BANO node software development kit

texane@gmail.com

1 Overview

This documents the BANO node software development kit, including the build environment and programming interface. It is primarly intended for node developers.

1.1 Installing SDK and dependencies

The BANO SDK depends on the AVR GNU toolchain being installed on the system and accessible using the PATH environment variable. On a LINUX DEBIAN system, this toolchain is installed using:

```
$> aptitude install gcc-avr
```

Also, the AVRDUDE tool is used to upload the binary file in the device flash:

```
$> aptitude install avrdude
```

Note that this tools are shipped with the ARDUINO environment.

Retrieving the BANO SDK requires cloning 3 repositories:

- the BANO SDK itself, which contains all the files required to develop node and a base applications,
- the NRF SDK, which provides support for NRF905 and NRF24L01P wireless chipsets from Nordic Semiconductor,
- the AVR CRYPTO library, which is used for message encryption.

It is recommended to install them at the same level:

```
$> cd ~/repo
$> git clone https://github.com/texane/bano.git
$> git clone https://github.com/texane/nrf.git
# only for message encryption
$> mkdir ~/repo/crypto-lib
$> cd ~/repo/crypto-lib
$> svn co http://das-labor.org/svn/microcontroller-2/crypto-lib .
```

Also, a node example example can be retrieved, built and uploaded using:

```
$> git clone https://github.com/texane/bano_led.git
$> cd bano_led
$> BANO_DIR=~/repo/bano make
$> BANO_DIR=~/repo/bano make upload
```

2 Build environment

2.1 Makefile variables

BANO allows the developer to interact with the build system by defining or overriding default variables in the node makefile:

- BANO_DIR: the BANO top directory. If the previous section instructions were followed, the BANO_DIR variable would be set to $(HOME)/repo/bano. This variable is mandatory,
- NRF_DIR: the NRF top directory. default to $(BANO_DIR)/../nrf,
- CRYPTOLIB_DIR: the CRYPTO-LIB top directory. default to $(BANO_DIR)/../crypto-lib,
- BANO_BOARD: the node board. Currently, only minipro_3v3 is supported. This variable is mandatory,
- NRF_DIR: the NRF top directory. By default, the SDK assumes that the NRF directory is located in the BANO parent directory, as recommended in the previous section,
- BANO_C_FILES: the list of C source files. This list can not be empty,
- BANO_S_FILES: an optional list of assembler source files. Names must end with big S suffixes (ie. main.S). GCC is used as the assembler allowing preprocessor directives. This list can be empty,
- BANO_NODL_ID: the NODL identifier as an hexadecimal 32 bits unsigned integer. If not defined, 0 is used,
- BANO_NODE_ADDR: the node address as an hexadecimal 32 bits unsigned integer. If not defined, a random value is generated by the build system,
- BANO_NODE_SEED: the node seed as an hexadecimal 32 bits unsigned integer. If not defined, a random value is generated by the build system,
- BANO_CIPHER_ALG: if defined, the 128 bits block cipher algorithm to use. Currently supported are: none, xtea and aes,
- BANO_CIPHER_KEY: if BANO_CIPHER_ALG is defined, this variable contains the key used to encrypt and decrypt messages. It is represented as a comma separated string of 16 8 bits unsigned integers in hexadecimal. If not defined, a random value is generated by the build system.

2.2 Makefile rules

The makefile provides the following rules:

- all: also the default rule. It produces the final image that can then be uploaded,
- upload: upload to the board,
- clean: clean all the temporary files.

2.3 Example makefile

```
# node built for the arduino minipro 3.3v board
# it assumes that BANO_DIR is defined by the environment
# it consists of a single C file main.c
# the node address is statically defined

BANO_DIR := $(HOME)/repo/bano
BANO_BOARD := minipro_3v3
BANO_NODE_ADDR := 0x5c5f8548
BANO_C_FILES := main.c

include $(BANO_DIR)/build/node/top.mk
```

3 Programming reference

3.1 Overview

BANO offers a runtime and the corresponding programming interface that abstracts a node application logic from low level details such as hardware architecture and protocol implementation. The interface is mainly descriptive and event based: the developer first initializes node related information. The BANO runtime then calls application handlers whenever appropriate: network messages reception, timers, hardware related interrupts ...

3.2 Files

node/bano_node.h: function and type declarations.

3.3 Types

```
typedef struct
{
  /* 100 milliseconds units, max 10736 */
  uint16_t timer_100ms;

  /* waking event mask */
#define BANO_WAKE_NONE 0
#define BANO_WAKE_TIMER (1 << 0)
#define BANO_WAKE_MSG (1 << 1)
#define BANO_WAKE_POLL (1 << 2)
#define BANO_WAKE_PCINT (1 << 3)
  uint8_t wake_mask;

  /* module disabling mask */
#define BANO_DISABLE_ADC (1 << 0)
#define BANO_DISABLE_WDT (1 << 1)
#define BANO_DISABLE_CMP (1 << 2)
#define BANO_DISABLE_USART (1 << 3)
#define BANO_DISABLE_NONE 0x00
#define BANO_DISABLE_ALL 0xff
  uint8_t disable_mask;

  uint32_t pcint_mask;

} bano_info_t;

static const bano_info_t bano_info_default =
{
  .wake_mask = BANO_WAKE_NONE,
  .disable_mask = BANO_DISABLE_ALL
};
```

3.4 Functions

```
/* exported by the runtime */
uint8_t bano_init(const bano_info_t*);
uint8_t bano_fini(void);
uint8_t bano_send_set(uint16_t, uint32_t);
uint8_t bano_wait_event(bano_msg_t*);
uint8_t bano_loop(void);

/* implemented by the application */
extern uint8_t bano_set_handler(uint16_t, uint32_t);
extern uint8_t bano_get_handler(uint16_t, uint32_t*);
extern void bano_timer_handler(void);
extern void bano_pcint_handler(void);
```

4 Examples

4.1 Enable disable a LED on BANO messages

```
#include <stdint.h>
#include <avr/io.h>
#include "bano/src/node/bano_node.h"

/* led routines */

#define LED_DDR DDRB
#define LED_PORT PORTB
#define LED_MASK (1 << 1)

static void led_set_high(void)
{
  LED_DDR |= LED_MASK;
  LED_PORT |= LED_MASK;
}

static void led_set_low(void)
{
  LED_DDR |= LED_MASK;
  LED_PORT &= ~LED_MASK;
}


/* event handlers */

#define LED_KEY 0x0000

static uint8_t led_value = 0;

uint8_t bano_get_handler(uint16_t key, uint32_t* val)
{
  /* called by the runtime on GET messages */

  if (key != LED_KEY) return BANO_FLAG_ERR;

  *val = led_value;
  return 0;
}

uint8_t bano_set_handler(uint16_t key, uint32_t val)
{
  /* called by the runtime on SET messages */

  if (key != LED_KEY) return BANO_FLAG_ERR;

  led_value = val;
  if (led_value == 0) led_set_low();
  else led_set_high();

  /* acknowledged operation */
  return BANO_FLAG_ACK;
}

/* unused */
void bano_pcint_handler(void) { }
void bano_timer_handler(void) { }

int main(void)
{
  /* initialize the runtime and loop forever */

  bano_info_t info;

  info = bano_info_default;
  info.wake_mask |= BANO_WAKE_MSG;

  bano_init(&info);
  bano_loop();
  bano_fini();

  return 0;
}
```

4.2 Send periodic messages

```
#include <stdint.h>
#include <avr/io.h>
#include "bano/src/node/bano_node.h"

void bano_timer_handler(void)
{
  /* called every 10 seconds */

  bano_send_set(0x002a, 0xdeadbeef);
}

/* unused */
uint8_t bano_get_handler(uint16_t key, uint32_t* val) { return BANO_FLAG_ERR; }
uint8_t bano_set_handler(uint16_t key, uint32_t val) { return BANO_FLAG_ERR; }
void bano_pcint_handler(void) { }

int main(void)
{
  bano_info_t info;

  info = bano_info_default;

  info.wake_mask |= BANO_WAKE_TIMER;
  info.timer_100ms = 100;

  bano_init(&info);
  bano_loop();
  bano_fini();

  return 0;
}
```

4.3 Send message when GPIO changes

```
#include <stdint.h>
#include <avr/io.h>
#include "bano/src/node/bano_node.h"

#define GPIO_KEY 0x0000

#define GPIO_DDR DDRD
#define GPIO_PIN PIND
#define GPIO_MASK (1 << 3)

void bano_pcint_handler(void)
{
  bano_send_set(GPIO_KEY, GPIO_PIN & GPIO_MASK);
  return 0;
}

/* unused */
uint8_t bano_get_handler(uint16_t key, uint32_t* val) { return BANO_FLAG_ERR; }
uint8_t bano_set_handler(uint16_t key, uint32_t val) { return BANO_FLAG_ERR; }
void bano_timer_handler(void) { }

int main(void)
{
  bano_info_t info;

  info = bano_info_default;

  info.wake_mask |= BANO_WAKE_PCINT;
  info.pcint_mask = 1UL << 19UL;

  bano_init(&info);
  bano_loop();
  bano_fini();

  return 0;
}
```