APPLICATION NOTE 503

Advanced remote management example with ESP2 and ESP3 inclusive 2 channel learn mode

June 1, 2011

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1 Introduction

1.1 Notation

- **RPC** - Remote Procedure Call
- **RMCC** - Remote Management Control Command – is a RPC that provides the basic functionality for Remote Management.

1.2 Purpose

This application note will explain:

- Different implementation of TCM300 Mode 2 functionality.
- Implementation of a task based application
- Implementation of a learn table
- The usage of Remote management concept with advanced learn functionality
- How to provide configuration interface of the application using DolphinStudio
- The usage of both serial protocols ESP2 and ESP3

The purpose is to demonstrate the concept in an actual implementation using an as simple as possible setup. It's not intended as ready to be used as production software, providing a full implementation for such a type of application. But the demo and description should be a tutorial and suitable for further enhancements and modifications and should be a good starting point for own Remote Management development projects. For a deeper understanding of the Remote Management concept please see **[1.] Remote Management specification**, . The resulting application demonstrates how to use custom RPCs and how to build a task-oriented solution.

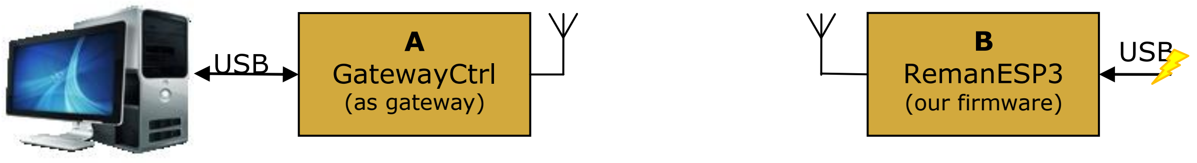
NOTE:
The software AN503RemanESP3 which is part of this application note is provided on an "AS-IS" basis.

2 Demo system

To reproduce our demo scenario following components are required:

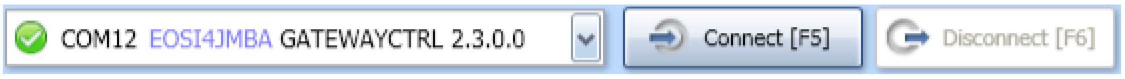
Setup:

- EVA300-3 with a module containing GatewayCtrl firmware (A)
- EVA300-3 with RemanESP3 firmware (B)
- DolphinView (3.1.1.0 or newer) application on PC
- DolphinAPI (2.2.1.0 or newer)

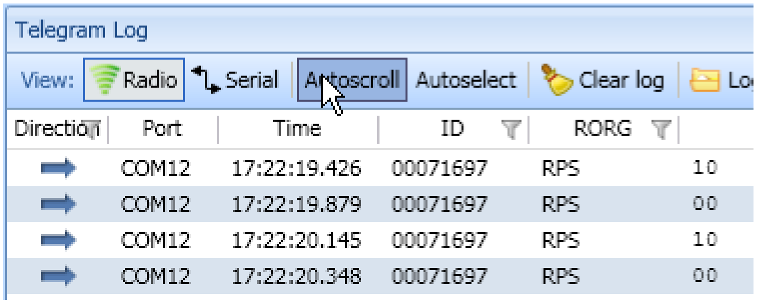


Step-by-step:

1. Copy the **DolphinView.Modules.APIExamples.dll** to DolphinView directory.
2. Download the GatewayCTRL firmware to the module A (using DolphinView)
3. Copy the RemanESP3 to the Example directory of the installed DolphinAPI
4. Compile the firmware and download it to module B
5. Disconnect the EVA board of module B from the programmer and provide power to the EVA using the J1 USB port
6. Start DolphinView, select serial port of EVA board and pres Connect

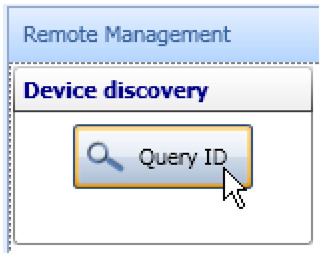


7. Press a PTM200 switch several times. The telegrams should appear in DolphinView telegram view window. The gateway works.

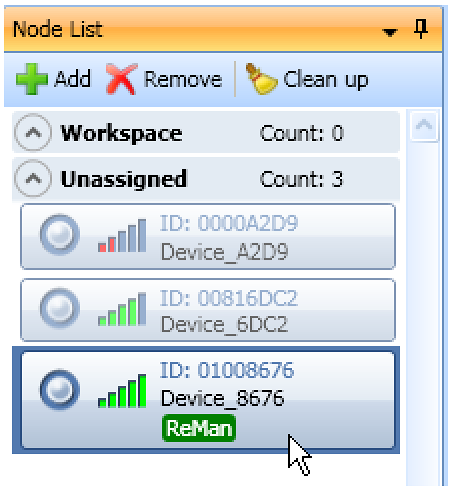


Direction	Port	Time	ID	RORG	
➡	COM12	17:22:19.426	00071697	RPS	10
➡	COM12	17:22:19.879	00071697	RPS	00
➡	COM12	17:22:20.145	00071697	RPS	10
➡	COM12	17:22:20.348	00071697	RPS	00

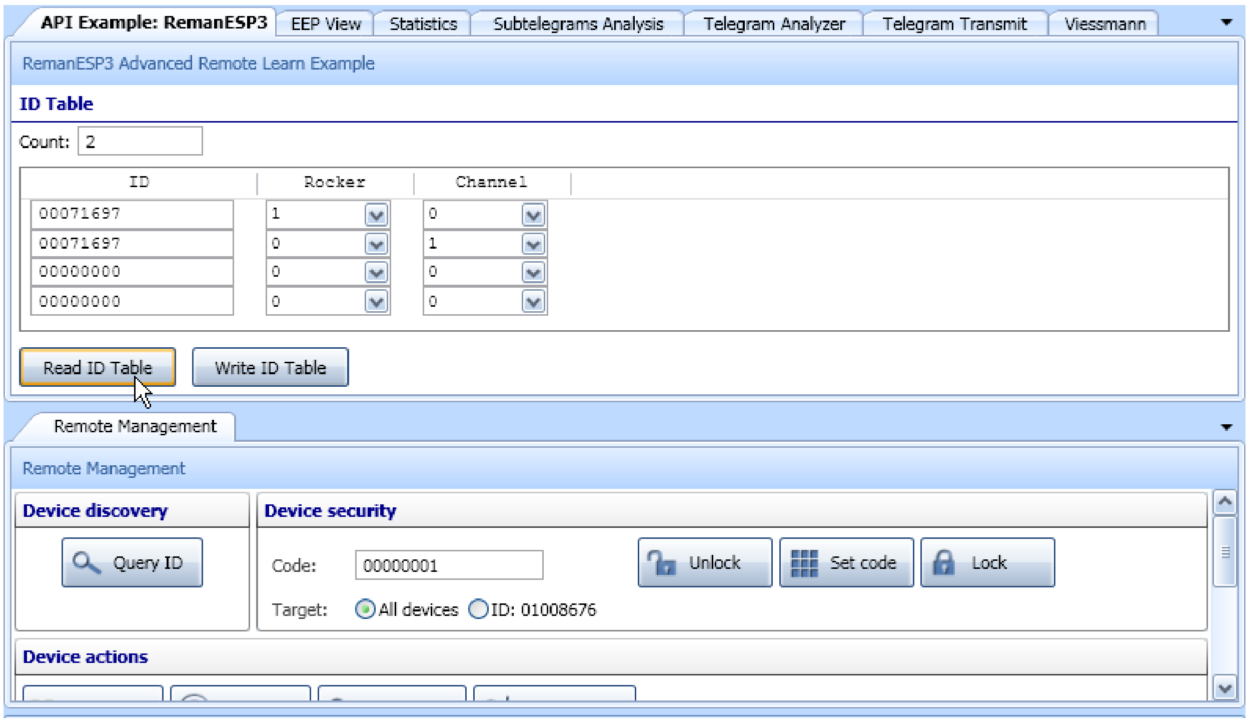
8. Press QueryID to query our Advanced RemoteManagement device. NOTE: The device will be automatically locked after 30 minutes.



9. Our device should respond to the QueryID and it should be visible in the Node List. Select the device using left mouse click.



10. Now we can read the ID table from the device. Select the module 'API Example: RemanESP3' and press 'Read ID Table'.



ID Table

Count: 2

ID	Rocker	Channel
00071697	1	0
00071697	0	1
00000000	0	0
00000000	0	0

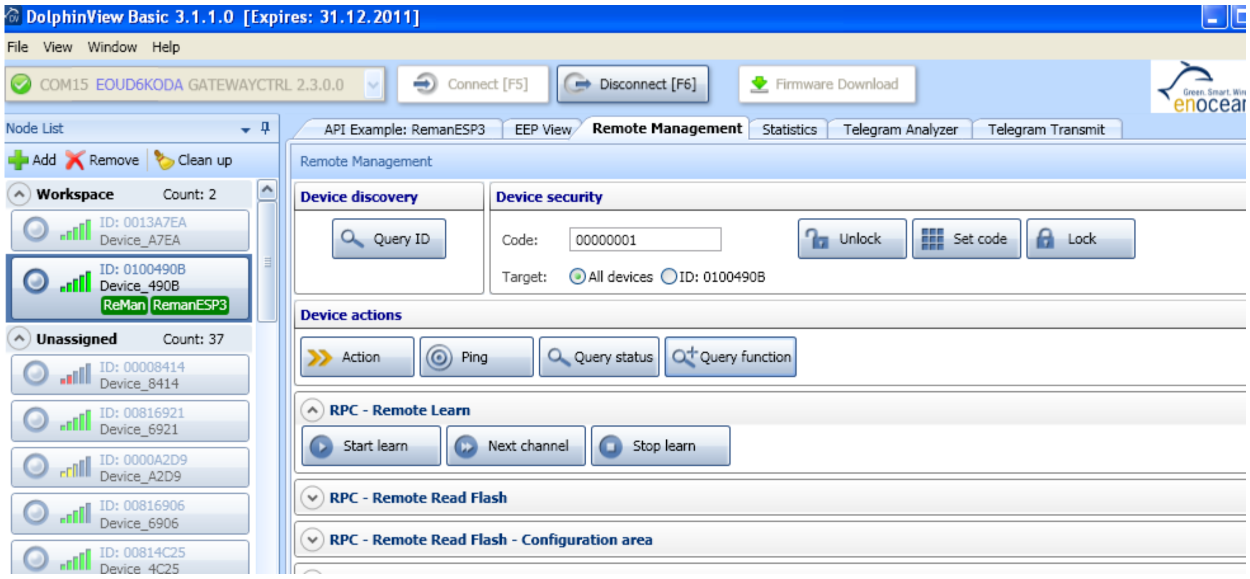
Code: 00000001

Target: [✓ All devices] ID: 01008676

'Read ID Table' function sends the RM_FN_IDTABLE_READ message to the selected device. We already selected the device in step 4.

Now you can modify the ID Table and write it back to our device. Note that the 'Count' value is also important as it defines how many ID entries are valid.

There is much more functionality of remote management embedded in the application as for instance all the remote management control commands (RMCC) as unlock, set-code, lock, action, ping, query function, etc. The functionality is implemented but not described in this document. The functionality can be demonstrated using the Remote Management tab in DolphinView.



Code: 00000001

Target: [✓ All devices] ID: 0100490B

3 Demo application explained

The demo application provides similarly functionality as TCM300 in Mode 3. However the source code is not based on TCM300 project but is completely rewritten and unlike TCM300 it uses task based approach. Following features are implemented:

- 2-channel relay
- Bidirectional radio to serial gateway
- Teach-in capability for up to 30 entries
- Remote management

Additionally to Mode 3 functionality the application also implements:

- Advanced RemoteLearn
- ESP2 and ESP3 protocol

At this point we briefly explain what the difference between standard RemoteLearn and Advanced RemoteLearn is. RemoteLearn as specified in EnOcean System Specification allows to 'press Learn button' by remote command. That means the TCM300 only switches to learn mode and the user has to press PTM200 switch manually.

To demonstrate the possibilities of remote management we introduced the Advanced Remote Learn concept. Behind the scene a custom RPC was added to allow remote access to id_table. In id_table the information about learned-in rockers are stored. Providing remote access to the id_table enables us to remove or learn-in new rocker switches without physically pressing the PTM200 switch buttons. We can also download or upload the whole id_table per remote. This way we could even backup the whole building setup. In case that a TCM300-like device fails it can be easily replaced and the corresponding id_table can be uploaded in no-time.

3.1 Data model

Before we describe the functional block of our demo application we take a look at data structures used. The most important data structure is the id_table. It stores all information about rockers switches learned-in.

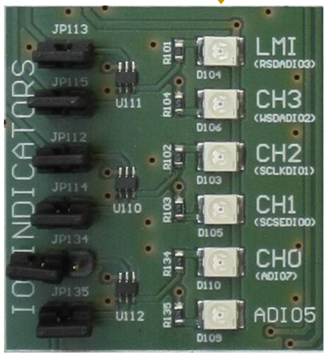
Code (mod_id.h):

```
typedef struct
{
      uint8       u8Rocker;
      uint8       u8Channel;
      uint8       u8Choice;
      uint32      u32Id;
} ID_ENTRY_TYPE;

ID_ENTRY_TYPE     id_table[ID_MAX_COUNT];
```

Example of id_table[]:

Index	u8Rocker	u8Choice	u32Id	u8Channel
0	0x00	0xA3	0x12345678	0x00
1	0x02	0xA3	0x12345678	0x01

PTM200



EVA300-3

Switch scenario step-by-step:

1. The PTM200 rocker is pressed and RPS telegram is sent:

Choice	Rocker	ID				Status
0xA3	0x30	0x12	0x34	0x56	0x78	0x00

Bit.7	Bit.6	Bit.5	Bit.4	Bit.3	Bit.2	Bit.1	Bit.0
Rocker 1st action			Energy bow	Rocker 2nd action			2nd action
0: AI 1: A0 2: BI 3: B0			0: Released 1: Pressed	0: AI 1: A0 2: BI 3: B0			0: no 2nd action 1: 2nd action valid

The 'Rocker 1st action value' is the only information we store in u8Rocker attribute in id_table[].

For more information about the RPS telegram data byte interpretation refer to EnOcean Equipment Profile documentation.

2. Telegram is received by our application.
3. The id_table[] is searched for all entries that match rocker, choice and ID. The LSB of u8Rocker byte signalizes whether a O or I on the rocker was pressed. Therefore when comparing u8Rocker information a 0xFE mask is used.

4. For each entry found the corresponding channel pins are set. The LSB of u8Rocker specifies the pin value (0 or 1). So if we press "I" on the left rocker the LED on CH0 is switchen ON – pin is set to 1. If we press "I" on the right rocker the LED on CH1 is switchen ON – pin is set to 1.

Code snippet for converting a RPS telegram to ID_ENTRY_TYPE (id_mod.c):

```
// In function: id_convTel(..)
switch (tel->raw.bytes[0])
{
  case RADIO_CHOICE_RPS:
       entry->u8Rocker  = tel->trps.u8Data >> 5;
       entry->u32Id     = tel->trps.u32Id;
       *u8Pressed       = (tel->trps.u8Data >> 4) & 1;
       *u8Value         = (tel->trps.u8Data >> 5) & 1;
       break;
```

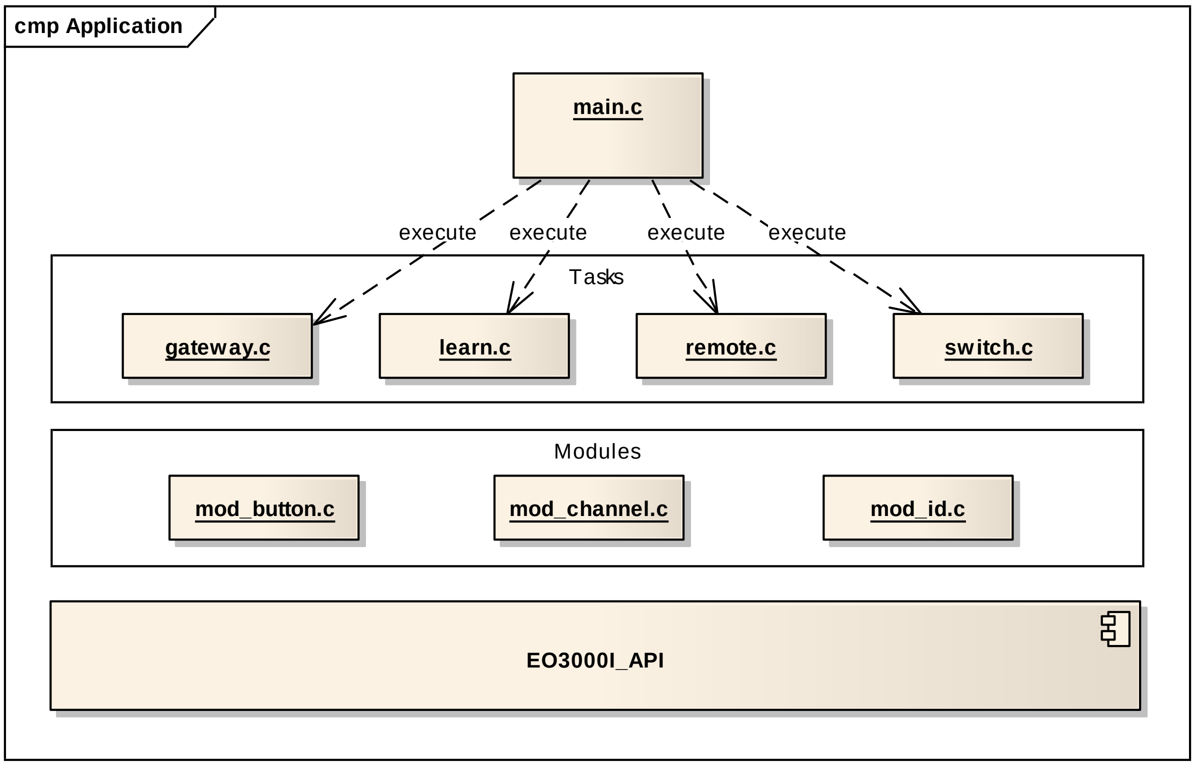
Code snippet for controlling the channels (switch.c):

```
// Set all channels from id_table
for (i=0; i<u8IdCount; i++)
{
  if ( id_table[i].u32Id    == entry.u32Id &&
       id_table[i].u8Choice == entry.u8Choice &&
      (id_table[i].u8Rocker & 0xFE) == (entry.u8Rocker & 0xFE))
      channel_set(id_table[i].u8Channel, bValue);
}
```

This code sets the channels according to received telegram. The *entry* structure contains all required information that was extracted from received telegram. For more information refer to *id_convTel()* function in *id_mod.c*. The variable bValue contains the LSB of u8Rocker byte.

3.2 Tasks

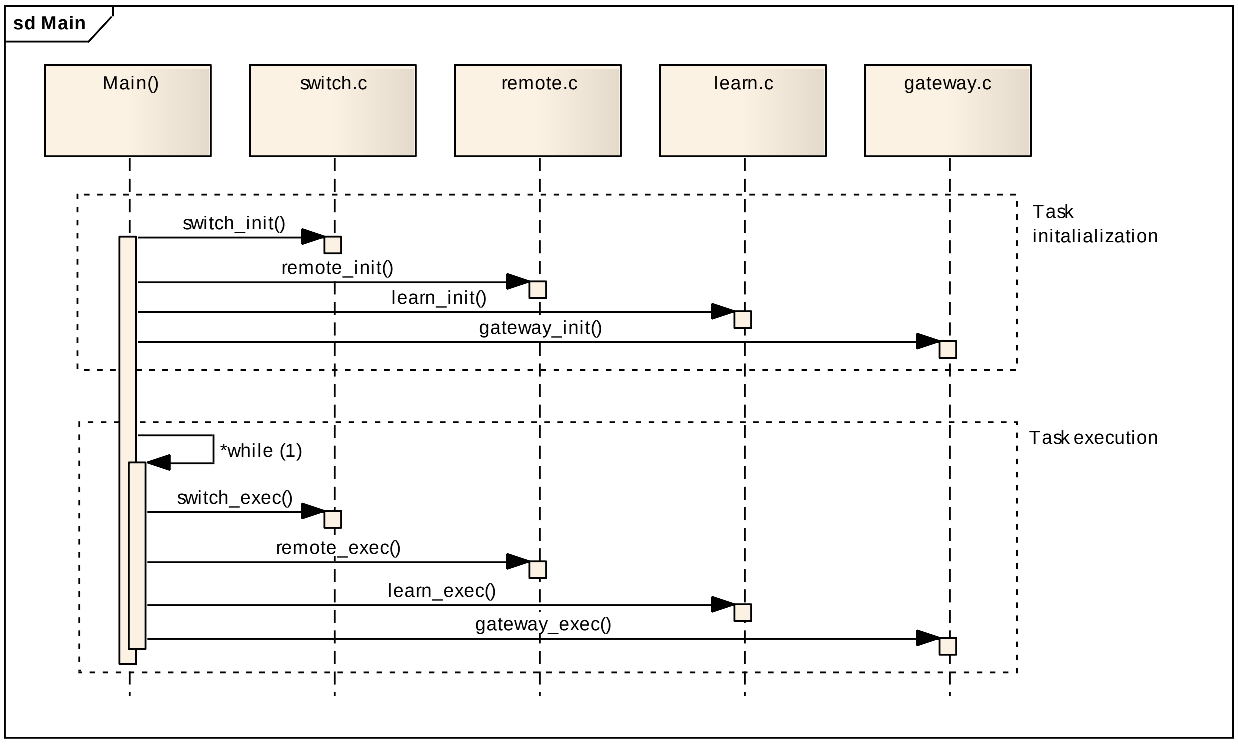
The application uses a task based approach to reduce the complexity of the implementation. Dividing application functionality into multiple well defined tasks provides more flexibility as well as more control over the application behaviour. Following diagram shows the 3 application layers.



3.2.1 Main (main.c)

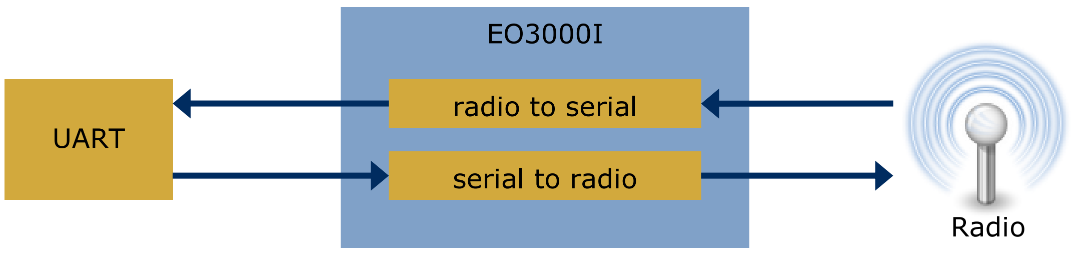
The application entry point. It initializes EO3000I peripherals, API modules and also all application tasks. Application tasks are executed periodically in main loop. The main application loop is the only place where radio_getTelegram() function is called. The result of radio_getTelegram() is stored to global application context (gContext). This is because multiple tasks are interested in the last received telegram.

Dividing application to tasks provides great flexibility and modularity. New tasks (e.g. Dimmer) can be easily added or removed according to current requirements. Each task provides custom functionality that can be enabled or disabled on runtime in main loop.



3.2.2 Gateway task (gateway.c)

Handles radio to serial and serial to radio communication. It supports both ESP2 and ESP3 protocol.



3.2.3 Learn task (learn.c)

Handles learn-in, learn-out of rocker switches. Supports both manual and remote learn.

Provides a set of function to control the learn functionality. These are used internally by the Learn task itself as well as by the RemoteManagement module to trigger the remote learn function.

3.2.4 Switch task (switch.c)

Switches channels CH0 to CH4 according to received radio telegram. Searches the whole id_table and operates all channels that are learned-in as described in section **Switch scenario step-by-step**, chapter 2.1**.** If a new telegram is received, the switch module looks in the id_table. If an entry that corresponds to received telegram is found then the channel is switched on/off.

3.2.5 Button module (mod_button.c)

The module provides structures and functions for capturing a push button input. The btn_getState() function is a state machine that captures input from physical pin and transforms it into button state. The state machine can filter peaks or bad contacts on the push button.

3.2.6 IDTable Management module (mod_id.c)

This module defines data structures required for switch and learn functionality. The id_table contains all information about rocker switches learned-in. The module also provides a set of functions to alter the id_table. These functions are used by Learn module.

3.2.7 Channel module (mod_channel.c)

Defines a hardware abstraction layer. Specific I/O ports (like SCSEDIO_0, WSDADIO_2) are mapped to logical channels like CH0 to CH3. The module defines a set of functions to control output channels.

An advantage of this abstraction is the flexibility of implementation. If the hardware changes or the count of logical channels is reduced or extended the overlaying implementation needn't be changed.

3.2.8 RemoteManagement task (remote.c)

Processes remote management messages and responds to RMCC's and RPC's. Currently all standard RMCC's are supported. Also following RPCs are supported:

RM_FN_REMOTE_READ

RM_FN_REMOTE_WRITE

RM_FN_REMOTE_LEARN

RM_FN_IDTABLE_READ

RM_FN_IDTABLE_WRITE

The remote read, write and learn are standard RPCs specified in EnOcean System Specification. The remote 'IDTable read and write' (RM_FN_IDTABLE_READ, RM_FN_IDTABLE_WRITE) are a custom RPCs defined for this example. It demonstrates advanced remote learn concept as well as the remote management usage. When pressing the CLR button not only the ID table will be cleared but also the REMAN code is deleted.

3.3 Remote command RM_FN_IDTABLE_READ

For the demo purposes we have defined a custom RPC called RM_FN_IDTABLE_READ. Using this RPC we are able to read the whole id_table.

NOTE: `ID_ENTRY is an ID_ENTRY_TYPE` structure defined in *io_mod.h*.

This RPC's is not standardized therefore not part of the EEP2.1 specification!

Table 1 IDTable read command description

Command	RM_FN_IDTABLE_READ
Function code	0x207
ManufacturerID	0x00B
Datalength	0
Broadcast	NO
Addressable	YES
Answer	YES

Message data description:

N/A – the message is has no data

Table 2 IDTable read command answer description

Command	RM_FN_IDTABLE_READ_ANS
Function code	0x807
ManufacturerID	0x00B
Datalength	1+7*N where N is the count of the ID entries in the ID_TABLE
Broadcast	NO
Addressable	YES
Answer	YES

Answer data description:

Offset	Size	Field	Description
0	1	Count	The count of the ID_ENTRY items
1	7	ID_ENTRY	ID_ENTRY item
8	7	ID_ENTRY	ID_ENTRY item
..	..	..	..
1+7*Count	7	ID_ENTRY	ID_ENTRY item

- The “n” is the count of id entries in the id_table[].

3.4 Remote command RM_FN_IDTABLE_WRITE

Similarly to RM_FN_IDTABLE_READ we defined the function RM_FN_IDTABLE_WRITE. Using this RPC we are able to write the whole id_table.

NOTE: `ID_ENTRY is an ID_ENTRY_TYPE` structure defined in *io_mod.h*.

This RPC's is not standardized therefore not part of the EEP2.1 specification!

Table 3 IDTable write command description

Command	RM_FN_IDTABLE_WRITE
Function code	0x208
ManufacturerID	0x00B
Datalength	0
Broadcast	NO
Addressable	YES
Answer	YES

Message data description:

Offset	Size	Field	Description
0	1	Count	The count of the ID_ENTRY items
1	7	ID_ENTRY	ID_ENTRY item
8	7	ID_ENTRY	ID_ENTRY item
..	..	..	..
1+7*Count	7	ID_ENTRY	ID_ENTRY item

- The "N" is the count of id entries in the id_table[].

Following code snipped illustrates how the remote IDTable read is implemented on EO3000I side **(remote.c)**:

```
case RM_FN_IDTABLE_READ:
        if (!misc_isLocalId(&gContext.pTel.p_rx.u32DestinationId))
                break;
        reman_getRpcManufacturerID(&u16RpcManufacturerID);
        // Process RPC from EnOcean only
        if (u16RpcManufacturerID!=ENOCEAN_ID)
        {
                reman_setError(RM_RETURN_CODE_WRONG_MANID);
                break;
        }
        // Read table from flash
        if (reman_sendMessage((uint8*)&id_table, sizeof(id_table),
                                RM_FN_IDTABLE_READ_ANS, FALSE)!=OK)
                reman_setError(RM_RETURN_CODE_DATA_SIZE_EXCEEDED);
        break;
```

3.5 Configuration

The RemanESP3 application provides a possibility of configuring several firmware parameters. In generally it is an advantage to provide a configuration interface. The user can then configure selected parameters of the final product without modifying the original firmware.

The configuration parameters are stored in the Configuration Area. The configuration structure is defined in **configuration.h.** For demonstration purposes we have defined following parameters in the APP_CFG_AREA structure:

```
// Structure of software configuration bytes in application section of CFG area\n
// Located in CFG-Area starting address 0x80
typedef struct
{
        // Serial Protocol Configuration
        // Located in CFG-Area 0x80
        // Default 0xFF: ESP3, 0x02: ESP2, other values: ESP3
        uint8  u8SerialProtocol;
        // Time [ms] after the output pin toggles during the learn mode.
        // Located in CFG-Area 0x81 \n
        // Default: 1000ms, all other values: time in milliseconds
        uint16 u16LearnToggleCyclus;
        // Time [ms] within the PTM switch has to be pressed 3 times to
       // learn-in during remote learn.
        // Located in CFG-Area 0x83 \n
        // Default: 2000ms, all other values: time in milliseconds
        uint16 u16LearnTime;
} APP_CFG_AREA;
```

In the file **configuration.c** the position of the `APP_CFG_AREA` structure in flash is defined:

```
//!Definition of the application configuration of the application
APP_CFG_AREA xdata  gAppCfg  _at_ (CFG_ADDR+128);
```

In order to enable the user to modify this defined structure we can use the *Modul configuration* functionality provided by DolphinStudio.

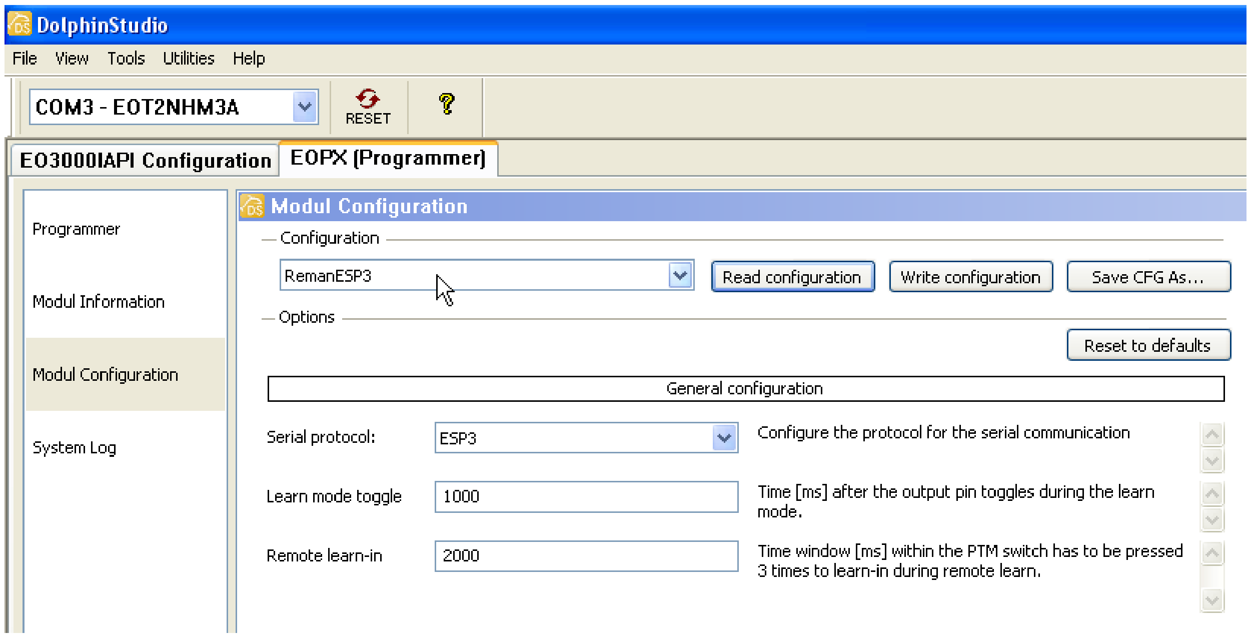
For this purpose we have to define the **remanesp3.xml**:

```
<?xml version="1.0" encoding="iso-8859-1" ?>
<configuration>
  <module name="RemanESP3">
    <!--  ***************  General configuration  **************  -->
    <data name="General configuration" type="group" />

    <data address="0x80" name="Serial protocol" size="01" type="int" default="0xFF">
       <description>Configure the protocol for the serial communication</description>
        <enum>
          <item value="0xFF">ESP3</item>
          <item value="0x02">ESP2</item>
        </enum>
    </data>

    <data address="0x81" name="Learn mode toggle time" size="02" type="int"
          default="1000" formatstring="%d">
       <description>Time [ms] after the output pin toggles during
                    the learn mode.</description>
    </data>

    <data address="0x83" name="Remote learn-in time" size="02" type="int"
           default="2000" formatstring="%d">
       <description>Time window [ms] within the PTM switch has to be
                    pressed 3 times to learn-in during remote learn.</description>
    </data>
  </module>
</configuration>
```

This XML reflects exactly the `APP_CFG_AREA` structure. Additionally it adds some comments and formatting for the user.

To use the defined XML we have to copy the file **remanESP3.xml** to the `DolphinStudio\Configuration` directory.

Then we can start the DolphinStudio and check the result:



Configuration: RemanESP3

Serial protocol:	ESP3	Configure the protocol for the serial communication
Learn mode toggle	1000	Time [ms] after the output pin toggles during the learn mode.
Remote learn-in	2000	Time window [ms] within the PTM switch has to be pressed 3 times to learn-in during remote learn.

Now we can easily modify the parameters and press 'Write configuration' button to write the configuration to the module.

NOTE: The remote learn-in time of 2000ms is standard for all EnOcean products. Changing this parameter is used for demonstration purposes only! It is not recommended to allow the change of this parameter for final products.

4 Demo Limitations

The demonstration has several limitations mainly to reduce the complexity and therefore increase the ease of understanding.

- The remote commands RM_FN_IDTABLE_READ and RM_FN_IDTABLE_WRITE are not standard commands defined in EEP 2.1. It should not be used as end-product solution.
- The rocked 2nd action is not supported.

4.1 Repeater level in remote management

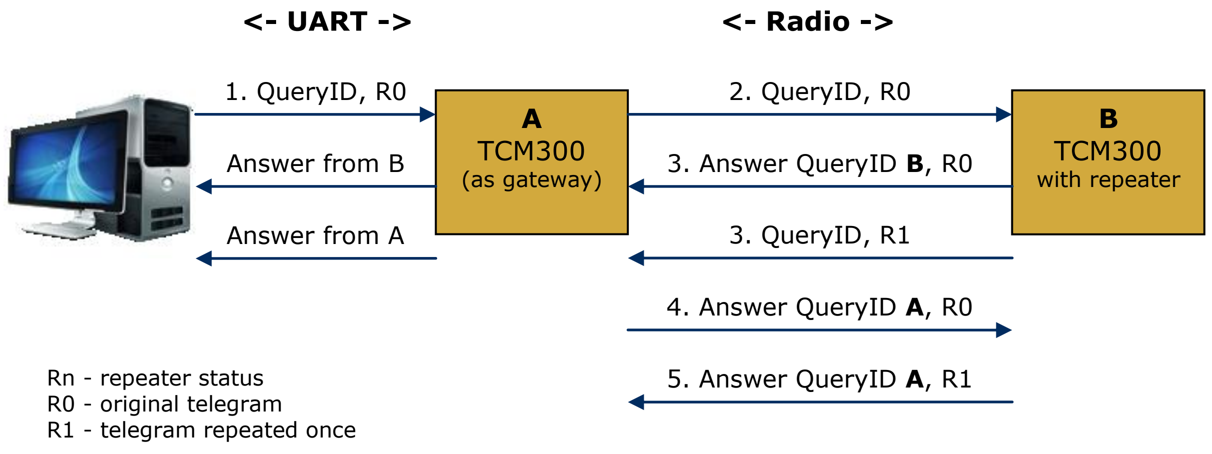
When using TCM300 as gateway the telegram repeater status should be considered. Following scenario shows what happens when sending QueryID telegram from PC with repeater status set to 0.

Setup:

1. PC – Computer running application like DolphinView
2. Device A – radio to serial gateway
3. Device B – device we want to control per remote management

Step-by-step:

- DolphinView sends QueryID telegram over serial, repeater status is 0.
- Device A receives serial telegram and forwards it to radio.
- Device B replays with QueryID Answer telegram.
- Device B repeats the QueryID, increases repeater status bits to 1 (R1).
- Device A receives the QueryID telegram.
- Device A replays witch QueryID Answer telegram.
- Device A repeats the QueryID Answer, increases repeater status.
- PC receives QueryID answer from device B and device A.



The problem with this scenario is that we actually queried also our gateway. There are several solutions for this problem:

- Use gateway software without remote management possibilities
- When sending remote management telegrams from an application set the status byte to 0xF – Telegram must not be repeated. This way the repeaters will not repeat the telegrams again. In some scenarios this also reduces the radio traffic.

Filter the remote management answers with gateway ID on application side.

5 Outlook

This application note demonstrated the operation of a remote managed application with TCM300 like functionality. The provided software and documentation shall make it easy to get familiar with the topic and starting own development based on this.

Further optimizations on the software side could e.g. be

- The structure of ID_ENTRY_TYPE should be reviewed to cover various rocker switch scenarios.
- Add dimmer task to support dimmer switch functionality

6 References

Further details can be found in the following documentation

[1.] Remote Management specification, 19.02.2010

[2.] EnOcean Serial Protocol 2 specification, v2.5

[3.] EnOcean Serial Protocol 3 specification, v1.4

[4.] DolphinAPI user manual, EO3000I_API.chm, 2.0.0.0

[5.] EnOcean Equipment Profiles (EEP), V2.1

[6.] Schematics EVA300-3

[7.] TCM300 User Manual

[8.] TCM300 Data Sheet

Useful web sites:

[9.] EnOcean website http://www.enocean.com

[10.] EnOcean Alliance website http://www.enocean-alliance.org

[11.] Wikipedia website http://www.wikipedia.org/