Abstract
This document intents to provide a description of the NXP-NCI_MCUXpressoExample project. This project demonstrates simple integration of NXP NCI NFC Controller without any OS resources dependencies.
## Revision history

<table>
<thead>
<tr>
<th>Rev</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>20181114</td>
<td>Updated with reference to SW package</td>
</tr>
<tr>
<td>1.0</td>
<td>20170607</td>
<td>First official version</td>
</tr>
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</table>
1 Introduction

The NXP-NCI_MCUXpressoExample project shows how to easily interact with NCI-based NXP’s NFC Controller in order to provide NFC capability to an embedded system with no OS resources required.

The code example is delivered in the form of MCUXpresso projects running on NXP’s LPC82x, LPC11Uxx and LPC11U6x microcontrollers from the LPC family or K64 microcontroller from the Kinetis K family.

The present example demonstrates NFC functionalities:

• R/W mode:
  – extract NDEF content from a remote NFC Forum tag
  – write NDEF content to NFC Forum Type 2 or Type 4 tag
  – authenticate/read/write MIFARE Classic card
  – raw card access (ISO14443-3A, ISO14443-4 card and ISO15693 cards)
  – multiple tag support (up to 2 of the same technology or multi-protocol card)
• P2P mode: exchange (in both way) NDEF content with remote P2P device
• Card emulation mode:
  – expose NDEF content to a remote NFC reader (Type 4 tag emulation)
  – raw card emulation (ISO14443-4 emulation)

The K64 related project (based on SDK2.2) shows code example integrated under RTOS (freeRTOS) while the LPC ones run without OS support.

In this document the term „MIFARE Classic card“ refers to a MIFARE Classic IC-based contactless card.
2 HW setup

2.1 LPC82x

To set up the project, we use OM13071 LPCXpresso824-MAX board (http://www.nxp.com/demoboard/OM13071).

Figure 1. OM13071 LPCXpresso824-MAX board

The board must be connected to NFC controller board using the following instructions:

<table>
<thead>
<tr>
<th>OM13071 board pin</th>
<th>NFC controller signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>V\textsubscript{OUT} 3.3 V</td>
<td>&lt;-&gt; V\textsubscript{BAT}</td>
</tr>
<tr>
<td>V\textsubscript{OUT} 3.3 V</td>
<td></td>
</tr>
<tr>
<td>+5 V USB out</td>
<td>&lt;-&gt; V\textsubscript{DD(PAD)} / P\textsubscript{VDD}</td>
</tr>
<tr>
<td>PIO0.10 / I2C0_SCL</td>
<td>&lt;-&gt; I2C_SCL</td>
</tr>
<tr>
<td>PIO0.11 / I2C0_SDA</td>
<td>&lt;-&gt; I2C_SDA</td>
</tr>
<tr>
<td>PIO0.13</td>
<td>&lt;-&gt; IRQ</td>
</tr>
<tr>
<td>PIO0.17</td>
<td>&lt;-&gt; V\textsubscript{EN}</td>
</tr>
<tr>
<td>GND</td>
<td>&lt;-&gt; GND</td>
</tr>
</tbody>
</table>

This matches Arduino version of OM5577 (http://www.nxp.com/demoboard/OM5577) and OM5578 (http://www.nxp.com/demoboard/OM5578) demo kits. Those kits can then be plugged on OM13071 board to run the example.
2.2 LPC11Uxx

To set up the project, we use OM13074 LPCXpresso board for LPC11U37H (http://www.nxp.com/demoboard/OM13074).

![OM13074 LPCXpresso board for LPC11U37H](image)

The board must be connected to NFC controller board using the following instructions:

<table>
<thead>
<tr>
<th>OM13074 board pin</th>
<th>NFC controller signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{OUT}$ 3.3 V</td>
<td>$V_{BAT}$</td>
</tr>
<tr>
<td>$V_{OUT}$ 3.3 V</td>
<td>$V_{DD(PAD)} / P_{VDD}$</td>
</tr>
<tr>
<td>+5 V USB out</td>
<td>$V_{ANT}$ (only OM5578)</td>
</tr>
<tr>
<td>PIO0.4 / I2C-SCL</td>
<td>I2C_SCL</td>
</tr>
<tr>
<td>PIO0.5 / I2C-SDA</td>
<td>I2C_SDA</td>
</tr>
<tr>
<td>PIO0.2</td>
<td>IRQ</td>
</tr>
<tr>
<td>PIO0.7</td>
<td>VEN</td>
</tr>
<tr>
<td>GND</td>
<td>GND</td>
</tr>
</tbody>
</table>

This matches Arduino version of OM5577 (http://www.nxp.com/demoboard/OM5577) and OM5578 (http://www.nxp.com/demoboard/OM5578) demo kits. Those kits can then be plugged on OM13074 board to run the example.
2.3 LPC11U6x

To set up the project, we use OM13058 LPCXpresso Board for LPC11U68 (http://www.nxp.com/demoboard/OM13058).

![OM13058 LPCXpresso Board for LPC11U68](image)

The board must be connected to NFC controller board using the following instructions:

<table>
<thead>
<tr>
<th>OM13058 board pin</th>
<th>NFC controller signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOUT 3.3 V</td>
<td>&lt;-&gt; VBAT</td>
</tr>
<tr>
<td>VOUT 3.3 V</td>
<td>&lt;-&gt; VDD(PAD) / P_VDD</td>
</tr>
<tr>
<td>+5 V USB out</td>
<td>&lt;-&gt; V_ANT (only OM5578)</td>
</tr>
<tr>
<td>PIO0.4 / I2C-SCL</td>
<td>&lt;-&gt; I2C_SCL</td>
</tr>
<tr>
<td>PIO0.5 / I2C-SDA</td>
<td>&lt;-&gt; I2C_SDA</td>
</tr>
<tr>
<td>PIO1.28</td>
<td>&lt;-&gt; IRQ</td>
</tr>
<tr>
<td>PIO1.25</td>
<td>&lt;-&gt; VEN</td>
</tr>
<tr>
<td>GND</td>
<td>&lt;-&gt; GND</td>
</tr>
</tbody>
</table>

This matches Arduino version of OM5577 (http://www.nxp.com/demoboard/OM5577) and OM5578 (http://www.nxp.com/demoboard/OM5578) demo kits. Those kits can then be plugged on OM13058 board to run the example.
2.4 K64

To set up the project, we use FRDM-K64F: Freedom Development Platform for Kinetis K64, K63, and K24 MCUs (http://www.nxp.com/demoboard/FRDM-K64F).

![FRDM-K64F: Freedom Development Platform](image)

The board must be connected to NFC controller board using the following instructions:

<table>
<thead>
<tr>
<th>FRDM-K64F pin</th>
<th>NFC controller signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>P3V3</td>
<td>&lt;-&gt; V_BAT</td>
</tr>
<tr>
<td>P3V3</td>
<td>&lt;-&gt; V_DDIPAD/P_VDD</td>
</tr>
<tr>
<td>P5V_USB</td>
<td>&lt;-&gt; V_ANT (only OM5578)</td>
</tr>
<tr>
<td>PTE24 / I2C-SCL</td>
<td>&lt;-&gt; I2CSCL</td>
</tr>
<tr>
<td>PTE25 / I2C-SDA</td>
<td>&lt;-&gt; I2CSDA</td>
</tr>
<tr>
<td>PTA0</td>
<td>&lt;-&gt; IRQ</td>
</tr>
<tr>
<td>PTC3</td>
<td>&lt;-&gt; VEN</td>
</tr>
<tr>
<td>GND</td>
<td>&lt;-&gt; GND</td>
</tr>
</tbody>
</table>

This matches Arduino version of OM5577 (http://www.nxp.com/demoboard/OM5577) and OM5578 (http://www.nxp.com/demoboard/OM5578) demo kits. Those kits can then be plugged on OM13071 board to run the example.
3 SW setup

MCUXpresso IDE can be downloaded from https://mcuxpresso.nxp.com/.

For K64 project setup, first make sure K64 MCUXpresso SDK 2.2 is installed in MCUXpresso (see https://mcuxpresso.nxp.com/en/builder).

- Create an empty workplace in MCUXpresso IDE:

![Figure 5. MCUXpresso IDE workplace](image)

- Import the targeted project from the NXP-NCI_MCUXpressoExample zip file (retrieved from https://www.nxp.com/doc/SW4325):

![Figure 6. Importing project in MCUXpresso IDE](image)
- Click on the “dark blue bug” icon to build the project, flash the binary into the MCU memory and start debugging:

![Debugging project in MCUXpresso IDE](image)

**Figure 7. Debugging project in MCUXpresso IDE**

- Start the execution (clicking on « Resume » button or pressing ‘f8’). This launches the discovery and following message is displayed in the « console » window of MCUXpresso:

![MCUXpresso console window when starting project execution](image)

**Figure 8. MCUXpresso console window when starting project execution**
4 Demonstration

4.1 R/W mode

Bringing an NFC Forum Tag containing NDEF content leads to a message display in the « console » window (in below example a Type 2 tag containing Text type NDEF message “NXP Semiconductors”):

![Figure 9. Terminal output when NDEF tag is read](image)

In case of several tags, the related information will be displayed one after the other in such way:

![Figure 10. Terminal output when multiple tags are detected](image)

4.2 P2P mode

Bringing an NFC Android phone and « beaming » a URL (select the URL inside the phone web browser, tap the phone to the antenna then click of the screen when invited for it by the Android « Beam » service) gives such result:
Simultaneously, the phone displays the received NDEF record from the NXP-NCI example project (NDEF Text type « Test » message):

Figure 11. Terminal output example when exchanging data with Android NFC phone

Figure 12. Android phone receiving NDEF message from NXP-NCI example project
4.3 Card Emulation mode

Bringing an NFC reader gives such result:

![Terminal output when exchanging data with Android NFC phone in card emulation mode](image)

**Note:** To perform such scenario, an NFC Android phone can be used but then P2P and R/W modes must be disabled inside the NXP-NCI example project (see chapter Section 6.3 for detailed procedure) since otherwise the P2P communication is favored or the NFC Android phone may be discovered as a card (if it supports this mode).
5 SW description

5.1 Architecture overview

The Application consists in an NFC task using NFC library API to register for NDEF functionalities and manage NXP-NCI processing.

{NXP-NCI} module offers high-level NFC API:
• Connection and configuration of the NFC controller
• Start of the NFC discovery
• Wait for NFC discovery
• Process the NFC discovery
• Offer raw access to remote tag or reader discovered

{NDEF library} module is composed of independent submodule:
• {RW_NDEF} implements NDEF extraction from NFC Forum tags (all 4 NFC Forum defined tag types) and NDEF write to NFC Forum Type 2 and Type 4 tags
• {P2P_NDEF} implements NDEF data exchange with P2P device (over NFC Forum LLCP and SNEP protocols)
• {T4T_NDEF_emu} implements NDEF message exposure through card emulation (NFC Forum Type 4 Tag protocol)

{TML} module brings HW abstraction to NFC library (abstract how the connection to NFC controller IC is managed).

5.2 Stack size

Below is insight about the stack size, compiled on an ARM Cortex M0 or M4 (no large difference observed) in « Release » configuration mode:
Table 5. Stack size from ARM Cortex M0/M4

<table>
<thead>
<tr>
<th>Module</th>
<th>Approx. Size (in bytes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDEF library</td>
<td>3900</td>
</tr>
<tr>
<td>RW_NDEF</td>
<td>200</td>
</tr>
<tr>
<td>RW_NDEF_T1T</td>
<td>420</td>
</tr>
<tr>
<td>RW_NDEF_T2T</td>
<td>580</td>
</tr>
<tr>
<td>RW_NDEF_T3T</td>
<td>300</td>
</tr>
<tr>
<td>RW_NDEF_T4T</td>
<td>1280</td>
</tr>
<tr>
<td>P2P_NDEF</td>
<td>720</td>
</tr>
<tr>
<td>T4T_NDEF_emu</td>
<td>400</td>
</tr>
<tr>
<td>NXP-NCI</td>
<td>3900</td>
</tr>
<tr>
<td>TML</td>
<td>200</td>
</tr>
</tbody>
</table>

The NFC library (NDEF library + NXP-NCI) is about 8000 bytes in its full configuration (RW, P2P and Card Emulation) but could be substantially reduced according to the targeted use case (for instance for T2T RW only support, size would be about 1800 bytes).

5.3 Porting recommendation for other MCUs

The present code example can be easily ported to any other target providing I2C-bus master and GPIO capabilities (I2C master may even be implemented in SW via GPIO control in case of no HW support is provided by the target).

The only modules requiring adaptations is the TML components (relates to how the target provides this support), others modules being platform agnostics.
6 Example customization

6.1 I2C address/speed

NFC Controller I2C address is by default set to 0x28 (matching OM5577 and OM5578 HW configuration. It can be changed in the file:

- Drivers/inc/driver-config.h for the LPC-related projects
- board/board.h for the K64 project

Table 6. I2C address setting
#define NXPNCI_I2C_ADDR 0x28U

6.2 PIOs assignment

In case a different connection is used than the one described in chapter Section 2, definition in the following file must reflect PIOs assignment:

- Drivers/inc/driver-config.h for the LPC-related projects
- board/board.h for the K64 project

Table 7. PIOs assignment for the LPC-related projects
#define PORT_IRQ PORT0
#define PORT_VEN PORT0
#define PIN_IRQ 13 // P0.13
#define PIN_VEN 17 // P0.17

Table 8. PIOs assignment for the K64 project
#define NXPNCI_IRQ_PORTIRQn PORTC_IRQn
#define NXPNCI_IRQ_GPIO (GPIOC)
#define NXPNCI_IRQ_PORT (PORTC)
#define NXPNCI_IRQ_PIN (12U)
#define NXPNCI_VEN_GPIO (GPIOC)
#define NXPNCI_VEN_PORT (PORTC)
#define NXPNCI_VEN_PIN (3U)

6.3 NFC modes compile flags

Three compile flags exist in this SW example allowing to separately disable modes:

- RW_SUPPORT
- P2P_SUPPORT
- CARDEMU_SUPPORT

There are defined by default (all 3 modes supported). To disable a mode, just remove the related definition in the project properties:
6.4 Discovery configuration

The discovery loop can be configured by setting `DiscoveryTechnologies` variable defined in `nfc_task.c` file.

By default, all technologies (required for the aimed demonstration) are enabled: Passive NFCA, NFCB and NFCF as well as Active NFCA and NFCF, in both POLL and LISTEN modes.

Simply adapt the discovery loop by commenting out the related technology you want to remove.

Table 9. Discovery configuration variable

```c
unsigned char DiscoveryTechnologies[] = { MODE_POLL | TECH_PASSIVE_NFCA,
                                      MODE_POLL | TECH_PASSIVE_NFCB,
                                      MODE_POLL | TECH_PASSIVE_NFCF,
                                      MODE_POLL | TECH_ACTIVE_NFCF,
                                      MODE_LISTEN | TECH_PASSIVE_NFCA,
                                      MODE_LISTEN | TECH_PASSIVE_NFCF,
                                      MODE_LISTEN | TECH_ACTIVE_NFCA,
                                      MODE_LISTEN | TECH_ACTIVE_NFCF};
```

6.5 Settings configuration

Dedicated settings can be applied to the NXP-NCI NFC Controller. Those are configured thanks to `NfcLibrary/inc/Nfc_settings.h` file.
Table 10. NFC settings configuration
/* Following definitions specify settings applied when NxpNci_ConfigureSettings() *
* API is called from the application */
#define NXP_CORE_CONF 1
#define NXP_CORE_CONF_EXTN 1
#define NXP_CORE_STANDBY 1
#define NXP_CLK_CONF 1 // 1=Xtal, 2=PLL
#define NXP_TVDD_CONF 1 // 1=CFG1, 2=CFG2
#define NXP_RF_CONF 1

Table 11. NXP_CORE_CONF setting definition
#if NXP_CORE_CONF
/* NCI standard dedicated settings */
* Refer to NFC Forum NCI standard for more details */
uint8_t NxpNci_CORE_CONF[]={0x20, 0x02, 0x07, 0x01, /* CORE_SET_CONFIG_CMD */
0x00, 0x02, 0x00, 0x01 /* TOTAL_DURATION */};
#endif

Table 12. NXP_CORE_CONF_EXTN setting definition
#if NXP_CORE_CONF_EXTN
/* NXP-NCI extension dedicated setting */
* Refer to NFC controller User Manual for more details */
uint8_t NxpNci_CORE_CONF_EXTN[]={0x20, 0x02, 0x0D, 0x03, /* CORE_SET_CONFIG_CMD */
0xA0, 0x40, 0x01, 0x00, /* TAG_DETECTOR_CFG */
0xA0, 0x41, 0x01, 0x04, /* TAG_DETECTOR_THRESHOLD_CFG */
0xA0, 0x43, 0x01, 0x00 /* TAG_DETECTOR_FALLBACK_CNT_CFG*/};
#endif

Table 13. NXP_CORE_STANDBY setting definition
#if NXP_CORE_STANDBY
/* NXP-NCI standby enable setting */
* Refer to NFC controller User Manual for more details */
uint8_t NxpNci_CORE_STANDBY[]={0x2F, 0x00, 0x01, 0x01}; /* last byte indicates enable/disable */
#endif
Table 14. NXP_CLK_CONF setting definition

```c
#if NXP_CLK_CONF
/* NXP-NCI CLOCK configuration  
  * Refer to NFC controller Hardware Design Guide document for more details  
*/
#if (NXP_CLK_CONF == 1)
/* Xtal configuration */
uint8_t NxpNci_CLK_CONF[]={0x20, 0x02, 0x05, 0x01, /* CORE_SET_CONFIG_CMD */
0xA0, 0x03, 0x01, 0x08 /* CLOCK_SEL_CFG */};
#else
/* PLL configuration */
uint8_t NxpNci_CLK_CONF[]={0x20, 0x02, 0x09, 0x02, /* CORE_SET_CONFIG_CMD */
0xA0, 0x03, 0x01, 0x11, /* CLOCK_SEL_CFG */
0xA0, 0x04, 0x01, 0x01 /* CLOCK_TO_CFG */};
#endif
#endif
```

Table 15. NXP_TVDD_CONF setting definition

```c
#if NXP_TVDD_CONF
/* NXP-NCI TVDD configuration  
  * Refer to NFC controller Hardware Design Guide document for more details  
*/
/* RF configuration related to 1st generation of NXP-NCI controller (e.g PN7120) */
uint8_t NxpNci_TVDD_CONF_1stGen[]={0x20, 0x02, 0x05, 0x01, 0xA0, 0x13, 0x01, 0x00};
/* RF configuration related to 2nd generation of NXP-NCI controller (e.g PN7150) */
#if (NXP_TVDD_CONF == 1)
/* CFG1: Vbat is used to generate the VDD(TX) through TXLDO */
uint8_t NxpNci_TVDD_CONF_2ndGen[]={0x20, 0x02, 0x07, 0x01, 0xA0, 0x0E, 0x03, 0x02, 0x09, 0x00};
#else
/* CFG2: external 5V is used to generate the VDD(TX) through TXLDO */
uint8_t NxpNci_TVDD_CONF_2ndGen[]={0x20, 0x02, 0x07, 0x01, 0xA0, 0x0E, 0x03, 0x06, 0x64, 0x00};
#endif
#endif
```
Table 16. NXP_RF_CONF settings definition

```c
#ifndef NXP_RF_CONF
/* NXP-NCI RF configuration
 * Refer to NFC controller Antenna Design and Tuning Guidelines document for more details */
/* RF configuration related to 1st generation of NXP-NCI controller (e.g. PN7120) */
uint8_t NxpNci_RF_CONF_1stGen[] = {
    0x20, 0x01, 0x38, 0x07,
    0xA0, 0x0D, 0x06, 0x42, 0x12, 0x00, 0x0F1, 0xFF,
    0xA0, 0x0D, 0x06, 0x44, 0xA3, 0x90, 0x03, 0x00,
    0xA0, 0x0D, 0x06, 0x34, 0x2B, 0x0C, 0x50, 0x0C, 0x00,
    0xA0, 0x0D, 0x04, 0x06, 0x06, 0x10, 0x00,
    0xA0, 0x0D, 0x03, 0x06, 0x16, 0x10,
    0xA0, 0x0D, 0x03, 0x06, 0x15, 0x00,
    0xA0, 0x0D, 0x06, 0x32, 0x4A, 0x53, 0x07, 0x01, 0x1B
};
/* RF configuration related to 2nd generation of NXP-NCI controller (e.g. PN7150) */
/* Following configuration relates to performance optimization of OM5578 demo kit */
uint8_t NxpNci_RF_CONF_2ndGen[] = {
    0x20, 0x02, 0xB7, 0x14,
    0xA0, 0x0D, 0x06, 0x04, 0x35, 0x90, 0x01, 0xF4, 0x01,
    0xA0, 0x0D, 0x06, 0x44, 0x01, 0x90, 0x03, 0x00,
    0xA0, 0x0D, 0x06, 0x06, 0x42, 0x02, 0x00, 0xFF, 0xFF,
    0xA0, 0x0D, 0x06, 0x30, 0xB0, 0x01, 0x10, 0x00,
    0xA0, 0x0D, 0x06, 0x42, 0x02, 0x00, 0xFF, 0xFF,
    0xA0, 0x0D, 0x06, 0x3F, 0x04,
    0xA0, 0x0D, 0x06, 0x32, 0x42, 0xF8, 0x00, 0xFF, 0xFF,
    0xA0, 0x0D, 0x06, 0x42, 0x2D, 0x15, 0x45, 0x0D, 0x00,
    0xA0, 0x0D, 0x06, 0x46, 0x2D, 0x05, 0x59, 0x0C, 0x00,
    0xA0, 0x0D, 0x06, 0x44, 0x42, 0x88, 0x00, 0xFF, 0xFF,
    0xA0, 0x0D, 0x06, 0x56, 0x2D, 0x05, 0x9F, 0x0C, 0x00,
    0xA0, 0x0D, 0x06, 0x54, 0x42, 0x88, 0x00, 0xFF, 0xFF,
    0xA0, 0x0D, 0x06, 0x42, 0x2D, 0x15, 0x45, 0x0D, 0x00,
    0xA0, 0x0D, 0x06, 0x46, 0x44, 0x22, 0x00,
    0xA0, 0x0D, 0x06, 0x46, 0x2D, 0x05, 0x59, 0x0E, 0x00,
    0xA0, 0x0D, 0x06, 0x44, 0x42, 0x88, 0x00, 0xFF, 0xFF,
    0xA0, 0x0D, 0x06, 0x56, 0x2D, 0x05, 0x9F, 0x0C, 0x00,
    0xA0, 0x0D, 0x06, 0x54, 0x42, 0x88, 0x00, 0xFF, 0xFF,
    0xA0, 0x0D, 0x06, 0x42, 0x2D, 0x15, 0x45, 0x0D, 0x00,
    0xA0, 0x0D, 0x06, 0x46, 0x44, 0x22, 0x00,
    0xA0, 0x0D, 0x06, 0x46, 0x2D, 0x05, 0x59, 0x0E, 0x00,
    0xA0, 0x0D, 0x06, 0x44, 0x42, 0x88, 0x00, 0xFF, 0xFF,
    0xA0, 0x0D, 0x06, 0x56, 0x2D, 0x05, 0x9F, 0x0C, 0x00,
    0xA0, 0x0D, 0x06, 0x54, 0x42, 0x88, 0x00, 0xFF, 0xFF,
    0xA0, 0x0D, 0x06, 0x4A, 0x33, 0x80, 0x86, 0x00, 0x70,
    0xA0, 0x0D, 0x11, 0x57, 0x33, 0x14, 0x17, 0x00, 0x04, 0x00, 0x63,
    0xA0, 0x0D, 0x00, 0x00, 0xA0
};
#endif
```

6.6 Reader/Writer mode raw access to tag

Demonstration of accessing in raw mode (non-NDEF) discovered card is present in the demo application. Enabling it is done defining `RW_RAW_EXCHANGE` compile flag in `nfc_task.c` file (just uncomment present definition), before building the project.

Pay attention that when enabling the `RW_RAW_EXCHANGE` option of the application there is no more any NDEF operation (neither read nor write). Instead, the scenario implemented in the following functions located in `nfc_task.c` file is executed per the discovered card type:

- **T2T:** `PCD_ISO14443_3A_scenario()` reads then writes and reads back memory block #5
- **T4T:** `PCD_ISO14443_4_scenario()` sends "Select PPSE" ISO7816 C-APDU and displays result according to the card answer
• ISO15693: PCD_ISO15693_scenario() reads then writes and reads back memory block #8
• MIFARE Classic: PCD_MIFARE_scenario() authenticates, reads then writes and reads back memory block #4

6.7 Card Emulation raw mode

Demonstration of raw exchanges (non-NDEF) in ISO14443-4 card emulation mode is present in the demo application. Enabling it is done defining CARDEMU_RAW_EXCHANGE compile flag in nfc_task.c file (just uncomment present definition), before building the project.

Pay attention that when enabling the CARDEMU_RAW_EXCHANGE option of the application there is no more any NDEF operation (NDEF record no more exposed to remote NFC reader). Instead, the scenario implemented in the function PICC_ISO14443_4_scenario() located in nfc_task.c file will be run, which consist in parsing incoming ISO7816 C-APDU and answering with “successful operation” R-APDU to any received C-APDU.

6.8 NDEF write operation

Demonstration the NDEF write operation is present in the demo application (but not enabled by default to prevent unintentional overwriting of tag content). Enabling it is done defining RW_NDEF_WRITING compile flag in nfc_task.c file (just uncomment present definition), before building the project. Then the write operation will occur just after the NDEF read operation.

The NDEF message which is written is defined in NDEF_MESSAGE variable (see Section 6.9).

Only Type 2 and Type 4 tags NDEF write operation is supported currently by the NFC library. For others tag types, write operation will simply not occur but no issue will be reported. Furthermore, the tag must be already NDEF formatted, the NFC library not implementing NDEF formatting functionality.

6.9 Shared NDEF message

NDEF message shared in P2P or Card Emulation mode (or even in RW mode while NDEF write operation is enabled, see Section 6.8) can be changed. Simply modify value of NDEF_MESSAGE variable, in file nfc_task.c, following NFC Forum NDEF specification.

Table 17. Shared NDEF message definition

| const char NDEF_MESSAGE[] = { 0xD1, // MB/ME/CF/1/IL/TNF 0x01, // TYPE LENGTH 0x07, // PAYLOAD LENTGH 'T', // TYPE 0x02, // Status 'e', 'n', // Language 'T', 'e', 's', 't' }; |
6.10 P2P timing optimization

The current example implementation allows sharing in both way NDEF message with a peer device (receiving and sending an NDEF message) in P2P mode over SNEP NFC Forum protocol.

The SNEP standard protocol being also implemented as native feature of Android, so-called "Beam" service, the NXP-NCI example shows NDEF message exchanges with NFC Android devices. Unfortunately, because of the "Beam" service implementation, the Android device cannot send any NDEF message after it has received one (until a new tap occurs).

To workaround this limitation, the NXP-NCI example defines a way to postpone sending NDEF message after the peer discovery, to give the Android device user to "Beam" the expected content. This is implemented as NDEF_PUSH_DELAY_COUNT variable inside NfcLibrary/NdefLibrary/src/P2P_NDEF.c file.

Table 18. P2P NDEF push delay definition

<table>
<thead>
<tr>
<th>/* Defines the number of symmetry exchanges is expected before initiating the NDEF push (to allow a remote phone to beam an NDEF message first) */</th>
</tr>
</thead>
<tbody>
<tr>
<td>#define NDEF_PUSH_DELAY_COUNT 2</td>
</tr>
</tbody>
</table>

6.11 Traces output

By default, the example outputs all traces in the console window of MCUXpresso IDE. To redirect the traces to the virtual COM port offered by the MCU board, the compile flag DEBUG_SEMIHOSTING must be disabled (definition removed) inside the LPC-related project properties (see Figure 15) before building the project.

For K64 project, refer to: https://community.nxp.com/docs/DOC-334074.

Then open a terminal (i.e. TeraTerm, HyperTerminal, Putty …) to the virtual COM port with the following configuration:

- baud rate=115200 for OM13051, 460800 for OM13074 and OM13058
- 8 data bits, no parity, 1 stop bit, no flow control

Related port number can be retrieved from the “Ports (COM & LPT)” list inside computer “Device Manager”:

Running the example, traces are logged into the related window, offering much faster execution time (semi hosting function is time consuming) but also standalone execution:
In case of frame misalignment, verify the terminal configuration about CR/LF handling. Indeed, the project only makes use of LF to indicate end of line, so the terminal must be configured to handle automatically line end or to understand implicit CR in every LF.

### 6.12 NCI communication debugging

Enabling NCI communication traces can be done defining `NCI_DEBUG` compile flag inside the project properties (see Figure 15), or directly in `NfcLibrary/NxpNci/inc/NxpNci.h` file, before building the project.

Pay attention that this significantly increases overall memory requirement and then may require disabling some modes (refer to Section 6.3) to allow building the project.
## 7 Abbreviations

<table>
<thead>
<tr>
<th>Abbr.</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>AN</td>
<td>Application Note</td>
</tr>
<tr>
<td>EMU</td>
<td>Emulation (card emulation)</td>
</tr>
<tr>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>GPIO</td>
<td>General Purpose Input Output</td>
</tr>
<tr>
<td>HW</td>
<td>Hardware</td>
</tr>
<tr>
<td>I²C</td>
<td>Inter-Integrated Circuit (serial data bus)</td>
</tr>
<tr>
<td>IC</td>
<td>Integrated Circuit</td>
</tr>
<tr>
<td>IO</td>
<td>Input / Output</td>
</tr>
<tr>
<td>IRQ</td>
<td>Interrupt Request</td>
</tr>
<tr>
<td>NDEF</td>
<td>NFC Data Exchange Format</td>
</tr>
<tr>
<td>NFC</td>
<td>Near Field Communication</td>
</tr>
<tr>
<td>NFCC</td>
<td>NFC Controller</td>
</tr>
<tr>
<td>OS</td>
<td>Operating System</td>
</tr>
<tr>
<td>P2P</td>
<td>Peer to peer</td>
</tr>
<tr>
<td>PCD</td>
<td>Proximity Coupling Device (Contactless reader)</td>
</tr>
<tr>
<td>PIO</td>
<td>Programmed Input/Output</td>
</tr>
<tr>
<td>PICC</td>
<td>Proximity Integrated Circuit Card (Contactless card)</td>
</tr>
<tr>
<td>RF</td>
<td>Radiofrequency</td>
</tr>
<tr>
<td>RTOS</td>
<td>Real-Time Operating System</td>
</tr>
<tr>
<td>RST</td>
<td>Reset</td>
</tr>
<tr>
<td>R/W</td>
<td>Reader/Writer</td>
</tr>
<tr>
<td>SW</td>
<td>Software</td>
</tr>
<tr>
<td>T1T</td>
<td>Type 1 Tag (NFC Forum tag types definition)</td>
</tr>
<tr>
<td>T2T</td>
<td>Type 2 Tag (NFC Forum tag types definition)</td>
</tr>
<tr>
<td>T3T</td>
<td>Type 3 Tag (NFC Forum tag types definition)</td>
</tr>
<tr>
<td>T4T</td>
<td>Type 4 Tag (NFC Forum tag types definition)</td>
</tr>
<tr>
<td>VEN</td>
<td>V ENable pin (NFCC Hard reset control)</td>
</tr>
</tbody>
</table>
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