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Example Projects for NXP RD710 Reader

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Application note
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Document information

Info	Content
Keywords	Example Projects Pegoda, Pegoda, MIFARE examples, Pegoda MIFARE Plus, Pegoda MIFARE Ultralight, Pegoda, MIFARE Ultralight C, Pegoda SAM modes
Abstract	This document provides illustrative information on setting up the Pegoda software stack and specific mode configurations.

Revision history

Rev	Date	Description
1.1	20120710	Outdated types removed, ISO replaced with ISO/IEC
1.0	20110401	First release.
	20101101	Draft version

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1. Introduction

1.1 Scope

The Pegoda development kit is delivered with an Example Project code solution. The goal of this project is to offer development people everything they need for rapid development.

The main target of this document is focused on explaining the steps to build up the software stack for different reader modes. For correct reader and chip configuration, different layer dependent objects must be generated and linked.

Protocol related communication to MIFARE cards is not scope of this document. For more information on card commands and how they are used, refer to the Example Project source code, the “NXP Reader library” document and the MIFARE application notes.

1.2 Audience

This document is intended for use by manufacturers wanting to develop applications based on the software stack delivered within the Pegoda package.

1.3 Applicable Documents or References

[1] [ISO/IEC 14443]

[2] PC/SC Workgroup Specifications
www.nxp.com/redirect/pcscworkgroup.com/specifications/specdownload

[3] NXP Reader Library (in .chm format on CD included)

[4] www.nxp.com/redirect/en.wikipedia.org/wiki/Interrupt_handler

1.4 Acronyms and Abbreviations

SAM	Secure Access Module
S	SAM in S-Mode
N	no SAM
X	SAM in X-Mode
BAL	Bus Abstraction Layer
HAL	Hardware Abstraction Layer
PAL	Protocol Abstraction Layer
AL	Application Layer

1.5 Requirements

Opening the Example Project Solution requires Microsoft Visual Studio 2005 or later.

Furthermore, a Pegoda reader is necessary to execute the examples.

For information on availability of samples as well as documentation, please refer to the application note ‘Pegoda EV710 Documentation and Sampling guide’.

2. Overview

The Example Project provides developers with plenty of card communication examples based on MIFARE card products to start rapid development of applications. Examples included are

- MIFARE Classic (Authentication, Read/Write Block)
- MIFARE Ultralight, MIFARE Ultralight C
- MIFARE Plus (Security Level 3)

Programming applications with the Pegoda kit requires a basic knowledge of the different reader modes and the BFL structure.

Note, the complete command set is described in the NXP Reader library [3]. In order to use the command set within a new application project, the NXPRdLib.dll has to be included in the project file.

Building the software stack for a specific reader mode requires different software models to be generated.

The three types of operating modes within the PC/SC mode are:

- **No SAM mode (only RD710)**

  The most important aspect of this mode is performing activation and polling sequence for ISO/IEC 14443 A type cards as defined in PC/SC part 3. Selected cards are put in slot manager and notification is sent to PC/SC driver. There can be only one ISO/IEC 14443-3 card or multiple (maximum 14) ISO/IEC 14443-4 cards in the field.

- **SAM in non X-mode**

  SAM in non X-mode is similar as No SAM mode. The only difference is that slot 0 is always occupied with SAM, which can be used as key store, cryptographic engine, etc. The reader chip cannot be controlled by SAM in this mode.

- **SAM in X-mode**

  In this mode communication is only through SAM (slot 0). Only limited number of proprietary commands can be executed.

The specific (SAM) mode has to be specified during initialization of the software components.

2.1 NXP Reader Library Overview

The NXP reader library is encapsulated into Layers and Components written in ANSI C. The library structure provides a modular way of programming and setting up the reader interface.

The reader library consists of 4 layers

- BAL (Bus Abstraction Layer)
- HAL (Hardware Abstraction Layer)
- PAL (Protocol Abstraction Layer)

- AL (Application Layer)

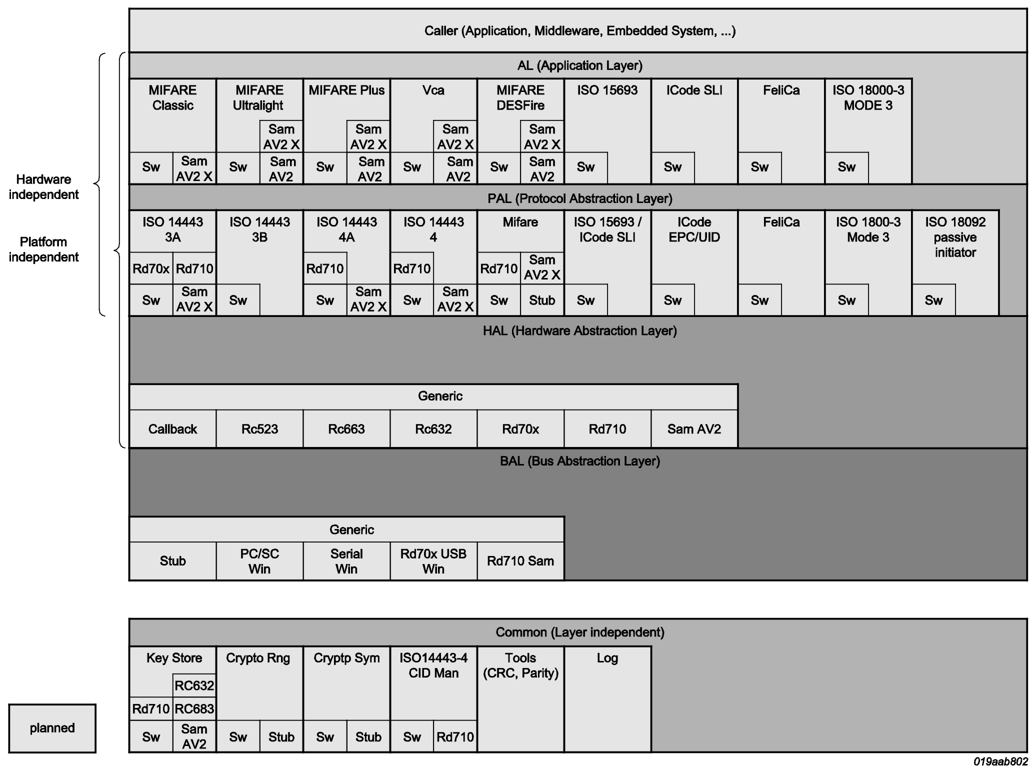

Fig 1. Reader Library Model

Each Layer consists of different components having a generic interface and a specific implementation.

2.2 Building the stack

In order to use the software library a stack of components has to be build up from bottom (BAL) to top (AL) layer. Fig 2 shows the various elements to build up a full software stack on the PC site for contactless card communication.

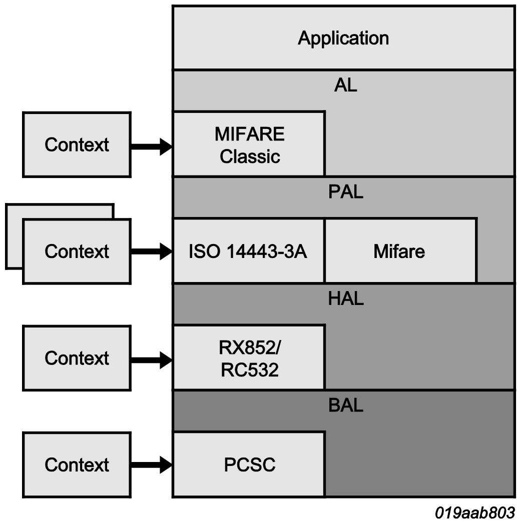

Fig 2. Building up the stack

Every component has to be initialized before usage. E.g. Initialization of the BAL layer requires specific context or data parameter to be fed into the component.

BAL Init

Therefore, Rd710 USB (Windows) BAL parameter structure has to be initialized

```
phbalReg_PcscWin_DataParams_t balPcsc;
```

and passed to the init function of the component

```
status = phbalReg_PcscWin_Init(&balPcsc, sizeof(phbalReg_PcscWin_DataParams_t));
```

Every component has an Init function for context data and component initialization. The init function checks the context data length to ensure no buffer overflow.

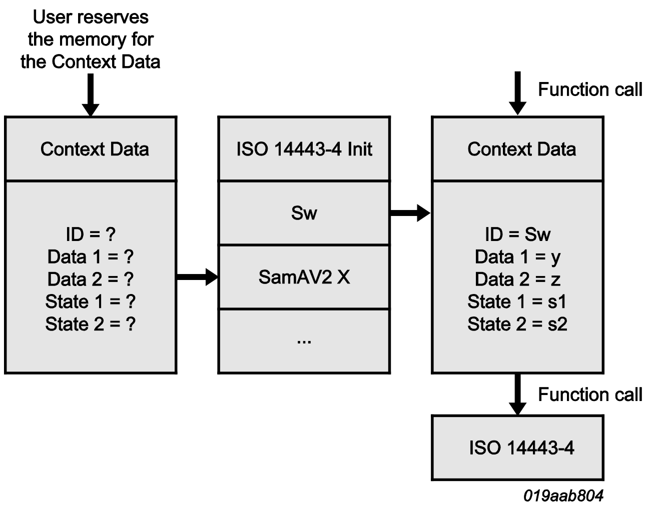

Fig 3. Context handling

The correct reader port parameter must be set with the setPort-function. Depending on the reader mode, different parameters are possible.

```
status = phbalReg_SetPort(&balReader, /**< [In] Port Name as String. */);
status = phbalReg_OpenPort(&balReader);
```

The next layer can now be built up using the same procedure.

HAL init

The HAL layer requires the structure

```
phhalHw_Rd710_DataParams_t halRd710;
```

to be initialized first.

The init routine is called by the HAL-structure parameter and referenced to the bottom BAL layer:

```
status = phhalHw_Rd710_Init(
            &halRd710,
            sizeof(phhalHw_Rd710_DataParams_t),
            &balPcsc,
            bHalBufferReaderTx,
            sizeof(bHalBufferReaderTx),
            bHalBufferReaderRx,
            sizeof(bHalBufferReaderRx));
```

Depending on the connected reader type (SAM, no SAM, …) it might be necessary to initialize additional structures. Refer to the examples in the code for more information.

PAL Init

The protocol abstraction layer inherits implementation of card activation and card protocol. Dependent on the card to be operated in the field, specific objects have to be initialized. For communication with a MIFARE Ultralight card on a Pegoda in non-SAM mode for example, we have to call the following structures:

```
status = phpalI14443p3a_Sw_Init(&palI14443p3a, sizeof(palI14443p3a), pHal);
CHECK_SUCCESS(status);

status = phpalI14443p4a_Sw_Init(&palI14443p4a, sizeof(palI14443p4a), pHal);
CHECK_SUCCESS(status);

status = phpalI14443p4_Sw_Init(&palI14443p4, sizeof(palI14443p4), pHal);
CHECK_SUCCESS(status);

status = phpalMifare_Sw_Init(&palMifare, sizeof(palMifare), pHal,&palI14443p4);
CHECK_SUCCESS(status);
```

Then, the HAL has to be configured for type-A cards with command

```
status = phhalHw_ApplyProtocolSettings(pHal, PHHAL_HW_CARDTYPE_ISO14443A);
```

Different card settings are defined in the header file ***phhalHw.h.***

AL operations

The application layer is the top layer of the software stack, providing specific implementations of various contactless protocols. The activation of the card must be done upfront in the lower protocol abstraction layer.

For detailed examples refer to the source code in the Example project.

Layer independent components

The software keystore and cryptographic functions in the library are not part of the layered approach. Before using any crypto operations within the provided functions, the dedicated crypto implementation has to be initialized:

```
phStatus_t phCryptoSym_Sw_Init  ( phCryptoSym_Sw_DataParams_t *  pDataParams,
  uint16_t  wSizeOfDataParams,
  void *  pKeyStoreDataParams
 )
```

3. How to set up different reader modes

The following subchapters should provide an entry point for understanding the basic handling of different reader modes and setting up the software stack, respectively.

Some points to remember from chapter 2:

- In order to use the library, the NXPRdLib software stack has to be built up from bottom to top layer
- Every component has dependencies to a component on the same layer or below
- For every card a complete stack has to be built to be able to communicate with the card
- The HAL layer provides the functionality to switch between multiple cards.

3.1 Single ISO/IEC 14443 card activation

The basic example of activation a single card and initializing the components and layers are already described in chapter 2.2. The stack model is outlined again in Fig 4.

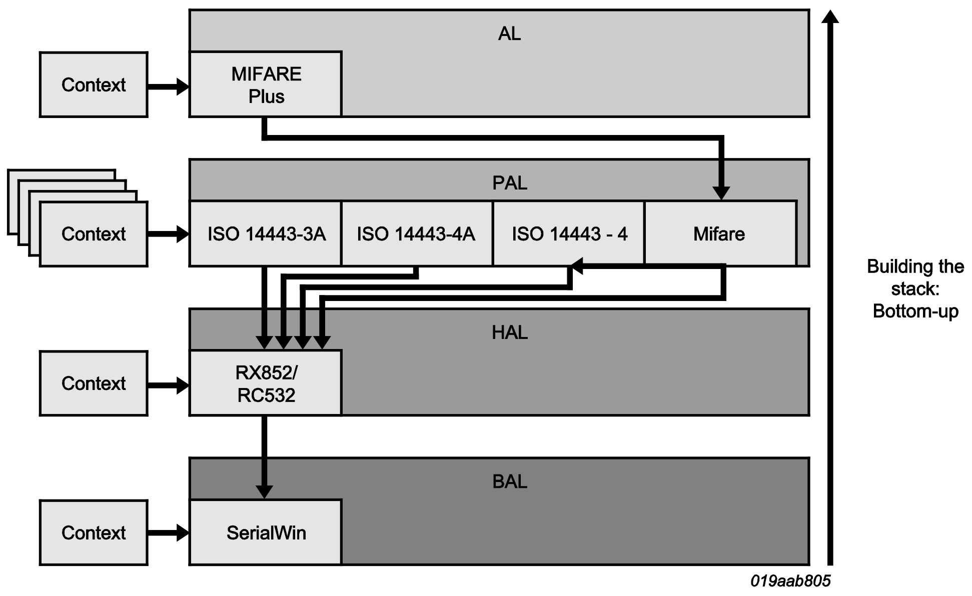

Fig 4. Single ISO/IEC 14443 card activation

3.2 Multiple ISO/IEC 14443 card activation

Communicating to more than one card requires initialization of additional HAL layers on a common BAL layer:

```
phhalHw_Rd710_DataParams_t halRd710[1];
phhalHw_Rd710_DataParams_t halRd710[2];
phhalHw_Rd710_DataParams_t halRd710[x];
```

All *halRD710[x]* objects have to be passed to the Init function to specify the BAL path.

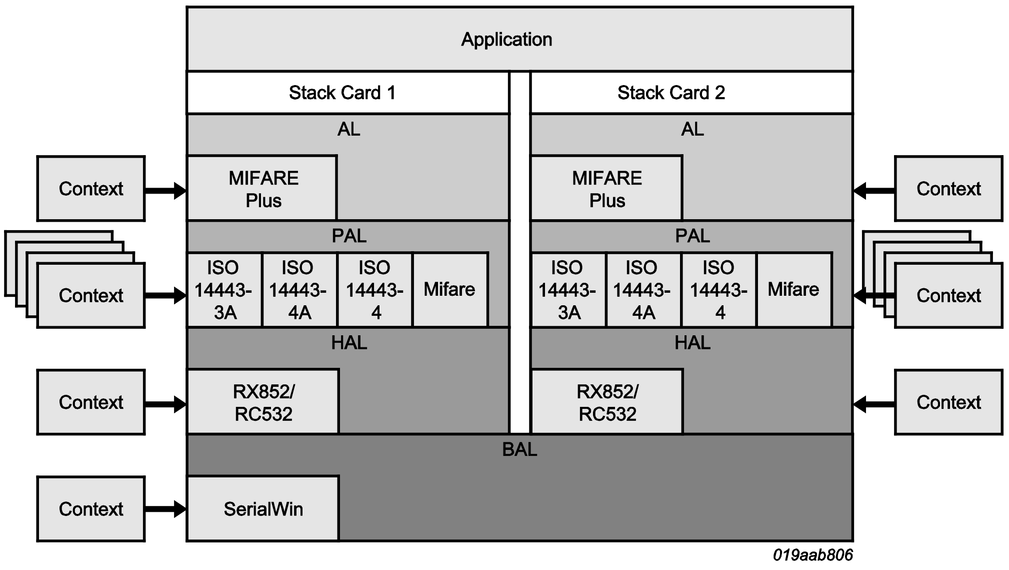

Fig 5. Multiple ISO/IEC 14443 card activation

3.3 SAM in X-Mode single card activation

The configuration of the Pegoda with SAM in X-Mode is different to non-SAM mode in the setup of the stack. Among others, it requires the ISO/IEC 14443 stack to be built-up on the SAM hardware. More details will follow; let’s see the steps to be done first:

1. The BAL PCSC components have to be initialized
   a. `phbalReg_PcscWin_DataParams_t balPcsc;`
   b. `phbalReg_PcscWin_Init(&balPcsc, sizeof(phbalReg_PcscWin_DataParams_t));`
2. Set the port to SAM in X-mode
   a. `phbalReg_SetPort(&balPcsc, (uint8_t*)PCSC_READER_P2_X_NAME);`
3. Generate an object for the SAM-HAL structure and initialize with the SamAVs_Init function
   a. `phhalHw_SamAV2_DataParams_t halSamLC0;`
   b. `phhalHw_SamAV2_Init(&halSamLC0,…)`
4. A keystore object can be created and a separate logical channel must be linked to this keystore object.
   a. `phKeyStore_SamAV2_DataParams_t keyStoreSAM;`
   b. `phhalHw_SamAV2_DataParams_t halSamLC1;`
   c. `phhalHw_SamAV2_Init(&halSamLC1,…)`
   d. `phKeyStore_SamAV2_Init(&keyStoreSAM, sizeof(phKeyStore_SamAV2_DataParams_t), &halSamLC1);`

Now, two logical channels have been created, one for the communication to the card, the other is linked to the keystore on the SAM

5. The reader can be opened now with
   a. `phbalReg_OpenPort(&balPcsc);`
6. So far the usage and initialization of the SAM structures were transparent. This means, we didn't differentiate between SAM AV1 or AV2 or even the connected Pegoda reader. We just generated SamAV2_DataParams objects for the keystore and the communication channel. Now it's time to get the SAM version with the getconfig command
   a. `phhalHw_GetConfig(&halSamLC0, PHHAL_HW_SAMAV2_CONFIG_HOSTMODE, aVersion);`

   This is necessary in order to load the DES or AES key into the corresponding SAM version and format the key entry correctly:

   b. `phKeyStore_FormatKeyEntry(pKeyStore, SAM_Key, /*Key_Type*/);`
7. Before we can communicate with the card, the ISO/IEC 14443-3 and ISO/IEC 14443-4 PAL layers have to be generated on the SAM. Therefore, we have to call SAM specific objects:
   a. `phpalI14443p3a_SamAV2_X_DataParams_t I14443p3a_X; /**< SAM PAL-ISO14443P3A parameter structure */`
   b. `phpalI14443p4a_SamAV2_X_DataParams_t I14443p4a_X; /**< SAM PAL-ISO14443P4A parameter structure */`
   c. `phpalI14443p4_SamAV2_X_DataParams_t I14443p4_X;   /**< SAM PAL-ISO14443P4 parameter structure */`

   This is different to the software based approach on the non SAM reader mode. Whenever it is necessary to generate the PAL stack on the PC/software side, we need to generate objects with

   d. `phpalI14443p3a_`**`Sw`**`_DataParams_t I14443p3a_Sw;`
   e. …
8. As usual the pointer of the generated objects and the underlying HAL layer must be linked with the corresponding Init functions:
   a. `phpalI14443p4a_SamAV2_X_Init((&I14443p4a_X, sizeof(phpalI14443p4a_SamAV2_X_DataParams_t), pHal);`
   b. `phpalI14443p4_SamAV2_X_Init(&I14443p4_X, sizeof(phpalI14443p4_SamAV2_X_DataParams_t), pHal);`
   c. `phpalMifare_SamAV2_X_Init(&palMifare_X, sizeof(phpalMifare_SamAV2_X_DataParams_t), pHal, &I14443p4_X);`
   d. `phalMfc_SamAV2_X_Init(&alMfc_X, sizeof(phalMfp_SamAV2_X_DataParams_t), pHal, &palMifare_X);`
9. Now we can perform host authentication and can communicate with the card

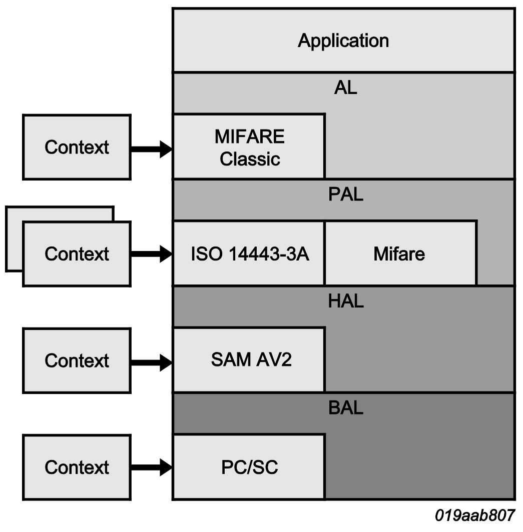

Fig 6. SAM in X-Mode

3.4 SAM in non X-Mode single card activation

1. The BAL PCSC components have to be initialized
   a. `phbalReg_PcscWin_DataParams_t balPcsc;`
   b. `phbalReg_PcscWin_Init(&balPcsc, sizeof(phbalReg_PcscWin_DataParams_t));`
2. Set the port to SAM in **non** X-mode
   a. `phbalReg_SetPort(&balPcsc, (uint8_t*) PCSC_READER_P2_NON_X_NAME);`
3. A HAL RD710 component has to be initilized
4. A second stack based on the RD710SAM BAL has to beinitialized and linked to the PCSC BAL as outlined in Fig 7.
   a. `phbalReg_Rd710Sam_Init(&balRd710Sam, sizeof(phbalReg_Rd710Sam_DataParams_t), &balPcsc, aBalBufferTx, sizeof(aBalBufferTx), aBalBufferRx, sizeof(aBalBufferRx));`
5. The last step would be the initiaization of the SAM logical channel component and opening the PCSC port.

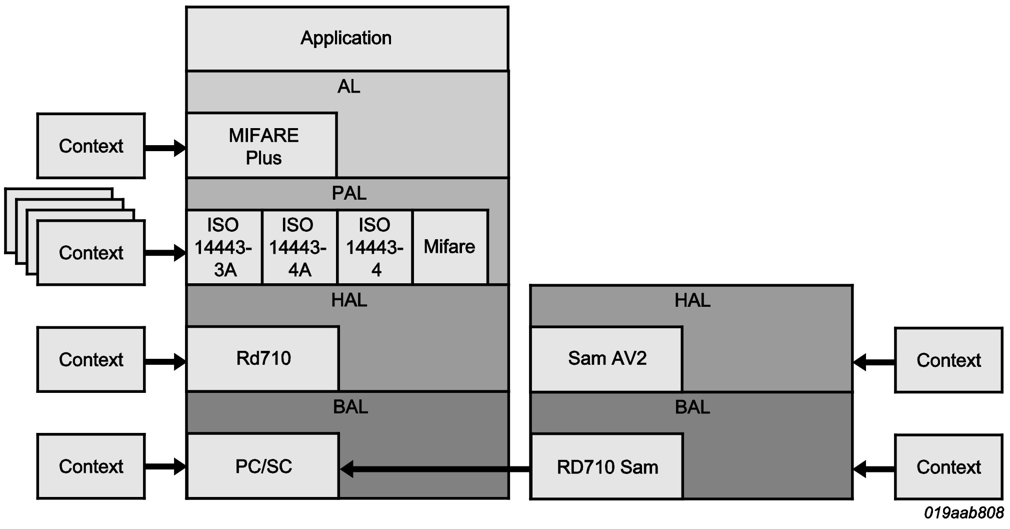

Fig 7. SAM in non X-Mode

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5. List of figures

6. Contents

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