;
WM_AD_BAD_ARGS	Function argument error;
WM_AD_BAD_FUNCTION	Bad function call;
WM_AD_FORBIDDEN	Access denied or illegal operation attempt;
WM_AD_OVERFLOW	Memory overflow;
WM_AD_REACHED_END	No more elements to enumerate;
WM_AD_NOT_AVAILABLE	Function not available (no initialisation done or operation not supported);
WM_AD_CLEANING_RQD	A cleaning operation is required to perform the requested command.

2.14.3 The wm_adAllocate Function

The **wm_adAllocate** function allows to allocate a new cell in the Application & Data storage space.

The prototype is:

```
s32 wm_adAllocate ( u32              CellId,
                    u32              Size,
                    wm_adHandle_t *  Handle );
```

2.14.3.1 Parameters

CellId
Unique identifier of the cell to allocate.

Size
Size in bytes of the cell to allocate.
The real used size in flash memory is the data size + the header size.
The header size is variable, with an average of 16 bytes.
If the Cell size is unknown at allocation time, the WM_AD_UNDEFINED may be used. In this case, the next wm_adAllocate function calls all fail, until the undefined size cell is finalized.

Handle
Returned handle on the new allocated cell.

2.14.3.2 Returned Values

This function returns OK if successful, otherwise, it returns an error value (please refer to § 2.14.2 "Returned Value Definition").

2.14.4 The wm_adRetrieve Function

The **wm_adRetrieve** function allows to initialize a handle on an already allocated cell.

The prototype is:

```
s32 wm_adRetrieve ( u32              CellId,
                    wm_adHandle_t *  Handle );
```

2.14.4.1 Parameters

CellId
Unique identifier of the cell to retrieve.

Handle
Returned handle on the retrieved cell.

2.14.4.2 Returned Values

This function returns OK if successful, otherwise, it returns an error value (see § 2.14.2 "Returned Value Definition").

2.14.5 The wm_adFindInit Function

The **wm_adFindInit** function initializes a cell search, between the two provided cell identifiers.

The prototype is:

```
s32 wm_adFindInit ( u32              MinCellId,
                    u32              MaxCellId,
                    wm_adBrowse_t *  BrowseInfo );
```

2.14.5.1 Parameters

MinCellId
Minimum value for wanted cell identifiers.
MaxCellId
Maximum value for wanted cell identifiers.
BrowseInfo
Returned browse information, to use with the **wm_adFindNext()** function.

2.14.5.2 Returned Values

This function returns OK if successful, otherwise, it returns an error value (see § 2.14.2 "Returned Value Definition").

2.14.6 The wm_adFindNext Function

The **wm_adFindNext** function performs a search on the browse information provided by the **wm_adFindInit()** function.

The prototype is:

```
s32 wm_adFindNext ( wm_adBrowse_t *  BrowseInfo
                    wm_adHandle_t *  Handle );
```

2.14.6.1 Parameters

BrowseInfo
Browse information, returned by the wm_adFindInit() function.
Handle
Next found cell handle.

2.14.6.2 Returned Values

This function returns OK when a handle is found, or WM_AD_REACHED_END when are no more corresponding handles.
Otherwise, the function returns an error value (see § 2.14.2 "Returned Value Definition").

2.14.7 The wm_adWrite Function

The **wm_adWrite** function appends data in an allocated cell.

The prototype is:

```
s32 wm_adWrite ( wm_adHandle_t *  Handle,
                 u32              Size,
                 void *           Data );
```

2.14.7.1 Parameters

Handle
Handle on the allocated cell (returned by the wm_adAllocate or the wm_adResume functions).
Size
Number of bytes to write.
Data
Data source buffer.

2.14.7.2 Returned Values

This function returns OK if successful, otherwise, the function returns an error value (see § 2.14.2 "Returned Value Definition").

2.14.8 The wm_adFinalise Function

The wm_adFinalise function finalizes the creation of a new record. Once completed, nothing more can be written in the cell.

The prototype is:

```
s32 wm_adFinalise ( wm_adHandle_t *   Handle );
```

2.14.8.1 Parameters

Handle

Handle on the allocated cell (returned by the wm_adAllocate or the wm_adResume functions) to finalize.

2.14.8.2 Returned Values

This function returns OK if successful.
Otherwise, the function returns an error value (see § 2.14.2 "Returned Value Definition").

2.14.9 The wm_adResume Function

The wm_adResume function allows to resume an interrupted write operation, on a call not finalized yet .

The prototype is:

```
s32 wm_adResume (   wm_adHandle_t *   Handle );
```

2.14.9.1 Parameters

Handle

Handle on the cell not finalized yet (returned by the **wm_adFindNext** or the **wm_adRetrieve** functions).

2.14.9.2 Returned Values

This function returns OK if successful.
Otherwise, the function returns an error value (see § 2.14.2 "Returned Value Definition").

2.14.10 The wm_adInfo Function

The wm_adInfo function provides information on the requested handle.

The prototype is:

```
s32 wm_adInfo ( wm_adHandle_t *  Handle
                wm_adInfo_t *    Info );
```

2.14.10.1 Parameters

Handle

Handle on the allocated cell from which to get information.

Info

Data returned on the provided handle, using following type:

```
typedef struct
{
    u32      ID,                // Cell identifier
    u32      size,              // Cell size
    void *   data,              // Pointer on stored data
    u32      remaining,         // Remaining writable space
    bool     finalised          // TRUE if entry is finalized
} wm_adInfo_t;
```

2.14.10.2 Returned Values

This function returns OK if successful.
Otherwise, the function returns an error value (see § 2.14.2 "Returned Value Definition").

2.14.11 The wm_adDelete Function

The **wm_adStats** function allows to delete the requested record. The cell is not physically deleted ; but will be during the next recompaction process.

The prototype is:

```
s32 wm_adDelete ( wm_adHandle_t * Handle );
```

2.14.11.1 Parameters

Handle

Handle on the cell to delete.

2.14.11.2 Returned Values

This function returns OK if successful.
Otherwise, the function returns an error value (see § 2.14.2 "Returned Value Definition").

2.14.12 The wm_adStats Function

The **wm_adStats** function provides global Application & Data space information.

The prototype is:

```
s32 wm_adStats ( wm_adStats_t * Info );
```

2.14.12.1 Parameters

Info

Information returned on the provided handle, using following type:

```
typedef struct
{
    u32      freemem,          // Free memory size
    u32      deletedmem,       // Deleted memory size
    u32      totalmem,         // Total memory size
    u16      numobjects,       // Number of objects
    u16      numdeleted,       // Number of deleted objects
    bool     need_recovery     // Set to TRUE, either if the volume
                                  state is not set to WM_AD_READY on
                                  startup, or if a cell allocated
                                  with an undefined size was not
                                  finalized before a product reset.
} wm_adStats_t;
```

2.14.12.2 Returned Values

This function returns OK if successful.
Otherwise, the function returns an error value (see § 2.14.2 "Returned Value Definition").

2.14.13 The wm_adSpaceState Function

The **wm_adSpaceState** function provides the Application & Data space current state.

The prototype is:

```
wm_adSpaceState_e wm_adSpaceState ( void );
```

2.14.13.1 Returned Values

This returned value uses the following type:

```
typedef enum
{
    WM_AD_READY = 1,    // Space is ready
    WM_AD_NOTAVAIL,     // Space is not available
    WM_AD_REPAIR,       // A product reset has occurred since last
                        // recompaction process. The application has
                        // to call wm_adRecompactInit to continue
                        // this process.
} wm_adSpaceState_e;
```

2.14.14 The wm_adFormat Function

The **wm_adFormat** function destroys the whole Application & Data space stored data. The function must be called a first time with the **WM_AD_FORMAT_INIT** mode, to initialize the formatting process. Then it must be called regularly (Eg. on a cyclic timer reception) with the **WM_AD_FORMAT_CONTINUE** mode, until the formatting process is completed.

The prototype is:

```
s32 wm_adFormat (wm_adFormatMode_eMode,
                 u32 *          FormatHandle,
                 u32 *          FormatProgress );
```

2.14.14.1 Parameters

Mode

Required operation mode, using the following type:

```
typedef enum
{
    WM_AD_FORMAT_INIT,       // Initialize the format process
    WM_AD_FORMAT_CONTINUE,   // Continue running the format process
    WM_AD_FORMAT_ABORT       // Abort format process
                             // (need to be re-started later)
} wm_adFormatMode_e;
```

FormatHandle

Pointer on an u32 integer, modified by the function; the same pointer must be used for every function call during the formatting process.

FormatProgress

Formatting process progress indicator (in percentage) updated by the function. The process is complete when this indicator reaches the 100 value.

2.14.14.2 Returned Values

This function returns OK if successful.
Otherwise, the function returns an error value (see § 2.14.2 "Returned Value Definition").

2.14.15 The wm_adRecompactInit Function

The wm_adRecompactInit function starts the recompaction process. The process steps are then done by the wm_adRecompcact() function.
The prototype is:

```
s32 wm_adRecompactInit ( void );
```

Note: when **wm_adRecompactInit** is called, **no other A&D function should be called** (except **wm_adRecompact**) **before recompaction completion**. If the recompaction is interrupted by a product reset,the **wm_adSpaceState** function returns the state: WM_AD_REPAIR.

2.14.15.1 Returned Values

This function returns OK if successful.
Otherwise, the function returns an error value (see § 2.14.2 "Returned Value Definition").

2.14.16 The wm_adRecompact Function

The **wm_adRecompact** function performs a new recompacting step. The recompacting process must be initialised by the **wm_adRecompactInit()** function.
The prototype is:

```
s32 wm_adRecompact ( void );
```

2.14.16.1 Returned Values

This function returns the completed percentage if successful. It must be called until the returned value is 100.
Otherwise, the function returns an error value (see § 2.14.2 "Returned Value Definition").

2.14.17 The wm_adInstall Function

The **wm_adInstall** function allows to install the content of the provided cell, if it is a "dwl" file (a Wavecom OS update, an Open AT® application, or an E2P configuration file).

The prototype is:

```
s32 wm_adInstall ( wm_adHandle_t * Handle );
```

2.14.17.1 Parameters

Handle
Handle on the cell to install.

2.14.17.2 Returned Values

This function resets the product and installs the "dwl" file on success.
The InitType parameter of all the Init functions is set to either WM_APM_DOWNLOAD_SUCCESS (on install success) or WM_APM_DOWNLOAD_ERROR (if the ".dwl" file is corrupted).
Otherwise, the function returns an error value (see 2.14.2 "Returned Value Definition").

2.15 IRQ API

The IRQ API allows the application to define interruption handlers.

Please note that this feature must be enabled on the Wireless CPU so that the API is accessible.

2.15.1 Required Header

This API is defined in the **wm_irq.h** header file.

This file is included by **wm_apm.h**.

2.15.2 The wm_irqSetHandler Function

The **wm_irqSetHandler** function allows the application to setup interruption handlers for the required interruption source.

The prototype is:

```
bool wm_irqSetHandler (     wm_irqID_e                IrqID,
                            wm_irqLowLevelHandler_f   LowLevelHandler,
                            wm_irqHighLevelHandler_f  HighLevelHandler,
                            wm_irqPriority_e          Priority );
```

2.15.2.1 Parameters

IrqID:

Interruption source identifier, using the values defined below. Please refer to interruption source APIs for more information.

```
typedef enum
{
    WM_IRQ_EXTINT0,        // External Interruption pin  #0
    WM_IRQ_EXTINT1,        // External Interruption pin  #1
    WM_IRQ_SCTU1           // System Controller Timer unit  #1
} wm_irqID_e;
```

LowLevelHandler:

The Low level interruption handler callback type uses the prototype below. This function is called in low level interruption handler context, as soon as the required source creates an interruption.

```
typedef bool  ( *    wm_irqLowLevelHandler_f )
              ( void   ** OutputDataPointer ) ;
```

The **OutputDataPointer** parameter value must be modified by the application. The supplied address is notified to the high level handler. This is a standard way to exchange data between low & high level interruption handlers.

The Boolean returned value allows the low level interruption handler to control the call of the high level one:

- if it is **TRUE**, the high level handler is called, if any

- if it is **FALSE**, the high level handler is not called.

HighLevelHandler:
The High level interruption handler callback type uses the prototype below. This function is called in high level interruption handler context, as soon as the low level interruption handler has been notified.

```
typedef void    ( *   wm_irqHighLevelHandler_f  )
                ( void    *    inputDataPointer ) ;
```

The **InputDataPointer** parameter value is supplied by the low level interruption handler.

Priority:
Low level interruption handler priority level, uses one of the values defined below.

```
typedef enum
{
    WM_IRQ_LOW_PRIORITY,      // Low priority, should be
                              interrupted by High priority
                              handlers.
    WM_IRQ_HIGH_PRIORITY,     // High priority, is not
                              interrupted by other handlers.
} wm_irqPriority_e;
```

2.15.2.2 Returned Values

- **TRUE** on success.
- **FALSE** on any error (invalid parameter or the features that are not enabled on Wireless CPU).

2.15.3 The wm_irqRemoveHandler Function

The **wm_irqRemoveHandler** function allows the application to remove previously defined interruption handlers from a specific source.

The prototype is:

```
bool wm_irqRemoveHandler ( wm_irqID_e  IrqID);
```

2.15.3.1 Parameters

IrqID:
Interruption source identifier.
Please refer to **wm_irqSetHandler** function description for more information.

2.15.3.2 Returned Values

- **TRUE** on success.
- **FALSE** on any error.

2.16 SCTU API

2.16.1 Required Header

This API is defined in the **wm_sctu.h** header file.

This file is included by **wm_apm.h**.

2.16.2 The wm_sctuOpen Function

The **wm_sctuOpen** function allows the application to setup and configure the required System Controller Timer Unit (SCTU) block.
Please refer to the ADL user guide for a complete SCTU functional description.

Please note that once the SCTU block is opened, the Wireless CPU cannot enter the low power consumption mode until it is closed.

The prototype is:

```
s32 wm_sctuopen (    wm_sctuID_e        SctuID,
                     u8                 PrescalerValue,
                     u16                ReloadValue,
                     bool               OverflowItEnabled );
```

2.16.2.1 Parameters

SctuID:
SCTU block identifier, uses the following type.

```
typedef enum
{
    WM_SCTU1,          // SCTU block  #1
} wm_sctuID_e;
```

PrescalerValue:
Value to be reloaded in the 8 bits prescaler, each time the 0xFF value is reached.

ReloadValue:
Value to be reloaded in the 16 bits timer counter, each time the 0xFFFF value is reached.

OverFlowItEnabled:
Boolean value which controls the timer overflow interruption source. If this flag is set, the SCTU interruption is generated on each timer counter overflow.

2.16.2.2 Returned Values

- Positive or null SCTU handle on success, to be used with other SCTU API function calls.
- **WM_SCTU_BAD_TIMER_ID** on unknown SCTU identifier.
- **WM_SCTU_NOT_AVAILABLE** if the timer is already opened.

2.16.3 The wm_sctuClose function

The **wm_sctuClose** function allows the application to close a previously opened SCTU block.

The prototype is:

```
s32 wm_sctuClose (  s32      Handle );
```

2.16.3.1 Parameters

Handle:

SCTU block handle, previously returned by the **wm_sctuOpen** function.

2.16.3.2 Returned Values

- **OK** on success.
- **WM_SCTU_BAD_HANDLE** on unknown SCTU handle.

WM_SCTU_TIMER_IS_RUNNING if the timer is running.

2.16.4 The wm_sctuSetChannelConfig Function

The **wm_sctuSetChannelConfig** function allows the application to configure one of the required SCTU block comparator channels.

The prototype is:

```
s32 wm_sctuSetchannelConfig ( s32                    Handle,
                              wm_sctuChannelID_e     ChannelID,
                              u16                    CompareValue,
                              bool                   ItEnabled );
```

2.16.4.1 Parameters

Handle:

SCTU block handle, previously returned by the **wm_sctuOpen** function.

ChannelID:

Comparator channel identifier, using the following type:

```
typedef enum
{
    WM_SCTU_CHANNEL_0,  // Comparator channel  #0
    WM_SCTU_CHANNEL_1,  // Comparator channel  #1
    WM_SCTU_CHANNEL_2,  // Comparator channel  #2
    WM_SCTU_CHANNEL_3,  // Comparator channel  #3
} wm_sctuChannelID_e;
```

CompareValue:
Value to be monitored by the comparator channel.

ItEnabled:
Boolean value which controls the comparator channel interruption generation. If it is set, the SCTU interruption is generated each time and the timer counter value matches with the comparator channel.

2.16.4.2 Returned Values

- **OK** on success.
- **WM_SCTU_BAD_HANDLE** on unknown SCTU handle.
- **WM_SCTU_TIMER_IS_RUNNING** if the timer is running.
- **WM_SCTU_CHANNEL_ID_ERROR** on bad channel identifier.
- **WM_SCTU_CHANNEL_VALUE_ERROR** on bad channel value.

2.16.5 The wm_sctuStart Function

The **wm_sctuStart** function allows an application to start the SCTU block timer. Interruptions are about to be generated and notified to the interruption handler subscribed through the IRQ API.

The prototype is:

```
s32 wm_sctuStart ( s32        Handle,);
```

2.16.5.1 Parameters

Handle:
SCTU block handle, previously returned by the **wm_sctuOpen** function.

2.16.5.2 Returned Values

- **OK** on success.
- **WM_SCTU_BAD_HANDLE** on unknown SCTU handle.
- **WM_SCTU_TIMER_IS_RUNNING** if the timer is already running.
- **WM_SCTU_NO_DEFINED_HANDLER** if no interruption handler is defined for the SCTU source
- **WM_SCTU_NO_IRQ_ENABLED** if neither overflow nor comparator interruption sources have been enabled

2.16.6 The wm_sctuStop Function

The **wm_sctuStop** function allows an application to stop the SCTU block timer. SCTU interruptions are not generated anymore.

The prototype is:

```
s32 wm_sctuStop ( s32      Handle,);
```

2.16.6.1 Parameters

Handle:
SCTU block handle, previously returned by the **wm_sctuOpen** function.

2.16.6.2 Returned Values

- **OK** on success.
- **WM_SCTU_BAD_HANDLE** on unknown SCTU handle.
- **WM_SCTU_TIMER_IS_STOPPED** if the timer is already stopped.

2.16.7 The wm_sctuRead Function

The **wm_sctuRead** function allows an application to retrieve the interruption source mask, when an SCTU interruption occurs.

The prototype is:

```
s32 wm_sctuRead (    s32      Handle,
                     u8  *    Status );
```

2.16.7.1 Parameters

Handle:
SCTU block handle, previously returned by the **wm_sctuOpen** function

Status
Interruption source mask, when an SCTU interruption occurs. It is a bitwise operator OR of the constants (one or more) defined below.

Constant	Use
WM_SCTU_IT_SRC_OVERFLOW	Counter overflow interruption source
WM_SCTU_IT_SRC_COMP_CHANNEL_0	Comparator channel 0 interruption source
WM_SCTU_IT_SRC_COMP_CHANNEL_1	Comparator channel 1 interruption source
WM_SCTU_IT_SRC_COMP_CHANNEL_2	Comparator channel 2 interruption source
WM_SCTU_IT_SRC_COMP_CHANNEL_3	Comparator channel 3 interruption source

2.16.7.2 Returned Values

- **OK** on success.
- **WM_SCTU_BAD_HANDLE** on unknown SCTU handle.
- **WM_SCTU_NO_EVENT** if no interruption has occurred yet.

2.16.8 The wm_sctuAck Function

The **wm_sctuAck** function allows an application to acknowledge the SCTU interruption source mask, retrieved from the **wm_sctuRead** function. A given interruption source needs to be acknowledged, if not, it will never occur again.

The prototype is:

```
s32 wm_sctuAck (     s32      Handle,
                     u8  *    Status );
```

2.16.8.1 Parameters

Handle:
SCTU block handle, previously returned by the **wm_sctuOpen** function

Status:
Interruption source mask, previously returned by the **wm_sctuRead** function

2.16.8.2 Returned Values

- **OK** on success.
- **WM_SCTU_BAD_HANDLE** on unknown SCTU handle.
- **WM_SCTU_ACK_OUT_OF_RANGE** on bad acknowledgement mask value
- **WM_SCTU_ACK_BAD_VALUE** if the acknowledged event has not occurred yet (only warning)

2.17 RTC API

2.17.1 Required Header

This API is defined in the `wm_rtc.h` header file.
This file is included by `wm_apm.h`.

2.17.2 RTC Related Types

2.17.2.1 The wm_rtcTime_t Type

This type is the structure used by the Wavecom OS in order to retrieve the current RTC time. This type is defined below:

```
typedef struct
{
    u16  Year;             // Year (Four digits)
    u8   Month;            // Month (1-12)
    u8   Day;              // Day of the month (1-31)
    u8   Hour;             // Hour (0-23)
    u8   Minute;           // Minute (0-59)
    u8   Second;           // Second (0-59)
    u8   Pad;              // Not used
    u16 SecondFracPart;    // Second fractional part
} wm_rtcTime_t;
```

The second fractional part step matches $1/2^{15}$ (about 30.5 μs), since the most significant bit is not used.

2.17.2.2 The wm_rtcTimeStamp_t Structure

This type may be used in order to perform arithmetic operations on time data; it is defined below:

```
typedef struct
{
    u32 TimeStamp;         // Seconds elapsed since 1st January 1970
    u16 SecondFracPart;    // Second fractional part
} wm_rtcTimeStamp_t;
```

The timestamp uses the Unix format (seconds elapsed since January 1st, 1970).

The second fractional part step matches $1/2^{15}$ (about 30.5 μs), since the most significant bit is not used.

2.17.3 The wm_rtcGetTime Function

The wm_rtcGetTime function retrieves the current RTC time structure.

The prototype is:

```
s32  wm_rtcGetTime ( wm_rtcTime_t * TimeStructure );
```

2.17.3.1 Parameters

TimeStructure
The returned time structure.

2.17.3.2 Returned Value

- OK on success.
- A negative error value if the provided time structure is set to NULL.

2.17.4 The wm_rtcConvertTime function

This function is able to convert RTC time structure to timestamp structure, and timestamp structure to RTC time structure.
The prototype is:

```
s32  wm_rtcConvertTime ( wm_rtcTime_t *        TimeStructure,
                         wm_rtcTimeStamp_t *   TimeStamp,
                         wm_rtcConvert_e       Conversion );
```

2.17.4.1 Parameters

TimeStructure:
Input/output RTC time structure

TimeStamp:
Input/output timestamp structure

Conversion:
Conversion mode, using the type below:

```
typedef enum
{
    WM_RTC_CONVERT_TO_TIMESTAMP,
    WM_RTC_CONVERT_FROM_TIMESTAMP
} wm_rtcConvert_e;
```

WM_RTC_CONVERT_TO_TIMESTAMP
This mode allows to convert TimeStructure parameter to TimeStamp one.

WM_RTC_CONVERT_FROM_TIMESTAMP
This mode allows to convert TimeStamp parameter to TimeStructure one.

2.17.4.2 Returned Value

- OK on success.
- ERROR if conversion failed (internal error) or if one parameter value is incorrect.

2.18 VariSpeed API

The VariSpeed API allows the application to control the Wireless CPU clock speed.

2.18.1 The wm_vsSetClockSpeed function

The wm_vsSetClockSpeed function allows the application to control the Wireless CPU clock speed.

The prototype is:

```
s32 wm_vsSetClockSpeed ( wm_vsMode_e ClockMode );
```

2.18.1.1 Parameters

ClockMode

Clock mode to apply to the Wireless CPU

```
typedef enum
{
    WM_VS_MODE_STANDARD,  // Standard CPU clock mode
    WM_VS_MODE_BOOST,     // Boost CPU clock mode
} wm_vsMode_e;
```

For more information on the available modes, please refer to the ADL User Guide.

2.18.1.2 Returned Values

- **OK** on success.
- **ERROR** on any error (invalid parameter, or Real Time Enhancement feature not enabled on the Wireless CPU).

2.19 Semaphore API

The Semaphore API allows the application to handle the semaphore resources supplied by the Open AT OS.

2.19.1 The wm_semInit function

The wm_semInit function allows the application to set a semaphore counter initial value.

The prototype is:

```
s32 wm_semInit (    u8 SemId,
                    u16 SemValue);
```

2.19.1.1 Parameters

SemId
Semaphore identifier (between 0 and **WM_SEM_MAX_ID**).

SemValue
Semaphore counter initial value.

2.19.1.2 Returned Values

- **OK** on success.
- **ERROR** if the semaphore identifier is invalid.

2.19.2 The wm_semConsume Function

The **wm_semConsume** function allows to reduce the semaphore inner counter value by one. If this value falls under zero, the calling task is suspended until the semaphore is produced by another task.

The prototype is:

```
s32 wm_semConsume ( u8 SemId );
```

2.19.2.1 Parameters

SemId
Semaphore identifier (between 0 and **WM_SEM_MAX_ID**)

2.19.2.2 Returned Values

- **OK** on success.
- **ERROR** if the semaphore identifier is invalid.

Exceptions should be raised if the semaphore has been used too many times.

2.19.3 The wm_semConsumeDelay Function

The **wm_semConsumeDelay** function allows to reduce the semaphore inner counter value by one. If this value falls under zero, the calling task is suspended until the semaphore is produced by another task. Moreover, if the semaphore is not produced during the supplied time-out duration, the calling task is automatically resumed.

The prototype is:

```
s32   wm_semConsumeDelay (    u8 SemId,
                               u32 TimeOut);
```

2.19.3.1 Parameters

SemId

Semaphore identifier (between 0 and **WM_SEM_MAX_ID**).

TimeOut

Time to wait before resuming the calling task if the semaphore is not produced. Time unit is the 18.5 ms tick.

2.19.3.2 Returned Values

- **OK** on success.
- **ERROR** if the semaphore identifier is invalid.

Exceptions should be raised if the semaphore has been used too many times.

2.19.4 The wm_semProduce Function

The **wm_semProduce function** allows to increase the semaphore inner counter value by one. If this value raises over zero, every task suspended due to this semaphore consumption is resumed.

The prototype is:

```
s32 wm_semProduce ( u8 SemId );
```

2.19.4.1 Parameters

SemId

Semaphore identifier (between 0 and **WM_SEM_MAX_ID**)

2.19.4.2 Returned Values

- **OK** on success
- **ERROR** if the semaphore identifier is invalid.

Exceptions should be raised if the semaphore has been used too many times.

2.20 ExtInt API

2.20.1 The wm_extintOpen Function

The **wm_extintOpen** function allows the application to setup and configure an external interruption pin. Please refer to the ADL user guide for a complete External Interruption Pins functional description.

The prototype is:

```
s32 wm_extintOpen ( wm_extintID_e ExtIntID,
                    u8            Config );
```

2.20.1.1 Parameters

ExtIntID

External Interrupt pin identifier, using the following type.

```
typedef enum
{
    WM_EXTINT_PIN_0,   // External interrupt pin #0
    WM_EXTINT_PIN_1    // External interrupt pin #1
} wm_extintID_e;
```

Config

External interruption pin configuration; must be a bitwise operator OR combination of the following values:

Processing:

```
WM_EXTINT_PROCESSING_BYPASS       // No filter
WM_EXTINT_PROCESSING_STRETCHING   // Signal stretching
WM_EXTINT_PROCESSING_DEBOUNCE     // Debounce mode
WM_EXTINT_PROCESSING_BOTH_EDGE    // Both edges debounce mode
```

Debouncing duration (in ms steps)

```
WM_EXTINT_DEBOUNCING_DURATION(X)
```

Input polarity

```
WM_EXTINT_POLARITY_NORMAL
// Falling edge/low state interruption
WM_EXTINT_POLARITY_REVERSE
// Rising edge/high state interruption
```

2.20.1.2 Returned Values

- **OK** on success
- **ERROR** if the pin identifier is unknown, or if it is unavailable.

2.20.2 The wm_extintConfig Function

2.20.2.1 The wm_extintConfig Function Parameters

ExtIntID
External Interrupt pin identifier.

Config
External interruption pin configuration;.

2.20.2.2 Returned Values

- `OK` on success
- `ERROR` if the pin identifier is unknown, or if it is unavailable.

2.20.3 The wm_extintClose Function

The `wm_extintClose` function allows the application to close a previously opened ExtInt pin.

The prototype is:

```
s32 wm_extintClose ( wm_extintID_e ExtIntID );
```

2.20.3.1 Parameters

ExtIntID
External Interrupt pin identifier.

2.20.3.2 Returned Values

- `OK` on success
- `ERROR` if the pin identifier is unknown, or if it is unavailable.

2.20.4 The wm_extintRead Function

The `wm_extintRead` function allows the application to retrieve the external interruption pin status.

The prototype is:

```
s32 wm_extintRead ( wm_extintID_e ExtIntID );
```

2.20.4.1 Parameters

ExtIntID
External Interrupt pin identifier.

2.20.4.2 Returned Values

- Pin status (0/1) on success.
- `ERROR` if the pin identifier is unknown, or if it is unavailable.

2.21 DAC API

2.21.1 Required Header

This API is defined in the `wm_dac.h` header file.
This file is included by `wm_apm.h`.

2.21.2 The wm_dacOpen Function

The **`wm_dacOpen`** function allows to allocate the DAC block, and to set the initial value.

The prototype is:

```
s32 wm_dacOpen ( wm_dacChannel_e   Channel,
                 wm_dacParam_t *   Param );
```

2.21.2.1 Parameters

Channel

Identifier of the DAC channel to be opened, using the type below:

```
typedef enum
{
    WM_DAC_CHANNEL_1,
    WM_DAC_NUMBER_OF_CHANNEL,
    WM_DAC_CHANNEL_PAD = 0x7fffffff
} wm_dacChannel_e;
```

Channel identifiers depend on the current module type (please refer to the module Product Technical Specification document for more information):

Module type	Channel Identifier	Output DAC PIN Name	Output DAC PIN Number
Q2687	**`WM_DAC_CHANNEL_1`**	AUXDAC	82

Param

DAC channel initialization parameters, using the type below:

```
typedef struct {
    u32  InitialValue;
} wm_dacParam_t;
```

`InitialValue:`
Initial value to be written on the DAC just after it has been opened. Significant bits and output voltage depend on the module type (please refer to the module Product Technical Specification document for more information).

Module type	Significant bits	Max. output voltage
Q2687	8 less significant bits	2.2 V (for 0xFF value)

2.21.2.2 Returned values

- A positive or null handle on success, to be used with further DAC API function calls.
- A negative error value:
  - WM_DAC_CHANNEL_NOT_FREE if the required DAC channel has already been opened.
  - WM_DAC_NO_MORE_HANDLE_FREE if there is no free handle left for the DAC API.
  - Generic ERROR code in other cases (bad parameter, no DAC API on the current module, invalid DAC channel).

2.21.2.3 Notes

- The DAC API is only available on the Q2687 module.

2.21.3 The wm_dacWrite Function

This function allows to set the output value of the DAC block.

The prototype is:

```
s32 wm_dacWrite ( s32  Handle,
                  u32  Value );
```

2.21.3.1 Parameter

Handle

Handle previously returned by the **wm_dacOpen** function.

Value

Value to be written on the DAC. Significant bits and output voltage depend on the module type (please refer to the module Product Technical Specification document for more information).

Module Type	Significant Bits	Max. Output Voltage
Q2687	8 less significant bits	2.2 V (for 0xFF value)

2.21.3.2 Returned values

- OK on success
- Generic ERROR code in other cases (bad parameter, bad handle).

2.21.4 The wm_dacClose Function

This function closes a previously opened DAC block.

The prototype is:

```
s32 wm_dacClose ( s32 Handle )
```

2.21.4.1 Parameter

Handle

Handle previously returned by the **wm_dacOpen** function.

2.21.4.2 Returned values

- OK on success
- Generic ERROR code in other cases (bad handle).

3 Operation

There are three different operation modes, depending on the type of application. They are described in the following paragraphs.

3.1 Standalone External Application

This mode corresponds to the standard operation mode: no Embedded Application is active.

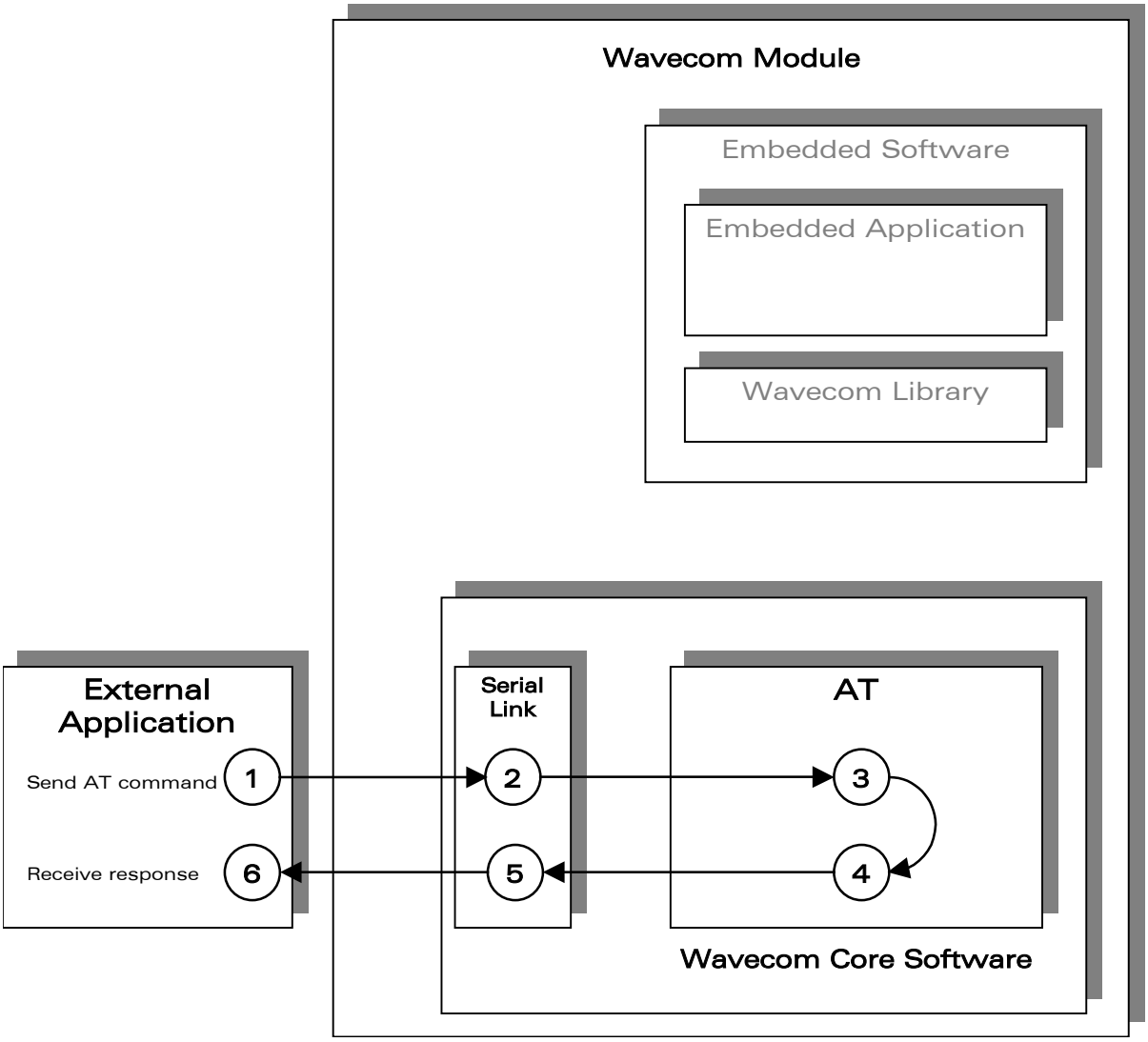


Figure 1: Standalone External Application Function

The steps are performed in the following sequence:

1) The External Application sends an AT command.
2) The serial link transmits the command to the AT processor function of the Wavecom OS.
3) The AT function processes the command.
4) The AT function sends an AT response to the External Application.
5) This response is sent through the serial link, and...
6) The External Application receives the response.

Note:
This mode is also compatible with the mode described in § 3.2, where the AT function is in charge of dispatching the responses to the appropriate application.

3.2 Embedded Application in Standalone Mode

This mode is based on an Embedded Application driving the GSM product independently.

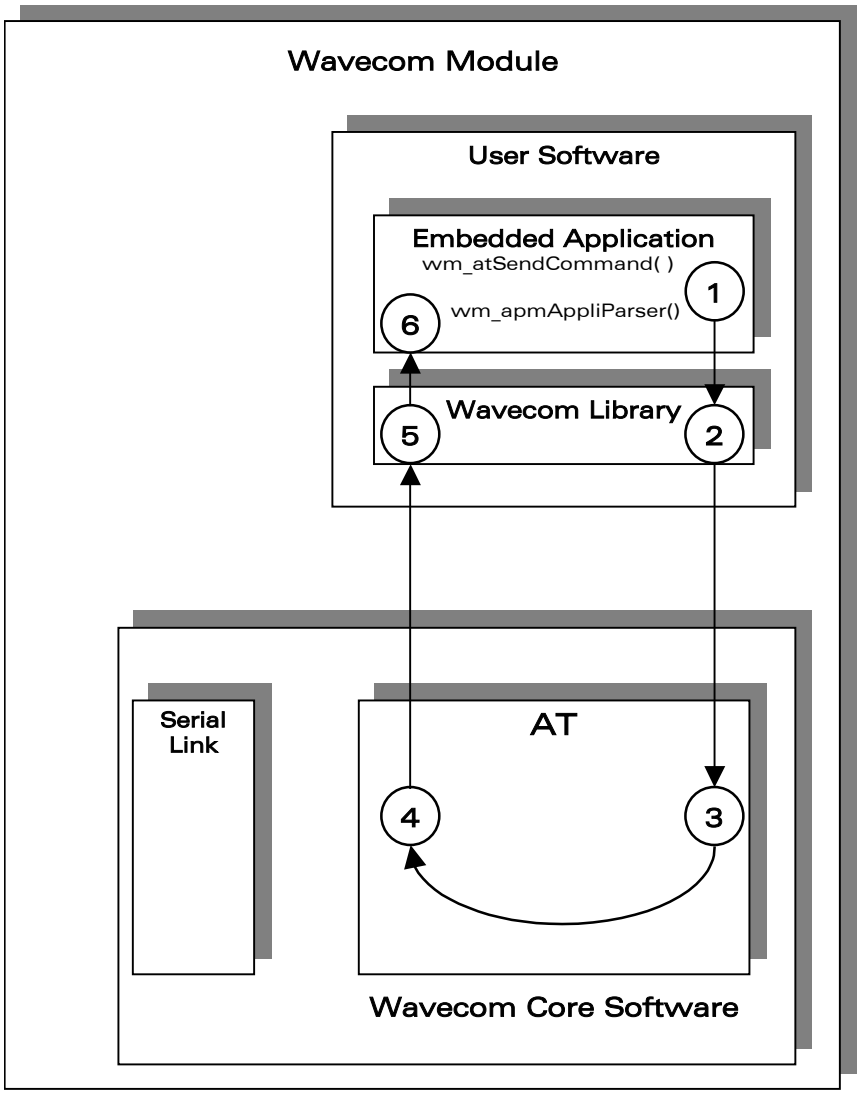


Figure 2: Embedded Application in Standalone Mode Function

The steps are performed in the following sequence:

1) The Embedded Application calls the "wm_atSendCommand" function to send an AT command.
   The response parameter is WM_AT_SEND_RSP_TO_EMBEDDED,
2) The Wavecom library calls the appropriate AT function from the Wavecom OS,
3) The AT function processes the command,
4) The AT function sends the AT response to the Embedded Application,
5) This response is dispatched by the Wavecom library which calls the "wm_apmAppliParser" function of the Embedded Application,
6) The "wm_apmAppliParser" function processes the response (the AT response is a parameter of the function). The Message type is WM_AT_RESPONSE.

Example: appli.c File of a Standalone Mode Embedded Application

```
/*************************************************/
/*  Appli.c   -  Copyright Wavecom S.A. (c) 2003 */
/*************************************************/

#include "wm_types.h"
#include "wm_apm.h"

#define TIMER 01

/*************************/
/*  Mandatory Functions   */
/*************************/

/***************************************/
/*  wm_apmAppliInit                    */
/* Embedded Application initialisation */
/***************************************/
s32 wm_apmAppliInit ( wm_apmInitType_e InitType )
{
    wm_osDebugTrace(1, "Embedded: Appli Init" );
    wm_osStartTimer ( TIMER, FALSE, WM_S_TO_TICK ( 2 ) );
    return OK;
}
```

```
/*****************************************/
/*  wm_apmAppliParser                    */
/* Embedded Application message parser */
/*****************************************/
s32 wm_apmAppliParser ( wm_apmMsg_t * pMessage )
{
    wm_osDebugTrace ( 1, "Embedded: Appli Parser" );

    switch ( pMessage->MsgTyp )
    {
        case WM_OS_TIMER:
            wm_osDebugTrace ( 1, "WM_OS_TIMER received" );
            if ( pMessage->Body.OSTimer.Ident == TIMER )
            {
                wm_atSendCommand ( 4, WM_AT_SEND_RSP_TO_EMBEDDED,
                                                    "AT\r" );
                wm_osDebugTrace ( 1, "Send command \"AT\\r\"" );
            }
        break;

        case WM_AT_RESPONSE:
            wm_osDebugTrace ( 1, "WM_AT_RESPONSE received" );
            if ( pMessage->Body.ATResponse.Type ==
                                    WM_AT_SEND_RSP_TO_EMBEDDED )
            {
                wm_osDebugTrace ( 1, "Response received:" );
                wm_osDebugTrace ( 1, pMessage->Body.ATResponse.StrData );
            }
        break;
    }

    return OK;
}
```

```
/*************************/
/*  Mandatory Variables   */
/*************************/

#define StackSize 1024
u32 Stack [ StackSize / 4 ];

// Tasks table
const wm_apmTask_t wm_apmTask [] =
{
{ StackSize, Stack, wm_apmAppliInit, wm_apmAppliParser },
{ 0,         NULL,  NULL,            NULL              },
{ 0,         NULL,  NULL,            NULL              }
};
```

Target Monitoring Tool traces with this example:

Trace	CUS	1	Embedded: Appli Init
Trace	CUS	1	Embedded: Appli Parser
Trace	CUS	1	WM_OS_TIMER received
Trace	CUS	1	Send command "AT\r"
Trace	CUS	1	Embedded: Appli Parser
Trace	CUS	1	WM_AT_RESPONSE received
Trace	CUS	1	Response received:
Trace	CUS	1	<CR><LF>OK<CR><LF>

3.3 Cooperative Mode

This mode corresponds to the interaction between an External Application and an Embedded Application.
Whenever the Embedded Application is configured to filter or spy **the commands** sent by the External Application, it can use the **command pre-parsing** mechanism.

Three types of subscription are available. They define the level of information required by the Embedded Application:

- The Embedded Application is not configured to filter or spy the commands sent by the External Application: this is done using WM_AT_CMD_PRE_WAVECOM_TREATMENT.
- The Embedded Application is configured to filter the AT commands sent by the External Application: this is done using WM_AT_CMD_PRE_EMBEDDED_TREATMENT.
  In this configuration, it is up to the Embedded Application to process or not the AT command and to send a response to the External Application.
- The Embedded Application is configured only to spy the AT commands sent by the External Application: this is done using WM_AT_CMD_PRE_BROADCAST.

Whenever the Embedded Application is configured to filter or spy the **responses** sent to the External Application, it can use the **response pre-parsing** mechanism.

Three types of subscription are available. They define the level of information required by the Embedded Application:

- The Embedded Application is not configured to filter or spy the responses sent to the External Application: this is done using WM_AT_RSP_PRE_WAVECOM_TREATMENT.
- The Embedded Application is configured to filter the AT responses sent to the External Application: this is done using WM_AT_RSP_PRE_EMBEDDED_TREATMENT.
  In this configuration, it is up to the Embedded Application to send a response to the External Application.
- The Embedded Application is configured only to spy the AT responses sent to the External Application: this is done using WM_AT_RSP_PRE_BROADCAST.

3.3.1 Command Pre-Parsing Subscription Mechanism: WM_AT_CMD_PRE_EMBEDDED_TREATMENT

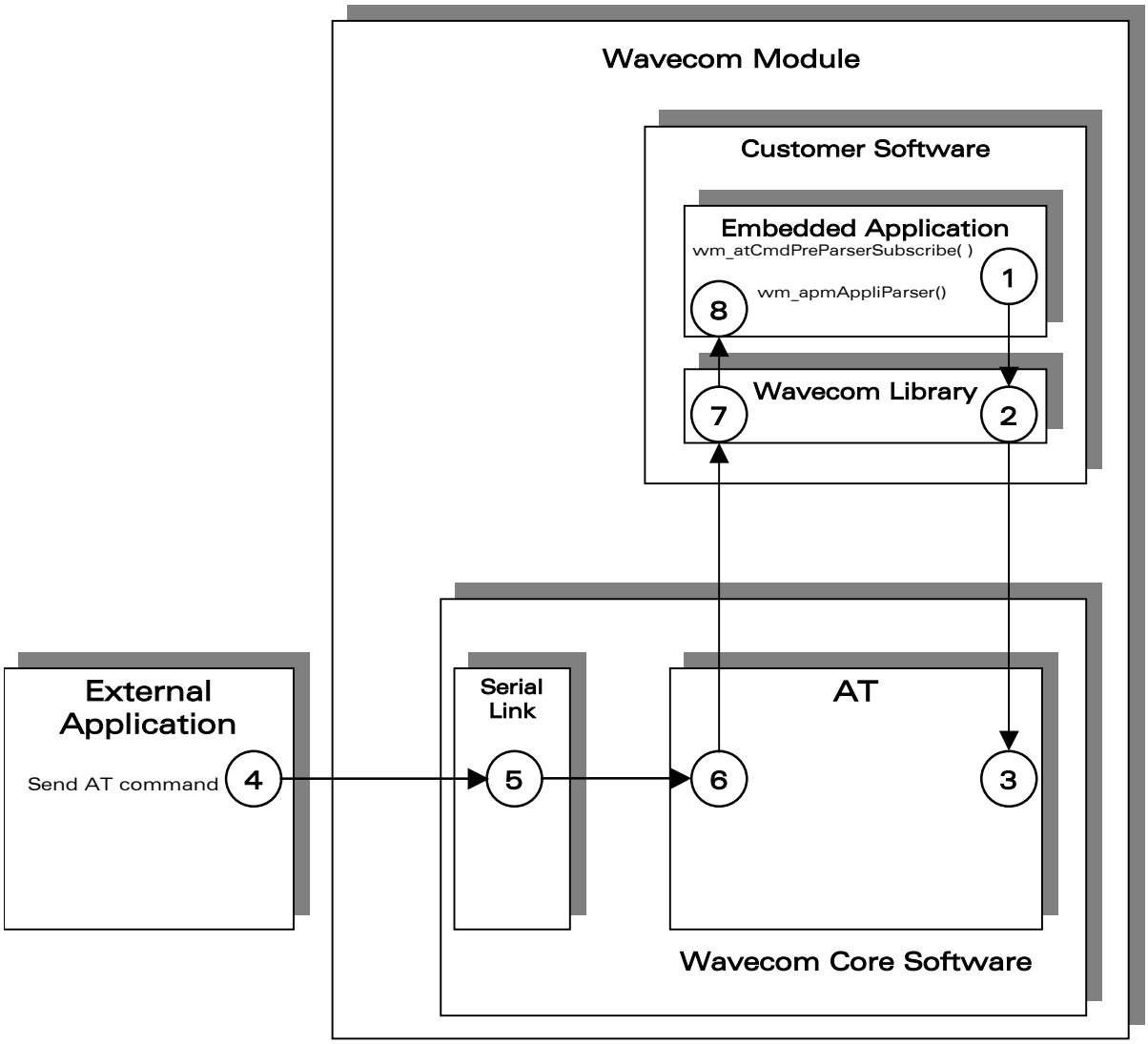


Figure 3: WM_AT_CMD_PRE_EMBEDDED_TREATMENT

The steps in a Pre-Parsing subscription are performed in the following sequence:

1) The Embedded Application subscribes to the command pre-parsing service, by calling the wm_atCmdPreParserSubscribe() function.
2) The Wavecom library calls the appropriate function from the Wavecom OS.
3) The AT function sets the subscription.

The steps in AT command processing are performed in the following sequence:

1) The External Application sends an AT command.
2) The serial link transmits the command to the AT processor function in the Wavecom OS.
3) The AT function does not process the command but transmits it to the Embedded Application.
4) The AT function does not process the command but transmits it to the Embedded Application.
5) The command is routed by the Wavecom library which calls the "wm_apmAppliParser" function of the Embedded Application (the Message type is WM_AT_CMD_PRE_PARSER).
6) This function processes the command: the parameters of the function include the AT command and an indication that the command comes from an External Application.

Example: appli.c file of a WM_AT_CMD_PRE_EMBEDDED_TREATMENT Mode Embedded Application
Example: appli.c file of a WM_AT_CMD_PRE_EMBEDDED_TREATMENT Mode Embedded Application

```
/*************************************************/
/*  Appli.c   -  Copyright Wavecom S.A. (c) 2003    */
/*************************************************/

#include "wm_types.h"
#include "wm_apm.h"

#define TIMER 01

/*************************/
/*  Mandatory Functions    */
/*************************/

/***********************************/
/*  wm_apmAppliInit                    */
/* Embedded Application initialisation */
/***********************************/
s32 wm_apmAppliInit ( wm_apmInitType_e InitType )
{
    wm_osDebugTrace(1, "Embedded: Appli Init" );
    wm_atCmdPreParserSubscribe (
                          WM_AT_CMD_PRE_EMBEDDED_TREATMENT );
    wm_osStartTimer ( TIMER, FALSE, WM_S_TO_TICK ( 2 ) );
    return OK;
}
```

```
/*************************************/
/*  wm_apmAppliParser                */
/* Embedded Application message parser */
/*************************************/
s32 wm_apmAppliParser ( wm_apmMsg_t * pMessage )
{
    wm_osDebugTrace ( 1, "Embedded: Appli Parser" );

    switch ( pMessage->MsgTyp )
    {
        case WM_OS_TIMER:
            wm_osDebugTrace ( 1, "WM_OS_TIMER received" );
        break;

        case WM_AT_CMD_PRE_PARSER:
            wm_osDebugTrace ( 1, "WM_AT_CMD_PRE_PARSER received" );
            if ( pMessage->Body.ATCmdPreParser.Type ==
                                    WM_AT_CMD_PRE_EMBEDDED_TREATMENT )
            {
                wm_osDebugTrace ( 1, "command received:" );
                wm_osDebugTrace ( 1, pMessage->Body.ATCmdPreParser.StrData
);

                if ( !wm_strncmp ( pMessage->Body.ATCmdPreParser.StrData,
                                            "AT-W", 4 ) )
                {
                    /* filter Specific embedded application command */
                    wm_osDebugTrace ( 1, "Specific embedded application
command" );

                    /* send response to external application */
                    wm_atSendRspExternalApp ( 10, "\r\n->WOK\r\n" );
                }
                else
                {
                    /* command must be treated by AT Software */
                    wm_osDebugTrace ( 1, "Wavecom OS command" );
                    wm_atSendCommand (
                            pMessage->Body.ATCmdPreParser.StrLength,
                           WM_AT_SEND_RSP_TO_EXTERNAL,
                           pMessage->Body.ATCmdPreParser.StrData );
                }
            }
        break;
    }

    return OK;
}
```

```
/*************************/
/*  Mandatory Variables   */
/*************************/

#define StackSize 1024
u32 Stack [ StackSize / 4 ];

// Tasks table
const wm_apmTask_t wm_apmTask [] =
{
{ StackSize, Stack, wm_apmAppliInit, wm_apmAppliParser },
{ 0,         NULL,  NULL,            NULL              },
{ 0,         NULL,  NULL,            NULL              }
};
```

An AT command log for the external application with this example:

```
AT
OK
AT-W
->WOK
```

Target Monitoring Tool traces with this example:

Trace	CUS	1	Embedded: Appli Init
Trace	CUS	1	Embedded: Appli Parser
Trace	CUS	1	WM_OS_TIMER received
Trace	CUS	1	Embedded: Appli Parser
Trace	CUS	1	WM_AT_CMD_PRE_PARSER received
Trace	CUS	1	command received:
Trace	CUS	1	AT<CR>
Trace	CUS	1	Wavecom OS command
Trace	CUS	1	Embedded: Appli Parser
Trace	CUS	1	WM_AT_CMD_PRE_PARSER received
Trace	CUS	1	command received:
Trace	CUS	1	AT-W<CR>
Trace	CUS	1	Specific embedded application command

3.3.2 Command Pre-Parsing Subscription Process: WM_AT_CMD_PRE_BROADCAST

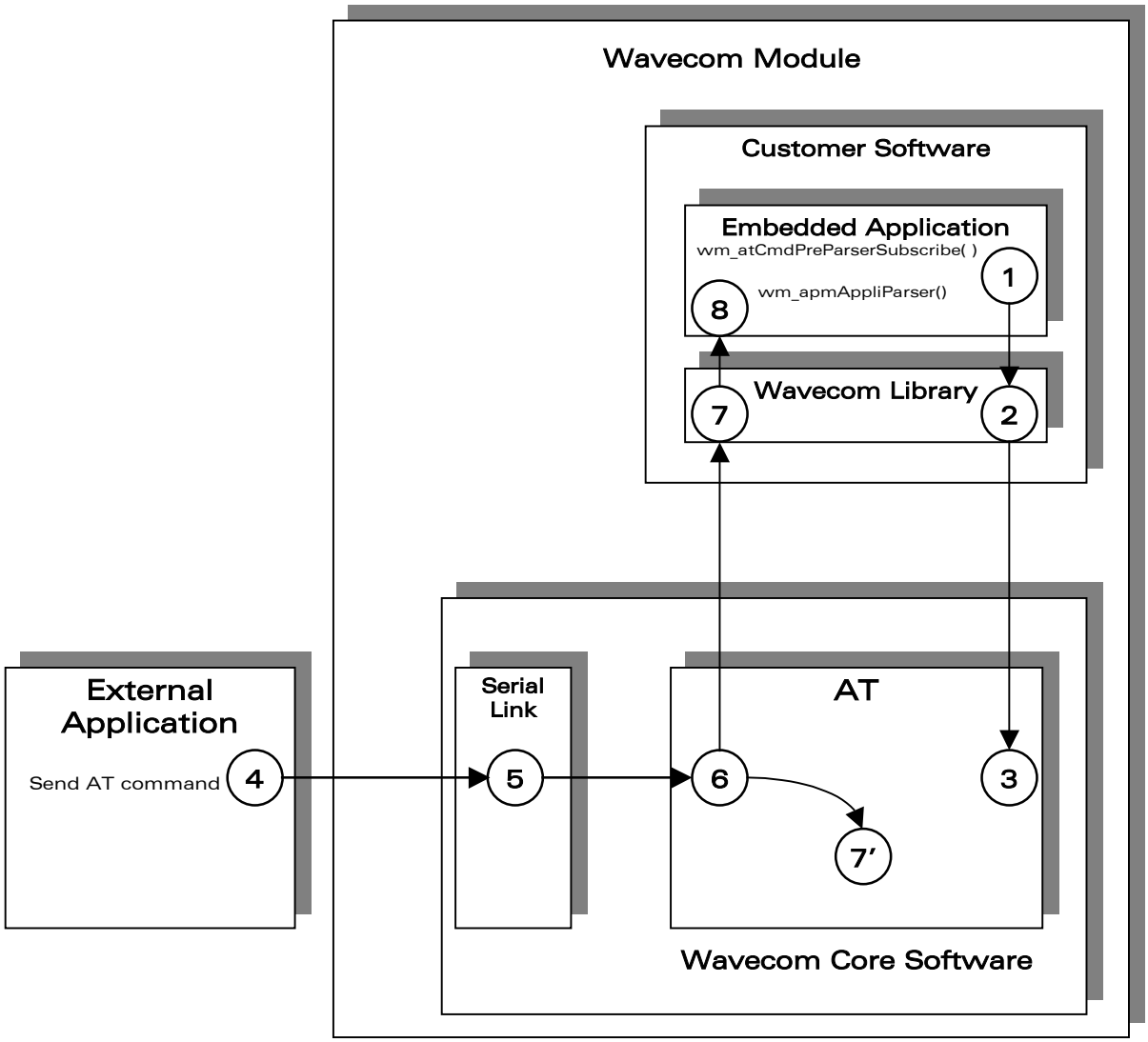


Figure 4: WM_AT_CMD_PRE_BROADCAST

The steps in a Pre-Parsing subscription are performed in the following sequence:

1) The Embedded Application subscribes to the command pre-parsing service, by calling the `wm_atCmdPreParserSubscribe()` function.
2) The Wavecom library calls the appropriate function in the Wavecom OS.
3) The AT function sets the subscription.

The steps in AT command processing are performed in the following sequence:

1) The External Application sends an AT command.
2) The serial link transmits the command to the AT function of the Wavecom OS.
3) This AT function checks the subscription status of the "external" AT command.
4) This external AT command is dispatched by the Wavecom library which calls the "wm_apmAppliParser" function of the Embedded Application,
7) Meanwhile, the AT function processes the command.
5) The "wm_apmAppliParser" function spies the command: the parameters include the AT command and the indication of whether or not the command is a copy (the Message type is WM_AT_CMD_PRE_PARSER).

Example: appli.c file of a WM_AT_CMD_PRE_BROADCAST Mode Embedded Application
Example: appli.c file of a WM_AT_CMD_PRE_BROADCAST Mode Embedded Application

```
/*********************************************/
/*  Appli.c   -  Copyright Wavecom S.A. (c) 2001    */
/*********************************************/

#include "wm_types.h"
#include "wm_apm.h"

#define TIMER 01

/*************************/
/*  Mandatory Functions    */
/*************************/

/***********************************/
/*  wm_apmAppliInit                          */
/* Embedded Application initialisation */
/***********************************/
s32 wm_apmAppliInit ( wm_apmInitType_e InitType )
{
    wm_osDebugTrace(1, "Embedded: Appli Init" );
    wm_atCmdPreParserSubscribe ( WM_AT_CMD_PRE_BROADCAST );
    wm_osStartTimer ( TIMER, FALSE, WM_S_TO_TICK ( 2 ) );
    return OK;
}
```

```
/***************************************/
/*  wm_apmAppliParser                  */
/* Embedded Application message parser */
/***************************************/
s32 wm_apmAppliParser ( wm_apmMsg_t * pMessage )
{
    wm_osDebugTrace ( 1, "Embedded: Appli Parser" );

    switch ( pMessage->MsgTyp )
    {
        case WM_OS_TIMER:
            wm_osDebugTrace ( 1, "WM_OS_TIMER received" );
        break;

        case WM_AT_CMD_PRE_PARSER:
            wm_osDebugTrace ( 1, "WM_AT_CMD_PRE_PARSER received" );
            if ( pMessage->Body.ATCmdPreParser.Type ==
                                                WM_AT_CMD_PRE_BROADCAST )
            {
                /* spy command sent by external application */
               wm_osDebugTrace  (  1,  "command  received  from  external
application" );
                wm_osDebugTrace  (  1,  pMessage->Body.ATCmdPreParser.StrData
);
            }
        break;
    }

    return OK;
}
```

```
/**************************/
/*  Mandatory Variables   */
/**************************/

#define StackSize 1024
u32 Stack [ StackSize / 4 ];

// Tasks table
const wm_apmTask_t wm_apmTask [] =
{
{ StackSize, Stack, wm_apmAppliInit, wm_apmAppliParser },
{ 0,         NULL,  NULL,            NULL              },
{ 0,         NULL,  NULL,            NULL              }
};
```

AT command log for the external application with this example:

```
at
OK
```

Target Monitoring Tool traces with this example:

Trace	CUS	1	Embedded: Appli Init
Trace	CUS	1	Embedded: Appli Parser
Trace	CUS	1	WM_OS_TIMER received
Trace	CUS	1	Embedded: Appli Parser
Trace	CUS	1	WM_AT_CMD_PRE_PARSER received
Trace	CUS	1	command received from external application
Trace	CUS	1	at<CR>

3.3.3 Response Pre-Parsing Subscription Process: WM_AT_RSP_PRE_EMBEDDED_TREATMENT

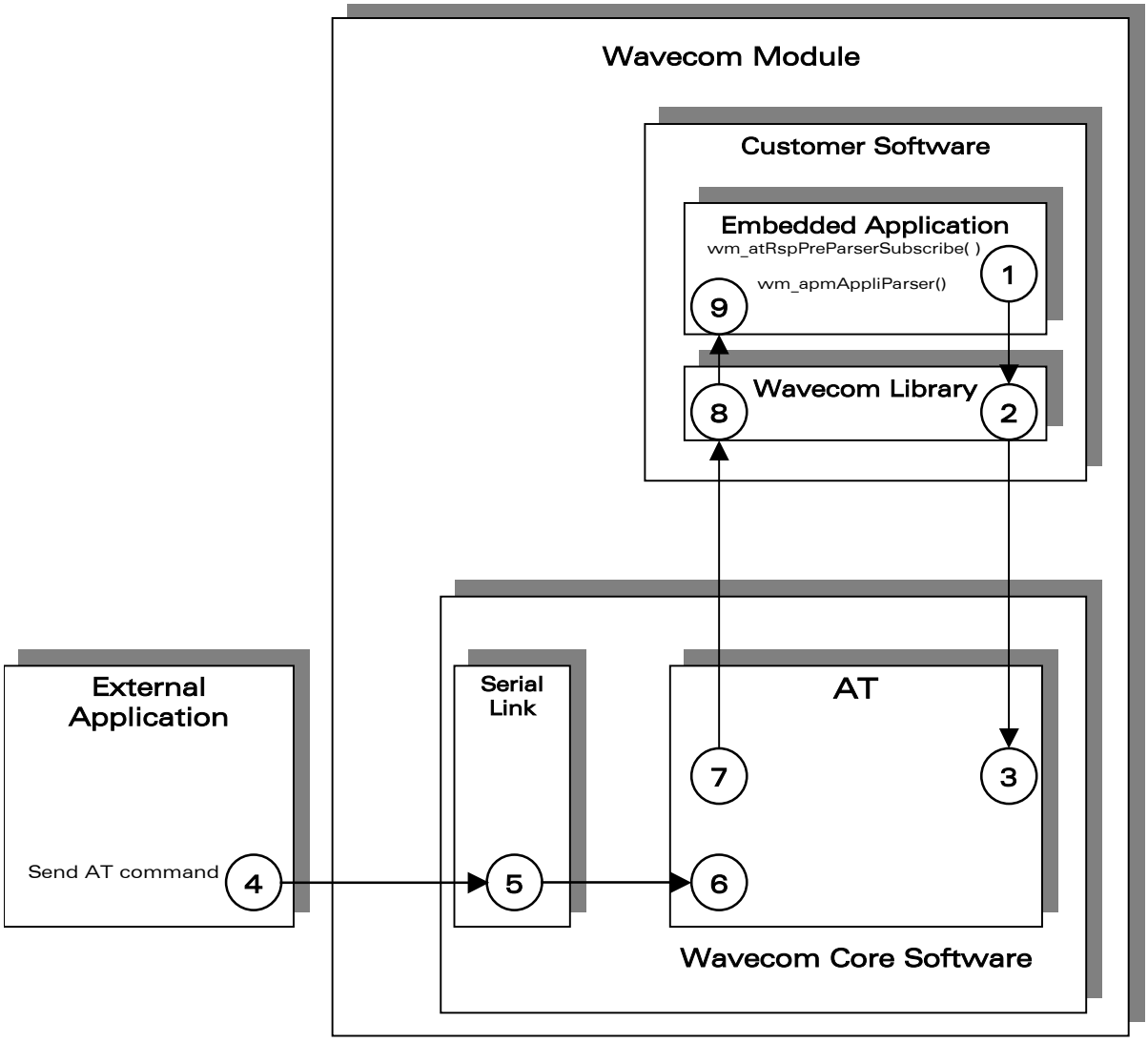


Figure 5: WM_AT_RSP_PRE_EMBEDDED_TREATMENT

The steps in a Pre-Parsing subscription are performed in the following sequence:

1) The Embedded Application subscribes to the response pre-parsing facility, by calling the `wm_atRspPreParserSubscribe()` function.
2) The Wavecom library calls the appropriate function from the Wavecom OS.
3) The AT function sets the subscription.

The steps in AT command processing are performed in the following sequence:

1) The External Application sends an AT command.
2) The serial link transmits the command to the AT function of the Wavecom OS.
3) This configuration does not rely on command pre–parsing. The AT function processes the command.
4) The AT function checks the subscription status of the response and does not send the response to the External Application. Instead, it sends the response to the Embedded Application.
5) The response is dispatched by the Wavecom library which calls the "`wm_apmAppliParser`" function of the Embedded Application (the Message type is WM_AT_RSP_PRE_PARSER).
6) This function processes the response (the parameters of the function include an indication of the response filtering).

Example: appli.c file of a WM_AT_RSP_PRE_EMBEDDED_TREATMENT Mode Embedded Application

```
/*********************************************/
/*  Appli.c   -  Copyright Wavecom S.A. (c) 2001    */
/*********************************************/

#include "wm_types.h"
#include "wm_apm.h"
#define TIMER 01

/*************************/
/*  Mandatory Functions    */
/*************************/
/***********************************/
/*  wm_apmAppliInit                          */
/* Embedded Application initialisation */
/***********************************/
s32 wm_apmAppliInit ( wm_apmInitType_e InitType )
{
    wm_osDebugTrace(1, "Embedded: Appli Init" );
   wm_atRspPreParserSubscribe ( WM_AT_RSP_PRE_EMBEDDED_TREATMENT );
    wm_osStartTimer ( TIMER, FALSE, WM_S_TO_TICK ( 2 ) );
    return OK;
}
```

```
/*****************************************/
/*  wm_apmAppliParser                    */
/* Embedded Application message parser */
/*****************************************/
s32 wm_apmAppliParser ( wm_apmMsg_t * pMessage )
{
    wm_osDebugTrace ( 1, "Embedded: Appli Parser" );

    switch ( pMessage->MsgTyp )
    {
        case WM_OS_TIMER:
            wm_osDebugTrace ( 1, "WM_OS_TIMER received" );
        break;

        case WM_AT_RSP_PRE_PARSER:
            wm_osDebugTrace ( 1, "WM_AT_RSP_PRE_PARSER received" );
            wm_osDebugTrace ( 1, pMessage->Body.ATRspPreParser.StrData );

            if ( pMessage->Body.ATRspPreParser.Type ==
                                    WM_AT_RSP_PRE_EMBEDDED_TREATMENT )
            {
                if ( !wm_strncmp ( "\r\nOK\r\n",
                           pMessage->Body.ATRspPreParser.StrData, 6 ) )
                {
                    wm_osDebugTrace ( 1, "OK response modified for external
                                                            application" );
                    wm_atSendRspExternalApp ( 10, "\r\n->WOK\r\n" );
                }
                else
                {
                    wm_osDebugTrace ( 1, "no modified response" );
                    wm_atSendRspExternalApp (
                pMessage->Body.ATRspPreParser.StrLength,
                         pMessage->Body.ATRspPreParser.StrData );
                }
            }
        break;
    }

    return OK;
}
```

```
/*************************/
/*  Mandatory Variables   */
/*************************/

#define StackSize 1024
u32 Stack [ StackSize / 4 ];

// Tasks table
const wm_apmTask_t wm_apmTask [] =
{
{ StackSize, Stack, wm_apmAppliInit, wm_apmAppliParser },
{ 0,         NULL,  NULL,            NULL              },
{ 0,         NULL,  NULL,            NULL              }
};
```

AT commands log for the external application with this example:

```
at
->WOK
at+wopen?
+WOPEN: 1
->WOK
```

Target Monitoring Tool traces with this example:

```
Trace   CUS   1   Embedded: Appli Init
Trace   CUS   1   Embedded: Appli Parser
Trace   CUS   1   WM_OS_TIMER received
Trace   CUS   1   Embedded: Appli Parser
Trace   CUS   1   WM_AT_RSP_PRE_PARSER received
Trace   CUS   1   <CR><LF>OK<CR><LF>
Trace   CUS   1   OK response modified for external application
Trace   CUS   1   Embedded: Appli Parser
Trace   CUS   1   WM_AT_RSP_PRE_PARSER received
Trace   CUS   1   <CR><LF>+WOPEN: 1<CR><LF>
Trace   CUS   1   no modified response
Trace   CUS   1   Embedded: Appli Parser
Trace   CUS   1   WM_AT_RSP_PRE_PARSER received
Trace   CUS   1   <CR><LF>OK<CR><LF>
Trace   CUS   1   OK response modified for external application
```

3.3.4 Response Pre-Parsing Subscription Process: WM_AT_RSP_PRE_BROADCAST

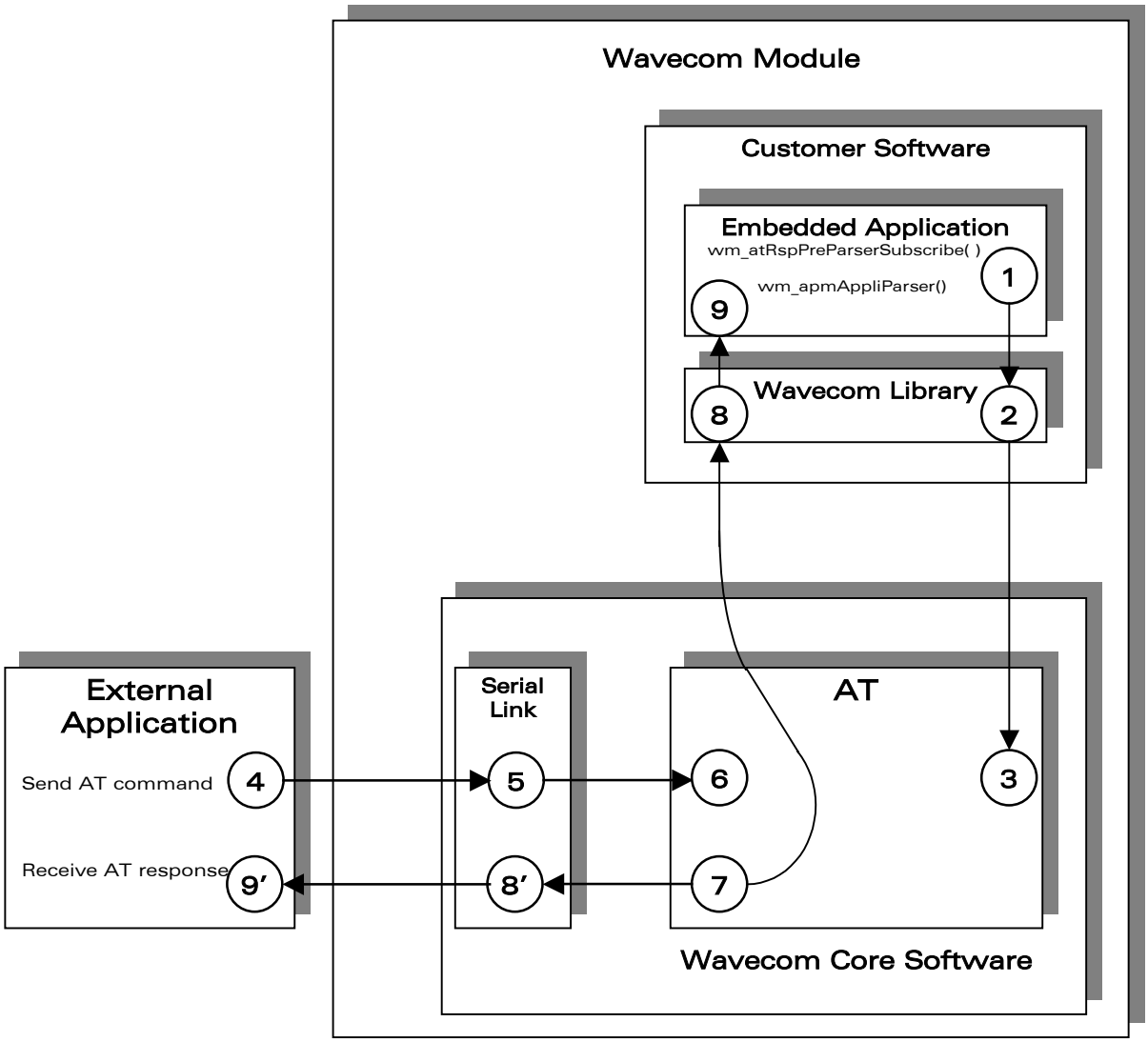


Figure 6: WM_AT_RSP_PRE_BROADCAST

The steps in a Pre-Parsing subscription are performed in the following sequence:

1) The Embedded Application subscribes to the response pre-parsing facility, by calling the `wm_atRspPreParserSubscribe()` function.
2) The Wavecom library calls the appropriate function in the Wavecom OS.
3) The AT function sets the subscription.

The steps in AT command processing are performed in the following sequence:

1) The External Application sends an AT command.
2) The serial link transmits the command to the AT function of the Wavecom OS.
3) This configuration does not rely on command pre–parsing. The AT function processes the command.
4) The AT function checks the subscription status of the response and sends it to both the External Application and the Embedded Application.
5) The response is dispatched by the Wavecom library, which calls the "wm_apmAppliParser" function of the Embedded Application (the Message type is WM_AT_RSP_PRE_PARSER).
6) This function processes the response (the parameters of the function include a broadcast response indication).
7) This response is sent through the serial link.
8) The External Application receives the response.

Example: appli.c file of a WM_AT_RSP_PRE_BROADCAST Mode Embedded Application

```
/*********************************************/
/*  Appli.c   -  Copyright Wavecom S.A. (c) 2001    */
/*********************************************/

#include "wm_types.h"
#include "wm_apm.h"
#define TIMER 01

/*************************/
/*  Mandatory Functions    */
/*************************/

/***********************************/
/*  wm_apmAppliInit                          */
/* Embedded Application initialisation */
/***********************************/
s32 wm_apmAppliInit ( wm_apmInitType_e InitType )
{
    wm_osDebugTrace(1, "Embedded: Appli Init" );
    wm_atRspPreParserSubscribe ( WM_AT_RSP_PRE_BROADCAST );
    wm_osStartTimer ( TIMER, FALSE, WM_S_TO_TICK ( 2 ) );
    return OK;
}
```

```
/*****************************************/
/*  wm_apmAppliParser                    */
/* Embedded Application message parser */
/*****************************************/
s32 wm_apmAppliParser ( wm_apmMsg_t * pMessage )
{
    wm_osDebugTrace ( 1, "Embedded: Appli Parser" );

    switch ( pMessage->MsgTyp )
    {
        case WM_OS_TIMER:
            wm_osDebugTrace ( 1, "WM_OS_TIMER received" );
        break;

        case WM_AT_RSP_PRE_PARSER:
            wm_osDebugTrace ( 1, "WM_AT_RSP_PRE_PARSER received" );

            if ( pMessage->Body.ATRspPreParser.Type ==
                                        WM_AT_RSP_PRE_BROADCAST )
            {
                /* spy response sent to external application */
                wm_osDebugTrace ( 1, "response sent to external
application" );
                wm_osDebugTrace (1,pMessage->Body.ATRspPreParser.StrData );
            }
        break;
    }

    return OK;
}
```

```
/*************************/
/*  Mandatory Variables   */
/*************************/

#define StackSize 1024
u32 Stack [ StackSize / 4 ];

// Tasks table
const wm_apmTask_t wm_apmTask [] =
{
{ StackSize, Stack, wm_apmAppliInit, wm_apmAppliParser },
{ 0,         NULL,  NULL,            NULL              },
{ 0,         NULL,  NULL,            NULL              }
};
```

AT command log for the external application with this example:

```
at
OK
```

Target Monitoring Tool traces with this example:

Trace	CUS	1	Embedded: Appli Init
Trace	CUS	1	Embedded: Appli Parser
Trace	CUS	1	WM_OS_TIMER received
Trace	CUS	1	Embedded: Appli Parser
Trace	CUS	1	WM_AT_RSP_PRE_PARSER received
Trace	CUS	1	response sent to external application
Trace	CUS	1	<CR><LF>OK<CR><LF>

3.3.5 Example: Embedded Application Using the Different Functioning Modes

```
/*************************************************/
/*  Appli.c   -  Copyright Wavecom S.A. (c) 2001    */
/*************************************************/

#include "wm_types.h"
#include "wm_apm.h"

#define TIMER 01

typedef enum
{
    STANDALONE,
    CMD_PREPARSING_EMBEDDED,
    CMD_PREPARSING_BROADCAST,
    RSP_PREPARSING_EMBEDDED,
    RSP_PREPARSING_BROADCAST,
} wm_AtMode_e;

/*************************/
/*  Global Variables           */
/*************************/

wm_AtMode_e AtMode = STANDALONE;
```

```
/*************************/
/*  Global Function             */
/*************************/

void AtAutomate(state)
{
  switch(state)
  {
  case STANDALONE:
    wm_osDebugTrace(1, "STANDALONE" );
    wm_atCmdPreParserSubscribe(WM_AT_CMD_PRE_WAVECOM_TREATMENT);
    wm_atRspPreParserSubscribe(WM_AT_RSP_PRE_WAVECOM_TREATMENT);
    wm_atSendRspExternalApp(16,"STANDALONE mode");
    wm_atSendRspExternalApp(18,"send an at command");
  break;

  case CMD_PREPARSING_EMBEDDED:
    wm_osDebugTrace(1, "CMD_PREPARSING_EMBEDDED" );
   wm_atCmdPreParserSubscribe(WM_AT_CMD_PRE_EMBEDDED_TREATMENT);
    wm_atRspPreParserSubscribe(WM_AT_RSP_PRE_WAVECOM_TREATMENT);
    wm_atSendRspExternalApp(29,"CMD_PREPARSING_EMBEDDED mode");
    wm_atSendRspExternalApp(18,"send an at command");
  break;

  case CMD_PREPARSING_BROADCAST:
    wm_osDebugTrace(1, "CMD_PREPARSING_BROADCAST" );
    wm_atCmdPreParserSubscribe(WM_AT_CMD_PRE_BROADCAST);
    wm_atRspPreParserSubscribe(WM_AT_RSP_PRE_WAVECOM_TREATMENT);
    wm_atSendRspExternalApp(30,"CMD_PREPARSING_BROADCAST mode");
    wm_atSendRspExternalApp(18,"send an at command");
  break;

  case RSP_PREPARSING_EMBEDDED:
    wm_osDebugTrace(1, "RSP_PREPARSING_EMBEDDED" );
    wm_atCmdPreParserSubscribe(WM_AT_CMD_PRE_WAVECOM_TREATMENT);
    wm_atRspPreParserSubscribe(WM_AT_RSP_PRE_EMBEDDED_TREATMENT);
    wm_atSendRspExternalApp(29,"RSP_PREPARSING_EMBEDDED mode");
    wm_atSendRspExternalApp(18,"send an at command");
  break;

  case RSP_PREPARSING_BROADCAST:
    wm_osDebugTrace(1, "RSP_PREPARSING_BROADCAST" );
    wm_atCmdPreParserSubscribe(WM_AT_CMD_PRE_WAVECOM_TREATMENT);
    wm_atRspPreParserSubscribe(WM_AT_RSP_PRE_BROADCAST );
    wm_atSendRspExternalApp(30,"RSP_PREPARSING_BROADCAST mode");
    wm_atSendRspExternalApp(18,"send an at command");
  break;

  default:
    wm_osDebugTrace(1, "mode unexpected" );
   break;
  }
}
```

```
/*************************/
/*  Mandatory Functions    */
/*************************/

/************************************/
/*  wm_apmAppliInit                 */
/* Embedded Application initialisation */
/************************************/
s32 wm_apmAppliInit ( wm_apmInitType_e InitType )
{
    wm_osDebugTrace(1, "Embedded: Appli Init" );
    wm_osStartTimer ( TIMER, FALSE, WM_S_TO_TICK ( 2 ) );
    return OK;
}

/***************************************/
/*  wm_apmAppliParser                  */
/* Embedded Application message parser */
/***************************************/
s32 wm_apmAppliParser ( wm_apmMsg_t * pMessage )
{
    wm_osDebugTrace ( 1, "Embedded: Appli Parser" );

    switch ( pMessage->MsgTyp )
    {
        case WM_OS_TIMER:
            wm_osDebugTrace ( 1, "WM_OS_TIMER received" );
            AtAutomate(AtMode);
            if (AtMode!=RSP_PREPARSING_BROADCAST)
            {
                AtMode++;
                wm_osStartTimer (TIMER, FALSE, WM_S_TO_TICK(10));
            }
        break;

        case WM_AT_RESPONSE:
            wm_atSendRspExternalApp( 33, "message WM_AT_RESPONSE
                                                    received:");
            wm_strncpy(strReceived, pMessage->Body.ATResponse.StrData,
                                pMessage->Body.ATResponse.StrLength);
            strReceived[pMessage->Body.ATResponse.StrLength] = '\0';
            wm_atSendRspExternalApp( pMessage->Body.ATResponse.StrLength+1,
                                                    strReceived );
        break;

        case WM_AT_CMD_PRE_PARSER:
            wm_atSendRspExternalApp(39, "message WM_AT_CMD_PRE_PARSER
                                                    received:");
            wm_strncpy(strReceived, pMessage->Body.ATCmdPreParser.StrData,
                                pMessage->Body.ATCmdPreParser.StrLength);
            strReceived[pMessage->Body.ATCmdPreParser.StrLength] = '\0';
            wm_atSendRspExternalApp(pMessage->Body.ATResponse.StrLength+1,
                                                    strReceived );
        break;
```

```
        case WM_AT_RSP_PRE_PARSER:
            wm_atSendRspExternalApp(39, "message WM_AT_RSP_PRE_PARSER
                                                              received:");
            wm_strncpy(strReceived, pMessage->Body.ATRspPreParser.StrData,
                                pMessage->Body.ATRspPreParser.StrLength);
            strReceived[pMessage->Body.ATRspPreParser.StrLength] = '\0';
            wm_atSendRspExternalApp(pMessage->Body.ATResponse.StrLength +
                                        1, strReceived );
        break;
    }

    return TRUE;
}
```

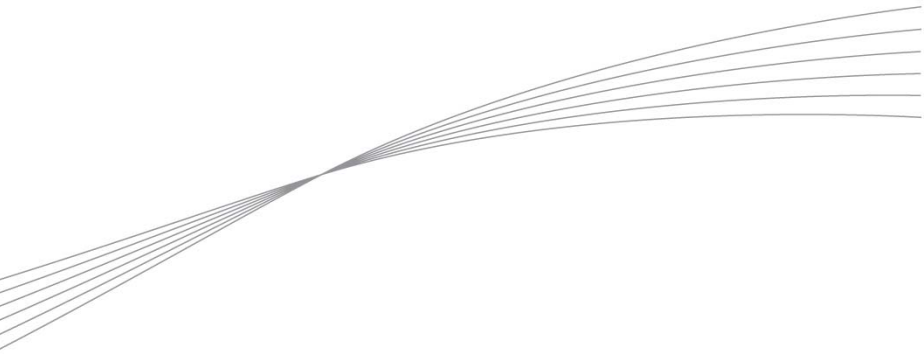
```
/*************************/
/*  Mandatory Variables   */
/*************************/

#define StackSize 1024
u32 Stack [ StackSize / 4 ];

// Tasks table
const wm_apmTask_t wm_apmTask [] =
{
{ StackSize, Stack, wm_apmAppliInit, wm_apmAppliParser },
{ 0,         NULL,  NULL,            NULL              },
{ 0,         NULL,  NULL,            NULL              }
};
```

AT command log for the external application with this example:

```
STANDALONE mode
at                  no interaction between external
OK                  and embedded application

CMD_PREPARSING_EMBEDDED mode
send an at command
at                  command sent to embedded application
message WM_AT_CMD_PRE_PARSER received:
at                  and not to Wavecom AT Software

CMD_PREPARSING_BROADCAST mode
send an at command
at                  command sent to both
OK                  response of Wavecom AT Software
message WM_AT_CMD_PRE_PARSER received:
at                  command received by embedded application

RSP_PREPARSING_EMBEDDED mode
send an at command
at                  command sent to Wavecom AT Software
message WM_AT_RSP_PRE_PARSER received:
OK                  response sent to embedded application

RSP_PREPARSING_BROADCAST mode
send an at command
at                  command sent to Wavecom AT Software
OK                  response sent to external application
message WM_AT_RSP_PRE_PARSER received:
OK                  response sent to embedded application
```

Target Monitoring Tool traces with this example:

```
Trace   CUS   1   Embedded: Appli Init
Trace   CUS   1   Embedded: Appli Parser
Trace   CUS   1   WM_OS_TIMER received
Trace   CUS   1   STANDALONE
Trace   CUS   1   Embedded: Appli Parser
Trace   CUS   1   WM_OS_TIMER received
Trace   CUS   1   CMD_PREPARSING_EMBEDDED
Trace   CUS   1   Embedded: Appli Parser
Trace   CUS   1   Embedded: Appli Parser
Trace   CUS   1   WM_OS_TIMER received
Trace   CUS   1   CMD_PREPARSING_BROADCAST
Trace   CUS   1   Embedded: Appli Parser
Trace   CUS   1   Embedded: Appli Parser
Trace   CUS   1   WM_OS_TIMER received
Trace   CUS   1   RSP_PREPARSING_EMBEDDED
Trace   CUS   1   Embedded: Appli Parser
Trace   CUS   1   Embedded: Appli Parser
Trace   CUS   1   WM_OS_TIMER received
Trace   CUS   1   RSP_PREPARSING_BROADCAST
Trace   CUS   1   Embedded: Appli Parser
```



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