AN11690

NXP NCI Android Porting Guidelines

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Application note
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Document information

Info	Content
Keywords	Android, NFC, NXP, NCI, PN7120, PN7150
Abstract	This note describes how to add support for a NXP NCI based NFC Controller to an Android system

Revision history

Rev	Date	Description
1.9	20200204	Added support for Android Q (PN7150 only), see section 3.1
1.8	20190710	Fixed confusing errors in Android Oreo guidelines
1.7	20181217	Fixed error in Android Pie installation guidelines (install script path) Mention added about PN7150 derivative support of Android Pie and Oreo
1.6	20181008	Repositories moved back to GitHub Added support for Android Pie (PN7150 only)
1.5	20180330	Repositories moved to CodeAurora Added support for Android Oreo (PN7150 only)
1.4	20170530	Added description of the NFC Factory Test native application
1.3	20170512	Added support for Android Nougat Added note about porting to other Android versions than referenced ones Fixed typo about kernel driver repository address Added information about sepolicy definition in the troubleshooting section
1.2	20160819	Added support for Android Marshmallow
1.1	20160525	Update for PN7150 support
1.0	20150602	First release

Contact information

For more information, please visit: http://www.nxp.com

1. Introduction

This document provides guidelines for the integration of NXP NCI based NFC Controller to an Android platform from software perspective.

It first explains how install the required kernel driver, then it describes step by step how to adapt the Android Open Source Project sources from the NXP-NCI Android NFC package delivery. Fig 1 shows the architecture of the Android NFC stack.

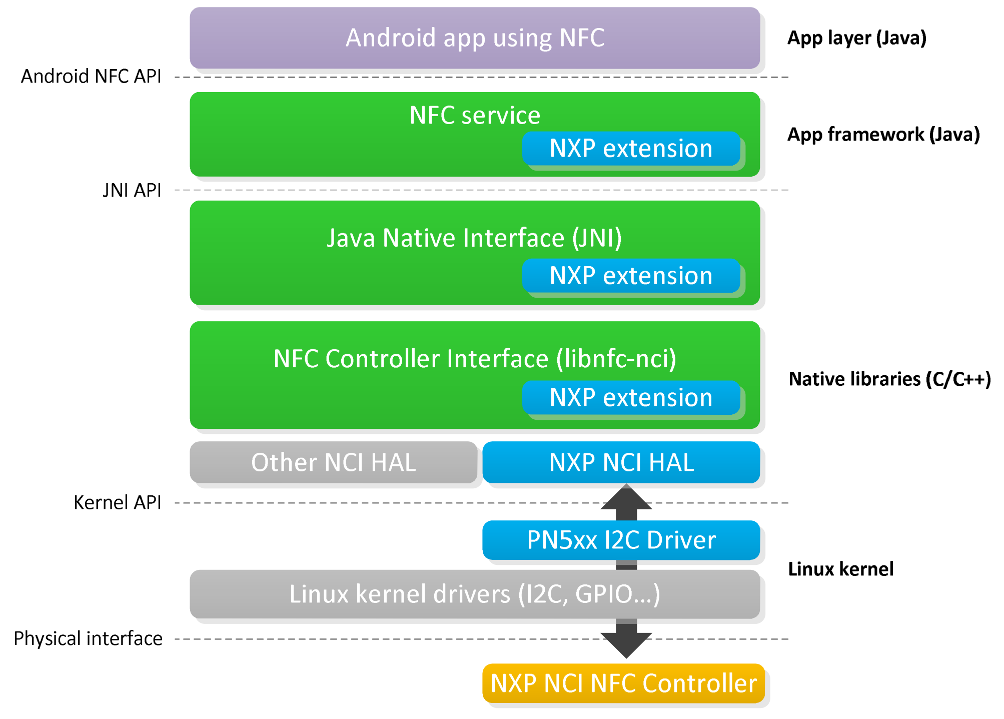


Fig 1. Android NFC stack overview

- The pn5xx_I2c driver is the kernel module allowing to access NXP NCI based NFC Controller hardware resource.
- The NXP NCI HAL module is the implementation of NXP NFC Controller's specific Hardware Abstraction Layer.
- The libnfc-nci is the native library providing NFC functionality for which extension is added to support NXP proprietary features (e.g. support for MIFARE Classic).
- The JNI is a glue code between Java and Native classes. Extension exposes related additional interface.
- The NFC service is the application framework module providing access to NFC functionality. Extension is delivered to support NXP proprietary features.

2. Kernel driver

The NXP-NCI Android stack uses PN5xx I2C kernel mode driver to communicate with the NXP NCI NFC Controller. It is available from the following repository: https://github.com/NXPNFCLinux/nxp-pn5xx.

2.1 Driver details

The PN5xx I2C driver offers communication to the NFC Controller connected over I2C physical interface. This is insured through the device node named */dev/pn544*. This low-level driver is compatible with a broad range of NXP's NFC Controllers (e.g. PN544).

2.2 Installation instructions

The following instructions assume the driver being installed under the *drivers/misc* kernel source sub-folder. Below instructions may have to be adapted accordingly in case another path is chosen for the driver installation.

2.2.1 Getting the driver

Clone the nxp-pn5xx repository into the kernel directory:

```
$ cd drivers/misc
$ git clone https://github.com/NXPNFCLinux/nxp-pn5xx.git
```

This will create the sub-folder *nxp-pn5xx* containing the following files:

- *pn5xx_i2c.c*: driver implementation
- *pn5xx_i2c.h*: driver interface definition
- *README.md*: repository comments
- *Makefile*: driver related makefile
- *Kconfig*: driver related config file
- *LICENSE*: driver licensing terms
- *sample_devicetree.txt*: example of device tree definition

2.2.2 Including the driver to the kernel

Include the driver to the compilation by adding below line to the heading makefile (*drivers/misc/Makefile*).

```
obj-y         += nxp-pn5xx/
```

Include the driver config by adding below line to the heading configuration file (*drivers/misc/Kconfig*).

```
source "drivers/misc/nxp-pn5xx/Kconfig"
```

2.2.3 Creating the device node

Two methods are supported for the creation of the */dev/pn544* device node: device tree and platform data. Any of the two methods can be used, but of course the I2C address (0x28 in the below examples) and GPIO assignments must be adapted to the hardware integration in the platform.

2.2.3.1 Device tree

Below is an example of definition to be added to the platform device tree file (*.dts* file located for instance under *arch/arm/boot/dts* kernel sub-folder for ARM based platform).

```
&i2c{
  status = "okay";
  pn547: pn547@28 {
    compatible = "nxp,pn547";
    reg = <0x28>;
    clock-frequency = <400000>;
    interrupt-gpios = <&gpio2 17 0>;
    enable-gpios = <&gpio4 21 0>;
  };
};
```

2.2.3.2 Platform data

Below is an example of definition to be added to the platform definition file. The structure *pn544_i2c_platform_data* being defined in the driver interface header file, *pn5xx_i2c.h* must be included in the platform definition file, and *pn5xx_i2c.h* file must be copied to *include/linux* kernel source sub-folder.

```
static struct pn544_i2c_platform_data nfc_pdata = {
  .irq_gpio = GPIO_TO_PIN(1,29),
  .ven_gpio = GPIO_TO_PIN(0,30),
  .firm_gpio = GPIO_UNUSED
  .clkreq_gpio = GPIO_UNUSED
};

static struct i2c_board_info __initdata nfc_board_info[] = {
  {
    I2C_BOARD_INFO("pn547", 0x28),
    .platform_data = &nfc_pdata,
  },
};
```

Then the declared ***nfc_board_info*** structure must be added to the platform using dedicated procedure (platform specific).

2.2.4 Building the driver

Through *menuconfig* procedure include the driver to the build, as built-in (<*>) or modularizes features (<M>):

```
Device Drivers --->
    Misc devices --->
        < > NXP PN5XX based driver
```

If <M> option is selected, build the driver and install the generated *pn5xx_i2c.ko* module. Otherwise if built-in, rebuild the complete kernel, the driver will be included in the kernel image.

If the device tree method was used in previous step, build the platform related device tree and install generated dtb file.

3. AOSP adaptation

3.1 Android Q

Below step-by-step procedure is based on NXP's Android NFC delivery from https://github.com/NXPNFCLinux/nxpnfc_android_q repository.

The current release is based on Android AOSP 10.0.0 version, porting on other Q version may requires minor adaptation of API (detected when compiling).

Pay attention that the AOSP adaptation of Android Q is only delivered for PN7150 (and PN7150 derivatives like PN7150X) support.

3.1.1 Step 1: retrieving NXP-NCI NFC delivery

Clone repository into AOSP source directory:

```
$ git clone https://github.com/NXPNFCLinux/nxpnfc_android_q.git
 ${ANDROID_BUILD_TOP}/vendor/nxp/nfc
```

3.1.2 Step 2: installing NXP-NCI delivery

Run the installation script:

```
$ ${ANDROID_BUILD_TOP}/vendor/nxp/nfc/install_NFC.sh
```

This will:

- Patch the AOSP *system/nfc* implementation to add PN7150 specific support
- Patch the AOSP *hardware/nxp/nfc* implementation to add PN7150 specific support
- Patch the AOSP *packages/apps/Nfc* folder to add support for PN7150 extensions feature
- Patch the AOSP *frameworks/native* definitions to add specific permissions

3.1.3 Step 3: updating configuration files

Adapt the *libnfc-nci.conf and libnfc-nxp.conf* files located in *vendor/nxp/nfc/hw/pn7150/conf* sub-folder, created at step 1, according to the integration specificities.

For instance if using a system clock instead of an on-board crystal, the value of parameter "NXP_SYS_CLK_SRC_SEL" in *libnfc-nxp.conf* must reflect this configuration.

More details about the configuration files can be find in chapter "4 Configuration Files".

3.1.4 Step 4: adding NFC to the build

In the *device.mk* makefile (e.g. *device/**brand**/**platform**/device.mk*), include specific makefile

```
$(call inherit-product, vendor/nxp/nfc/device-nfc.mk)
```

In the *BoardConfig.mk* makefile (e.g. *device/**brand**/**platform**/BoardConfig.mk*), include specific makefile

```
-include vendor/nxp/nfc/BoardConfigNfc.mk
```

3.1.5 Step 5: building and installing NFC

Build and flash the system image (the boot image shall already contain the kernel driver as instructed in chapter “2. Kernel driver”).

3.1.6 Step 6: verifying NFC functionality

In “Settings” app check NFC is ON. NFC functionality should be then up and running, ready to discover NFC tags or exchange data with remote NFC devices.

3.2 Android Pie

Below step-by-step procedure is based on NXP's Android NFC delivery from https://github.com/NXPNFCLinux/nxpnfc_android_pie repository.

The current release is based on Android AOSP 9.0.0 version, porting on other Pie version may requires minor adaptation of API (detected when compiling).

Pay attention that the AOSP adaptation of Android Pie is only delivered for PN7150 (and PN7150 derivatives like PN7150X) support.

3.2.1 Step 1: retrieving NXP-NCI NFC delivery

Clone repository into AOSP source directory:

```
$ git clone https://github.com/NXPNFCLinux/nxpnfc_android_pie.git
 ${ANDROID_BUILD_TOP}/vendor/nxp/nfc
```

3.2.2 Step 2: installing NXP-NCI delivery

Run the installation script:

```
$ ${ANDROID_BUILD_TOP}/vendor/nxp/nfc/install_NFC.sh
```

This will:

- Patch the AOSP *hardware/nxp/nfc* implementation to add PN7150 specific support
- Patch the AOSP *packages/apps/Nfc* to add support for PN7150 AGC debug feature

3.2.3 Step 3: updating configuration files

Adapt the *libnfc-nci.conf and libnfc-nxp.conf* files located in *vendor/nxp/nfc/hw/pn7150/conf* sub-folder, created at step 1, according to the integration specificities.

For instance if using a system clock instead of an on-board crystal, the value of parameter “NXP_SYS_CLK_SRC_SEL” in *libnfc-nxp.conf* must reflect this configuration.

More details about the configuration files can be find in chapter “4 Configuration Files”.

3.2.4 Step 4: adding NFC to the build

In the *device.mk* makefile (e.g. *device/**brand**/**platform**/device.mk*), include specific makefile

```
$(call inherit-product, vendor/nxp/nfc/device-nfc.mk)
```

In the *BoardConfig.mk* makefile (e.g. *device/**brand**/**platform**/BoardConfig.mk*), include specific makefile

```
-include vendor/nxp/nfc/BoardConfigNfc.mk
```

3.2.5 Step 5: building and installing NFC

Build and flash the system image (the boot image shall already contain the kernel driver as instructed in chapter “2. Kernel driver”).

3.2.6 Step 6: verifying NFC functionality

In “Settings” app check NFC is ON. NFC functionality should be then up and running, ready to discover NFC tags or exchange data with remote NFC devices.

3.3 Android Oreo

Below step-by-step procedure is based on NXP's Android NFC delivery from the following repositories: https://github.com/NXPNFCLinux/nxpnfc_android_oreo (later referenced as [NxpNfc_Android_oreo]) and https://source.codeaurora.org/external/nfcandroid (later referenced as [NfcAndroid_Project]).

The current release is based on Android AOSP 8.1.0 version, porting on other Oreo version may requires minor adaptation of API (detected when compiling).

Pay attention that the AOSP adaptation of Android Oreo is only delivered for PN7150 (and PN7150 derivatives like PN7150X) support.

3.3.1 Step 1: retrieving NXP-NCI NFC delivery

Retrieve the NXP-NCI NFC Android manifest file from [NxpNfc_Android_oreo] using *wget* command:

```
$ wget
https://raw.githubusercontent.com/NXPNFCLinux/nxpnfc_android_oreo/master
/nxpnfc_manifest.xml
```

Or using *curl* command:

```
$ curl
https://raw.githubusercontent.com/NXPNFCLinux/nxpnfc_android_oreo/master
/nxpnfc_manifest.xml > nxpnfc_manifest.xml
```

Then install it as local manifest in the AOSP source directory (if not existing, simply create it):

```
& mv nxpnfc_manifest.xml {ANDROID_BUILD_TOP}/.repo/local_manifests/
```

And apply changes brought by NXP-NCI NFC Android manifest:

```
$ repo sync --force-sync
```

This will autonomously:

- Retrieve source code to be used in next step 2 from [NfcAndroid_Project]/NfcAndroid_LibnfcNci, [NfcAndroid_Project]/NfcAndroid_Nfc, [NfcAndroid_Project]/NfcAndroid_Vendor and [NfcAndroid_Project]/NfcAndroid_Base.
- Retrieve installation scripts, patches to be used in next step 2, configuration files and native Factory Test application source code from [NxpNfc_Android_oreo]

3.3.2 Step 2: installing NXP-NCI delivery

Run the installation script:

```
$ ./NxpNfcAndroid/install_NFC.sh
```

This will autonomously:

- Replace AOSP *frameworks/base/core/java/android/nfc* folder with the one from NxpNfcAndroid sub-folder created at step 1
- Copy the content of NxpNfcAndroid/NfcAndroid_Vendor sub-folder, created at step 1, to AOSP *vendor* folder with the one from NxpNfcAndroid sub-folder
- Replace AOSP *packages/apps/Nfc* folder with the one from NxpNfcAndroid sub-folder created at step 1
- Replace AOSP *system/nfc* folder with the one from NxpNfcAndroid sub-folder created at step 1
- Patch the AOSP *core/tasks/check_boot_jars/package_whitelist.txt* to add NFC authorization
- Patch the AOSP *frameworks/base/Android.mk* to remove useless missing API
- Patch *system/sepolicy* files to add NFC specific rights
- Patch *external/libnfc-nci/halimpl/pn54x/Android.mk* and *external/libnfc-nci/Android.mk* to set support of PN7150 or PN7120
- Patch *system/nfc/halimpl/pn54x/configs/NxpNfcCapability.cpp* and *system/nfc/halimpl/pn54x/hal/phNxpNciHal_ext.c* in specific case of PN7150
- Patch *packages/apps/Nfc/nci/jni/NativeNfcManager.cpp* in specific case of PN7150

3.3.3 Step 3: updating configuration files

Adapt the *libnfc-brcm.conf*, *libnfc-nxp.conf* and *libnfc-nxp_RF.conf* files located in *NxpNfcAndroid/conf* sub-folder, created at step 1, according to the integration specificities.

For instance if using a system clock instead of an on-board crystal, the value of parameter “NXP_SYS_CLK_SRC_SEL” in *libnfc-nxp.conf* must reflect this configuration.

More details about the configuration files can be find in chapter “4 Configuration Files”.

3.3.4 Step 4: adding NFC to the build

In the *device.mk* makefile (e.g. *device/**brand**/**platform**/device.mk*)

- Add the NFC related packages to the android build

```
PRODUCT_PACKAGES += \
    NfcNci \
    Tag \
    android.hardware.nfc@1.0-impl \
    vendor.nxp.nxpnfc@1.0-impl \
    nfc_nci.pn54x
```

```
ifeq ($(ENABLE_TREBLE), true)
PRODUCT_PACKAGES += \
    vendor.nxp.nxpnfc@1.0-service
endif

PRODUCT_PROPERTY_OVERRIDES += \
    ro.hardware.nfc_nci=pn54x
```

- Add xml files to Android launches the NFC functionalities:

```
PRODUCT_COPY_FILES += \
frameworks/native/data/etc/android.hardware.nfc.xml:system/etc/permissio
ns/android.hardware.nfc.xml \
frameworks/native/data/etc/android.hardware.nfc.hce.xml:system/etc/permi
ssions/android.hardware.nfc.hce.xml \
frameworks/native/data/etc/android.hardware.nfc.hcef.xml:system/etc/perm
issions/android.hardware.nfc.hcef.xml \
NxpNfcAndroid/conf/libnfc-brcm.conf:system/vendor/etc/libnfc-brcm.conf \
NxpNfcAndroid/conf/libnfc-nxp.conf:system/vendor/etc/libnfc-nxp.conf \
NxpNfcAndroid/conf/libnfc-nxp_RF.conf:system/vendor/libnfc-nxp_RF.conf
```

3.3.5 Step 5: changing device owner and permissions

In the *system/core/rootdir/init.rc* file, add the following lines to the end of the *on post-fs* section:

```
    mkdir /data/vendor 0777 nfc nfc
    mkdir /data/vendor/nfc 0777 nfc nfc
    mkdir /data/vendor/nfc/param 0777 nfc nfc
    setprop ro.nfc.port "I2C"
    chmod 0660 /dev/pn544
    chown nfc nfc /dev/pn544
```

Add the following definition to device manifest file (*device/**brand**/**platform**/manifest.xml*)

```
    <hal format="hidl">
        <name>android.hardware.nfc</name>
        <transport>hwbinder</transport>
        <impl level="generic"></impl>
        <version>1.0</version>
        <interface>
            <name>INfc</name>
            <instance>default</instance>
        </interface>
    </hal>
    <hal format="hidl">
```

```
        <name>vendor.nxp.nxpnfc</name>
        <transport>hwbinder</transport>
        <impl level="generic"></impl>
        <version>1.0</version>
        <interface>
            <name>INnxpNfc</name>
            <instance>default</instance>
        </interface>
    </hal>
```

3.3.6 Step 6: building and installing NFC

Build and flash the system image (the boot image shall already contain the kernel driver as instructed in chapter “2. Kernel driver”).

3.3.7 Step 7: verifying NFC functionality

In “Settings” app check NFC is ON. NFC functionality should be then up and running, ready to discover NFC tags or exchange data with remote NFC devices.

3.4 Android Nougat

Below step-by-step procedure is based on NXP's Android NFC delivery from the following repositories: https://github.com/NXPNFCLinux/nxpnfc_android_nougat (later referenced as [NxpNfc_Android_nougat]) and https://github.com/NXPNFCProject (later referenced as [NxpNfc_Project]).

The current release is based on Android AOSP 7.1.1 version, porting on other Nougat version may requires minor adaptation of API (detected when compiling).

3.4.1 Step 1: retrieving NXP-NCI NFC delivery

Retrieve the NXP-NCI NFC Android manifest file from [NxpNfc_Android_nougat] using *wget* command:

```
$ wget
https://raw.githubusercontent.com/NXPNFCLinux/nxpnfc_android_nougat/mast
er/nxpnfc_manifest.xml
```

Or using *curl* command:

```
$ curl
https://raw.githubusercontent.com/NXPNFCLinux/nxpnfc_android_nougat/mast
er/nxpnfc_manifest.xml > nxpnfc_manifest.xml
```

Then install it as local manifest in the AOSP source directory:

```
& mv nxpnfc_manifest.xml {ANDROID_BUILD_TOP}/.repo/local_manifests/
```

And apply changes brought by NXP-NCI NFC Android manifest:

```
$ repo sync --force-sync
```

This will autonomously:

- Replace original AOSP *external/libnfc-nci* folder with the one from [NxpNfc_Project]/NFC_NCIHAL_libnfc-nci
- Replace original AOSP *packages/apps/Nfc* folder with the one from [NxpNfc_Project]/NFC_NCIHAL_Nfc and [NxpNfc_Project]/NXPNFC_Reference
- Retrieve source code to be merge with AOSP in next step 2 from [NxpNfc_Project]/NFC_NCIHAL_base
- Retrieve installation scripts, patches to be used in next step 2, configuration files and native Factory Test application source code from [NxpNfc_Android_nougat]

3.4.2 Step 2: installing NXP-NCI delivery

Run the installation script (with either PN7120 or PN7150 as <NFCC> parameter):

```
$ ./NxpNfcAndroid/install_NFC.sh <NFCC>
```

This will autonomously:

- Replace AOSP *hardware/libhardware/include/hardware/nfc.h* file with the one from NxpNfcAndroid sub-folder created at step 1
- Replace AOSP *frameworks/base/core/java/android/nfc* folder with the one from NxpNfcAndroid sub-folder created at step 1
- Copy AOSP *frameworks/base/core/java/com/nxp* folder from NxpNfcAndroid sub-folder created at step 1
- Copy AOSP *frameworks/base/core/java/com/vzw* folder from NxpNfcAndroid sub-folder created at step 1
- Patch the AOSP *frameworks/base/Android.mk* to insert NXP additions
- Patch *external/libnfc-nci/halimpl/pn54x/Android.mk* and *external/libnfc-nci/Android.mk* to set support of PN7150 or PN7120
- Patch *external/libnfc-nci/halimpl/pn54x/hal/phNxpNciHal.c* and *external/libnfc-nci/halimpl/pn54x/tml/phTmlNfc.c* in specific case of PN7120
- Patch *packages/apps/Nfc/nci/jni/Android.mk* to set support of PN7150 or PN7120
- Patch *packages/apps/Nfc/nci/jni/NativeNfcManager.cpp* in specific case of PN7150
- Copy configuration files, according to the NFCC selection, for further installation into the android system image

3.4.3 Step 3: updating configuration files

Adapt the *libnfc-brcm.conf* and *libnfc-nxp.conf* files located in *NxpNfcAndroid/conf* sub-folder, created at step 2, according to the integration specificities.

For instance if using a system clock instead of an on-board crystal, the value of parameter “NXP_SYS_CLK_SRC_SEL” in *libnfc-nxp.conf* must reflect this configuration.

More details about the configuration files can be find in chapter “4 Configuration Files”.

3.4.4 Step 4: adding NFC to the build

In the *device.mk* makefile (e.g. *device/**brand**/**platform**/device.mk*)

- Add the NFC related packages to the android build

```
# NFC packages
PRODUCT_PACKAGES += \
            libnfc-nci \
            libnfc_nci_jni \
            nfc_nci_pn54x.default\
            NfcNci \
            Tag \
            com.android.nfc_extras
```

- Add xml files to Android launches the NFC functionalities:

```
PRODUCT_COPY_FILES += \
frameworks/native/data/etc/com.nxp.mifare.xml:system/etc/permissions/com
.nxp.mifare.xml \
frameworks/native/data/etc/com.android.nfc_extras.xml:system/etc/permiss
ions/com.android.nfc_extras.xml \
frameworks/native/data/etc/android.hardware.nfc.xml:system/etc/permissio
ns/android.hardware.nfc.xml \
frameworks/native/data/etc/android.hardware.nfc.hce.xml:system/etc/permi
ssions/android.hardware.nfc.hce.xml \
NxpNfcAndroid/android.hardware.nfc.hcef.xml:system/etc/permissions/andro
id.hardware.nfc.hcef.xml \
NxpNfcAndroid/conf/libnfc-brcm.conf:system/etc/libnfc-brcm.conf \
NxpNfcAndroid/conf/libnfc-nxp.conf:system/etc/libnfc-nxp.conf
```

3.4.5 Step 5: changing device owner and permissions

On the *system/core/rootdir/init.rc* file, add the following lines to the end of the *on-boot* section:

```
# NFC
    setprop ro.nfc.port "I2C"
    chmod 0660 /dev/pn544
    chown nfc nfc /dev/pn544
```

3.4.6 Step 6: building and installing NFC

Build and flash the system image (the boot image shall already contain the kernel driver as instructed in chapter “2. Kernel driver”).

3.4.7 Step 7: verifying NFC functionality

In “Settings” app check NFC is ON. NFC functionality should be then up and running, ready to discover NFC tags or exchange data with remote NFC devices.

3.5 Android Marshmallow

Below step-by-step procedure is based on NXP's Android NFC delivery from the following repositories: https://github.com/NXPNFCLinux/nxpnfc_android_marshmallow (later referenced as [NxpNfc_Android_marshmallow]) and https://github.com/NXPNFCProject (later referenced as [NxpNfc_Project]).

The current release is based on Android AOSP 6.0.1 version, porting on other Marshmallow version may requires minor adaptation of API (detected when compiling).

3.5.1 Step 1: retrieving NXP-NCI NFC delivery

Retrieve the NXP-NCI NFC Android manifest file from [NxpNfc_Android_marshmallow] using *wget* command:

```
$ wget
https://raw.githubusercontent.com/NXPNFCLinux/nxpnfc_android_marshmallow
/master/nxpnfc_manifest.xml
```

Or using *curl* command:

```
$ curl
https://raw.githubusercontent.com/NXPNFCLinux/nxpnfc_android_marshmallow
/master/nxpnfc_manifest.xml > nxpnfc_manifest.xml
```

Then install it as local manifest in the AOSP source directory:

```
& mv nxpnfc_manifest.xml {ANDROID_BUILD_TOP}/.repo/local_manifests/
```

And apply changes brought by NXP-NCI NFC Android manifest:

```
$ repo sync --force-sync
```

This will autonomously:

- Replace original AOSP *external/libnfc-nci* folder with the one from [NxpNfc_Project]/NFC_NCIHAL_libnfc-nci
- Replace original AOSP *packages/apps/Nfc* folder with the one from [NxpNfc_Project]/NFC_NCIHAL_Nfc and [NxpNfc_Project]/NXPNFC_Reference
- Retrieve source code to be merge with AOSP in next step 2 from [NxpNfc_Project]/NFC_NCIHAL_base
- Retrieve installation scripts, patches to be used in next step 2, configuration files and native Factory Test application source code from [NxpNfc_Android_marshmallow]

3.5.2 Step 2: installing NXP-NCI delivery

Run the installation script (with either PN7120 or PN7150 as <NFCC> parameter):

```
$ ./NxpNfcAndroid/install_NFC.sh <NFCC>
```

This will autonomously:

- Replace AOSP *hardware/libhardware/include/hardware/nfc.h* file with the one from NxpNfcAndroid sub-folder created at step 1
- Replace AOSP *frameworks/base/core/java/android/nfc* folder with the one from NxpNfcAndroid sub-folder created at step 1
- Copy AOSP *frameworks/base/core/java/com/nxp* folder from NxpNfcAndroid sub-folder created at step 1
- Copy AOSP *frameworks/base/core/java/com/vzw* folder from NxpNfcAndroid sub-folder created at step 1
- Patch the AOSP *frameworks/base/Android.mk* to insert NXP additions
- Patch the AOSP *frameworks/base/api/current.txt, frameworks/base/api/system-current.txt, frameworks/base/core/java/android/content/pm/PackageManager.java* and *frameworks/base/core/res/res/values/attrs.xml* to add FeliCa HCE support in the scope of PN7150
- Patch *external/libnfc-nci/halimpl/pn54x/Android.mk* and *external/libnfc-nci/Android.mk* to set support of PN7150 or PN7120
- Patch *external/libnfc-nci/halimpl/pn54x/hal/phNxpNciHal.c* in specific case of PN7120
- Patch *packages/apps/Nfc/nci/jni/Android.mk* to set support of PN7150 or PN7120
- Patch *packages/apps/Nfc/nci/jni/NativeNfcManager.cpp* in specific case of PN7150
- Copy configuration files, according to the NFCC selection, for further installation into the android system image

3.5.3 Step 3: updating configuration files

Adapt the *libnfc-brcm.conf* and *libnfc-nxp.conf* files located in *NxpNfcAndroid/conf* sub-folder, created at step 2, according to the integration specificities.

For instance if using a system clock instead of an on-board crystal, the value of parameter “NXP_SYS_CLK_SRC_SEL” in *libnfc-nxp.conf* must reflect this configuration.

More details about the configuration files can be find in chapter “4 Configuration Files”.

3.5.4 Step 4: adding NFC to the build

In the *device.mk* makefile (e.g. *device/**brand**/**platform**/device.mk*)

- Add the NFC related packages to the android build

```
# NFC packages
PRODUCT_PACKAGES += \
            libnfc-nci \
            libnfc_nci_jni \
            nfc_nci_pn54x.default\
            NfcNci \
            Tag \
            com.android.nfc_extras
```

- Add xml files to Android launches the NFC functionalities:

```
PRODUCT_COPY_FILES += \
frameworks/native/data/etc/com.nxp.mifare.xml:system/etc/permissions/com
.nxp.mifare.xml \
frameworks/native/data/etc/com.android.nfc_extras.xml:system/etc/permiss
ions/com.android.nfc_extras.xml \
frameworks/native/data/etc/android.hardware.nfc.xml:system/etc/permissio
ns/android.hardware.nfc.xml \
frameworks/native/data/etc/android.hardware.nfc.hce.xml:system/etc/permi
ssions/android.hardware.nfc.hce.xml \
NxpNfcAndroid/android.hardware.nfc.hcef.xml:system/etc/permissions/andro
id.hardware.nfc.hcef.xml \
NxpNfcAndroid/conf/libnfc-brcm.conf:system/etc/libnfc-brcm.conf \
NxpNfcAndroid/conf/libnfc-nxp.conf:system/etc/libnfc-nxp.conf
```

3.5.5 Step 5: changing device owner and permissions

On the *system/core/rootdir/init.rc* file, add the following lines to the end of the *on-boot* section:

```
# NFC
    setprop ro.nfc.port "I2C"
    chmod 0660 /dev/pn544
    chown nfc nfc /dev/pn544
```

3.5.6 Step 6: building and installing NFC

Build and flash the system image (the boot image shall already contain the kernel driver as instructed in chapter “2. Kernel driver”).

3.5.7 Step 7: verifying NFC functionality

In “Settings” app check NFC is ON. NFC functionality should be then up and running, ready to discover NFC tags or exchange data with remote NFC devices.

3.6 Android Lollipop

Below step-by-step procedure is based on NXP's Android NFC delivery from the following repositories: https://github.com/NXPNFCLinux/nxpnfc_android_lollipop (later referenced as [NxpNfc_Android_lollipop]) and https://github.com/NXPNFCProject (later referenced as [NxpNfc_Project]).

The current release is based on Android AOSP 5.1.1 version, porting on other Lollipop version may requires minor adaptation of API (detected when compiling).

3.6.1 Step 1: retrieving NXP-NCI NFC delivery

Retrieve the NXP-NCI NFC Android manifest file from [NxpNfc_Android_lollipop] using *wget* command:

```
$ wget
https://raw.githubusercontent.com/NXPNFCLinux/nxpnfc_android_lollipop/ma
ster/nxpnfc_manifest.xml
```

Or using *curl* command:

```
$ curl
https://raw.githubusercontent.com/NXPNFCLinux/nxpnfc_android_lollipop/ma
ster/nxpnfc_manifest.xml > nxpnfc_manifest.xml
```

Then install it as local manifest in the AOSP source directory:

```
& mv nxpnfc_manifest.xml {ANDROID_BUILD_TOP}/.repo/local_manifests/
```

And apply changes brought by NXP-NCI NFC Android manifest:

```
$ repo sync --force-sync
```

This will autonomously:

- Replace original AOSP *external/libnfc-nci* folder with the one from [NxpNfc_Project]/NFC_NCIHAL_libnfc-nci
- Replace original AOSP *packages/apps/Nfc* folder with the one from [NxpNfc_Project]/NFC_NCIHAL_Nfc and [NxpNfc_Project]/NXPNFC_Reference
- Retrieve source code to be merge with AOSP in next step 2 from [NxpNfc_Project]/NFC_NCIHAL_base
- Retrieve installation scripts, patches to be used in next step 2, configuration files and native Factory Test application source code from [NxpNfc_Android_lollipop]

3.6.2 Step 2: installing NXP-NCI delivery

Run the installation script (with either PN7120 or PN7150 as <NFCC> parameter):

```
$ ./NxpNfcAndroid/install_NFC.sh <NFCC>
```

This will autonomously:

- Replace AOSP *hardware/libhardware/include/hardware/nfc.h* file with the one from NxpNfcAndroid sub-folder created at step 1
- Replace AOSP *frameworks/base/core/java/android/nfc* folder with the one from NxpNfcAndroid sub-folder created at step 1
- Copy AOSP *frameworks/base/core/java/com/nxp* folder from NxpNfcAndroid sub-folder created at step 1
- Copy AOSP *frameworks/base/core/java/com/vzw* folder from NxpNfcAndroid sub-folder created at step 1
- Patch the AOSP *frameworks/base/Android.mk* to insert NXP additions
- Patch *external/libnfc-nci/halimpl/pn54x/Android.mk* and *external/libnfc-nci/Android.mk* to set support of PN7120 if selected as script parameter
- Patch *packages/apps/Nfc/nci/jni/Android.mk* to set support of PN7120 if selected as script parameter

3.6.3 Step 3: updating configuration files

Adapt the *libnfc-brcm.conf* and *libnfc-nxp.conf* files located in *NxpNfcAndroid/conf* sub-folder, created at step 1, according to the integration specificities.

For instance if using a system clock instead of an on-board crystal, the value of parameter “NXP_SYS_CLK_SRC_SEL” in *libnfc-nxp.conf* must reflect this configuration.

More details about the configuration files can be find in chapter “4 Configuration Files”.

3.6.4 Step 4: adding NFC to the build

In the *device.mk* makefile (e.g. *device/**brand**/**platform**/device.mk*)

- Add the NFC related packages to the android build

```
# NFC packages
PRODUCT_PACKAGES += \
            libnfc-nci \
            libnfc_nci_jni \
            nfc_nci_pn54x.default\
            NfcNci \
            Tag \
            com.android.nfc_extras
```

- Add xml files to Android launches the NFC functionalities:

```
PRODUCT_COPY_FILES += \
frameworks/native/data/etc/com.nxp.mifare.xml:system/etc/permissions/com
.nxp.mifare.xml \
frameworks/native/data/etc/com.android.nfc_extras.xml:system/etc/permiss
ions/com.android.nfc_extras.xml \
frameworks/native/data/etc/android.hardware.nfc.xml:system/etc/permissio
ns/android.hardware.nfc.xml \
frameworks/native/data/etc/android.hardware.nfc.hce.xml:system/etc/permi
ssions/android.hardware.nfc.hce.xml \
NxpNfcAndroid/conf/libnfc-brcm.conf:system/etc/libnfc-brcm.conf \
NxpNfcAndroid/conf/libnfc-nxp.conf:system/etc/libnfc-nxp.conf
```

3.6.5 Step 5: changing device owner and permissions

On the *system/core/rootdir/init.rc* file, add the following lines to the end of the *on-boot* section:

```
# NFC
    setprop ro.nfc.port "I2C"
    chmod 0660 /dev/pn544
    chown nfc nfc /dev/pn544
```

3.6.6 Step 6: building and installing NFC

Build and flash the system image (the boot image shall already contain the kernel driver as instructed in chapter “2. Kernel driver”).

3.6.7 Step 7: verifying NFC functionality

In “Settings” app check NFC is ON. NFC functionality should be then up and running, ready to discover NFC tags or exchange data with remote NFC devices.

3.7 Android KitKat

Below step-by-step procedure is based on NXP-NCI Android NFC package delivered by NXP on the following repository: https://github.com/NXPNFCLinux/nxpnfc_android_kitkat.

The current release is based on Android AOSP 4.4.4 version, porting on other KitKat versions may requires minor adaptation of API (detected when compiling).

3.7.1 Step 1: getting the release package

Clone the related repository:

```
$ git clone https://github.com/NXPNFCLinux/nxpnfc_android_kitkat.git
```

The following directory structure will be created:

```
├── aosp
│   └── external/libnfc-nci
│       └── ...
│   └── frameworks/base
│       └── core/java/android/nfc
│           └── ...
│       └── core/java/com/vzw/nfc
│           └── ...
│       └── Android.mk
│   └── hardware/libhardware/include/hardware
│       └── nfc.h
│   └── packages/apps/Nfc
│       └── ...
├── conf
│   └── libnfc-brcm.conf
│   └── libnfc-nxp.conf
├── FactoyTestApp
│   └── Android.mk
│   └── NfcFactoryTestApp.c
├── doc
│   └── AN11690 – NXP-NCI Android Porting Guidelines.pdf
└── README.txt
```

3.7.2 Step 2: merging files

Merge the files from the NXP-NCI Android NFC package (*aosp* sub-folder) into the target AOSP source directory:

- Replace original AOSP *external/libnfc-nci* folder
- Replace original AOSP *frameworks/base/core/java/android/nfc* folder

- Copy or replace original AOSP *frameworks/base/core/java/com/vzw/nfc* folder
- Merge original AOSP *frameworks/base/Android.mk* with the one from the delivery (only "nfc" related items must be added to the original makefile)
- Replace original AOSP *hardware/libhardware/include/hardware/nfc.h* file
- Replace original AOSP *packages/apps/Nfc* folder
- Copy FactoryTestApp sub-folder into a new folder named *NxpNxpNfcAndroid* (at AOSP root path)

3.7.3 Step 3: selecting the NFC Controller

In the following makefiles:

- *aosp/external/libnfc-nci/Android.mk*
- *aosp/external/libnfc-nci/halimpl/pn54x/Android.mk*
- *aosp/packages/apps/Nfc/nci/jni/Android.mk*

Adapt the following line according to the integrated NFC Controller:

➢ for PN7150

```
D_CFLAGS += -DNFC_NXP_CHIP_PN548AD=TRUE
```

➢ for PN7120

```
D_CFLAGS += -DNFC_NXP_CHIP_PN548AD=FALSE
```

3.7.4 Step 4: adding NFC to the build

In the *device.mk* makefile (e.g. *device/**brand**/**platform**/device.mk*)

- Add the NFC related packages to the android build

```
# NFC packages
PRODUCT_PACKAGES += \
            libnfc-nci \
            libnfc_nci_jni \
            nfc_nci_pn54x.default\
            NfcNci \
            Tag \
            com.android.nfc_extras
```

- Add xml files to Android launches the NFC functionalities:

```
PRODUCT_COPY_FILES += \
frameworks/native/data/etc/com.nxp.mifare.xml:system/etc/permissions/com
.nxp.mifare.xml \
frameworks/native/data/etc/com.android.nfc_extras.xml:system/etc/permiss
ions/com.android.nfc_extras.xml \
frameworks/native/data/etc/android.hardware.nfc.xml:system/etc/permissio
ns/android.hardware.nfc.xml \
frameworks/native/data/etc/android.hardware.nfc.hce.xml:system/etc/permi
ssions/android.hardware.nfc.hce.xml
```

3.7.5 Step 5: changing device owner and permissions

On the *system/core/rootdir/init.rc* file, add the following lines to the end of the *on-boot* section:

```
# NFC
setprop ro.nfc.port "I2C"
chmod 0660 /dev/pn544
chown nfc nfc /dev/pn544
```

3.7.6 Step 6: building and installing NFC

Build and flash the system image (the boot image shall already contain the kernel driver as instructed in chapter “2. Kernel driver”).

Once the Android platform boots up, add the 2 configuration files required by the libnfc-nci library:

```
$ adb push libnfc-brcm.conf /etc/
$ adb push libnfc-nxp.conf /etc/
```

Examples are given in the NXP-NCI Android NFC package, under *conf* sub-directory, but pay attention that some adaptation may be required according to your integration (see chapter “4 Configuration Files” for more details). Then reboot the platform.

3.7.7 Step 7: verifying NFC functionality

In “Settings” app check NFC is ON.

NFC functionality should be then up and running, ready to discover NFC tags or exchange data with remote NFC devices.

3.8 Others Android versions

For other Android versions the AOSP must be manually adapted (merged) from the source retrieved as detailed in previous chapters depending of the targeted version.

4. Configuration Files

4.1 Android Pie

Two files allow configuring the libnfc-nci library at runtime: *libnfc-nci.conf* and *libnfc-nxp.conf*. There are defining tags which are impacting library behavior. The value of the tags depends on the NFC Controller IC and the targeted platform. For more details, refer to the examples given in *vendor/nxp/nfc/hw/pn7150* sub-folder of the stack delivery (see chapter 3.2.3).

These files are loaded by the library, from */vendor/etc* directory of the target, during the initialization phase.

Pay attention that the configuration files provided as example relates to the NFC Controller demo boards. These files must be adapted according to the targeted integration.

Below is the description of the different useful tags in the configuration files (refer to the conf files for detailed information about the tag values).

Table 1. Tag list of libnfc-nci.conf file

Tag	Description
APPL_TRACE_LEVEL	Log levels for libnfc-nci. Recommended value for debugging is 0xFF.
PROTOCOL_TRACE_LEVEL	Log levels for libnfc-nci. Recommended value for debugging is 0xFF.
NFA_STORAGE	Set the target directory for NFC file storage
HOST_LISTEN_TECH_MASK	Configure HOST listen feature.
SCREEN_OFF_POWER_STATE	Configuration of screen off power state.
POLLING_TECH_MASK	Configuration of the polling technologies.
P2P_LISTEN_TECH_MASK	Configuration of listen technologies for P2P.
NFA_DM_DISC_DURATION_POLL	Configuration of the discovery loop TOTAL DURATION (in milliseconds).
NFA_MAX_EE_SUPPORTED	Set the maximum number of Execution Environments supported.

Table 2. Tag list of libnfc-nxp.conf file

Tag	Description
NXPLOG_EXTNS_LOGLEVEL	Set level of EXTNS logs. Recommended value for debug is 0x03.
NXPLOG_NCIHAL_LOGLEVEL	Set level of NCIHAL logs. Recommended value for debug is 0x03.
NXPLOG_NCIX_LOGLEVEL	Set level of NCIX logs. Recommended value for debug is 0x03.
NXPLOG_NCIR_LOGLEVEL	Set level of NCIR logs. Recommended value for debug is 0x03.

Tag	Description
NXPLOG_FWDNLD_LOGLEVEL	Set level of FWDNLD logs. Recommended value for debug is 0x03.
NXPLOG_TML_LOGLEVEL	Set level of FWDNLD logs. Recommended value for debug is 0x03.
NXP_NFC_DEV_NODE	Set the NFC device node name.
MIFARE_READER_ENABLE	Set the support of the reader for MIFARE Classic.
NXP_SYS_CLK_SRC_SEL	Configure the clock source of the NFC Controller.
NXP_SYS_CLK_FREQ_SEL	Set the clock frequency in case of PLL clock source.
NXP_SYS_CLOCK_TO_CFG	Set clock request acknowledgment time value in case of PLL clock source.
NXP_ACT_PROP_EXTN	Set NXP's NFC Controller proprietary features.
NXP_CORE_STANDBY	Set the standby mode enabled or disabled.
NFA_PROPRIETARY_CFG	Set Vendor proprietary configuration.
NXP_EXT_TVDD_CFG	Set TVDD configuration mode (PN7150 only).
NXP_EXT_TVDD_CFG_x	Configure TVDD settings according TVDD mode selected (PN7150 only).
NXP_SET_CONFIG_ALWAYS	Set configuration optimization decision setting.
NXP_NFC_PROFILE_EXTN	Set discovery profile.
NXP_I2C_FRAGMENTATION_ENABLED	Configure I2C fragmentation.
NXP_RF_CONF_BLK_x	Set platform specific RF configuration.
NXP_CORE_CONF_EXTN	Configure proprietary parts of the NFC Controller.
NXP_CORE_CONF	Configure standardized parts of the NFC Controller.
NXP_CORE_MFCKEY_SETTING	Proprietary configuration for the key storage for MIFARE Classic.

4.2 Android Oreo

Three files allow configuring the libnfc-nci library at runtime: *libnfc-brcm.conf*, *libnfc-nxp.conf* and *libnfc-nxp_RF.conf*. There are defining tags which are impacting library behavior. The value of the tags depends on the NFC Controller IC and the targeted platform. For more details, refer to the examples given in *conf* sub-folder of the stack delivery (see chapter 3.3.3).

These files are loaded by the library, from */system/vendor/etc* directory (*/system/vendor* for *libnfc-nxp_RF.*conf file) on the target, during the initialization phase.

Pay attention that the configuration files provided as example relates to the NFC Controller demo boards. These files must be adapted according to the targeted integration.

Below is the description of the different useful tags in the configuration files (refer to the conf files for detailed information about the tag values).

Table 3. Tag list of libnfc-brcm.conf file

Tag	Description
APPL_TRACE_LEVEL	Log levels for libnfc-nci. Recommended value for debugging is 0xFF.
PROTOCOL_TRACE_LEVEL	Log levels for libnfc-nci. Recommended value for debugging is 0xFF.
HOST_LISTEN_TECH_MASK	Configure HOST listen feature.
SCREEN_OFF_POWER_STATE	Configuration of screen off power state.
PRESENCE_CHECK_ALGORITHM	Configure the T4T presence check method.
POLLING_TECH_MASK	Configuration of the polling technologies.
P2P_LISTEN_TECH_MASK	Configuration of listen technologies for P2P.
NCI_HAL_MODULE	Set NCI HAL module name.
NFA_DM_DISC_DURATION_POLL	Configuration of the discovery loop TOTAL DURATION (in milliseconds).
NFA_MAX_EE_SUPPORTED	Set the maximum number of Execution Environments supported.

Table 4. Tag list of libnfc-nxp.conf file

Tag	Description
NXPLOG_EXTNS_LOGLEVEL	Set level of EXTNS logs. Recommended value for debug is 0x03.
NXPLOG_NCIHAL_LOGLEVEL	Set level of NCIHAL logs. Recommended value for debug is 0x03.
NXPLOG_NCIX_LOGLEVEL	Set level of NCIX logs. Recommended value for debug is 0x03.
NXPLOG_NCIR_LOGLEVEL	Set level of NCIR logs. Recommended value for debug is 0x03.
NXPLOG_FWDNLD_LOGLEVEL	Set level of FWDNLD logs. Recommended value for debug is 0x03.
NXPLOG_TML_LOGLEVEL	Set level of FWDNLD logs. Recommended value for debug is 0x03.
NXP_NFC_DEV_NODE	Allow setting the device node name (if not set “/dev/pn544” is used by default).
MIFARE_READER_ENABLE	Set the support of the reader for MIFARE Classic..
NXP_SYS_CLK_SRC_SEL	Configure the clock source of the NFC Controller.
NXP_SYS_CLK_FREQ_SEL	Set the clock frequency in case of PLL clock source.

Tag	Description
NXP_SYS_CLOCK_TO_CFG	Set clock request acknowledgment time value in case of PLL clock source.
NXP_ACT_PROP_EXTN	Set NXP's NFC Controller proprietary features.
NXP_NFC_MERGE_RF_PARAMS	Set NFCC Configuration control.
NXP_CORE_STANDBY	Set the standby mode enabled or disabled.
NXP_EXT_TVDD_CFG	Set TVDD configuration mode (PN7150 only).
NXP_EXT_TVDD_CFG_x	Configure TVDD settings according TVDD mode selected (PN7150 only).
NXP_SET_CONFIG_ALWAYS	Force the clock configuration.
NXP_I2C_FRAGMENTATION_ENABLED	Set the I2C fragmentation capability.
NXP_NFC_PROFILE_EXTN	Set discovery profile.
NXP_CORE_MFCKEY_SETTING	Proprietary configuration for Key storage of MIFARE Classic.

Table 5. Tag list of libnfc-nxp_RF.conf file

Tag	Description
NXP_RF_CONF_BLK_x	Set platform specific RF configuration.
NXP_CORE_CONF_EXTN	Configure proprietary parts of the NFC Controller.
NXP_CORE_CONF	Configure standardized parts of the NFC Controller.

4.3 Android Nougat and previous versions

Two files allow configuring the libnfc-nci library at runtime: *libnfc-brcm.conf* and *libnfc-nxp.conf*. There are defining tags which are impacting library behavior. The value of the tags depends on the NFC Controller IC and the targeted platform. For more details, refer to the examples given in *conf* sub-folder of the stack delivery (see chapter 3.4.3, 3.5.3, 3.6.3 or 3.7.1).

These files are loaded by the library, from */etc* directory of the target, during the initialization phase.

Pay attention that the configuration files provided as example relates to the NFC Controller demo boards. These files must be adapted according to the targeted integration.

Below is the description of the different useful tags in the configuration files (refer to the conf files for detailed information about the tag values).

Table 6. Tag list of libnfc-brcm.conf file

Tag	Description
APPL_TRACE_LEVEL	Log levels for libnfc-nci. Recommended value for debugging is 0xFF.

Tag	Description
PROTOCOL_TRACE_LEVEL	Log levels for libnfc-nci. Recommended value for debugging is 0xFF.
HOST_LISTEN_ENABLE	Configure force HOST listen feature.
SCREEN_OFF_POWER_STATE	Configuration of screen off power state.
POLLING_TECH_MASK	Configuration of the polling technologies.
P2P_LISTEN_TECH_MASK	Configuration of listen technologies for P2P.
NFA_DM_DISC_DURATION_POLL	Configuration of the discovery loop TOTAL DURATION (in milliseconds).
NFA_MAX_EE_SUPPORTED	Set the maximum number of Execution Environments supported.

Table 7. Tag list of libnfc-nxp.conf file

Tag	Description
NXPLOG_EXTNS_LOGLEVEL	Set level of EXTNS logs. Recommended value for debug is 0x03.
NXPLOG_NCIHAL_LOGLEVEL	Set level of NCIHAL logs. Recommended value for debug is 0x03.
NXPLOG_NCIX_LOGLEVEL	Set level of NCIX logs. Recommended value for debug is 0x03.
NXPLOG_NCIR_LOGLEVEL	Set level of NCIR logs. Recommended value for debug is 0x03.
NXPLOG_FWDNLD_LOGLEVEL	Set level of FWDNLD logs. Recommended value for debug is 0x03.
NXPLOG_TML_LOGLEVEL	Set level of FWDNLD logs. Recommended value for debug is 0x03.
MIFARE_READER_ENABLE	Set the support of the reader for MIFARE Classic.
NXP_SYS_CLK_SRC_SEL	Configure the clock source of the NFC Controller.
NXP_SYS_CLK_FREQ_SEL	Set the clock frequency in case of PLL clock source.
NXP_SYS_CLOCK_TO_CFG	Set clock request acknowledgment time value in case of PLL clock source.
NXP_ACT_PROP_EXTN	Set NXP's NFC Controller proprietary features.
NXP_NFC_MERGE_RF_PARAMS	Set NFCC Configuration control.
NXP_CORE_STANDBY	Set the standby mode enabled or disabled.
NXP_EXT_TVDD_CFG	Set TVDD configuration mode (PN7150 only).
NXP_EXT_TVDD_CFG_x	Configure TVDD settings according TVDD mode selected (PN7150 only).
NXP_NFC_PROFILE_EXTN	Set discovery profile.
NXP_RF_CONF_BLK_x	Set platform specific RF configuration.

Tag	Description
NXP_CORE_CONF_EXTN	Configure proprietary parts of the NFC Controller.
NXP_CORE_CONF	Configure standardized parts of the NFC Controller.
NXP_CORE_MFCKEY_SETTING	Proprietary configuration for Key storage for MIFARE Classic.

5. Factory Test native application

To ease the characterization of the NFC integration in the Android device, the FactoryTestApp native application is offered. It allows setting the NFC controller into either:

- Constant RF emission mode (no modulation)
- or PRBS (Pseudo Random Binary Sequence) mode (continuous modulation)

The source code is delivered together with the AOSP adaptation release (see above steps 1 in AOSP adaptation procedures).

The binary is generated while building the system image, but can also be independently built using following command (depending on the Android release version):

- **Android version till Oreo:**

```
$ mmm vendor/nxp/nfc/FactoryTestApp
```

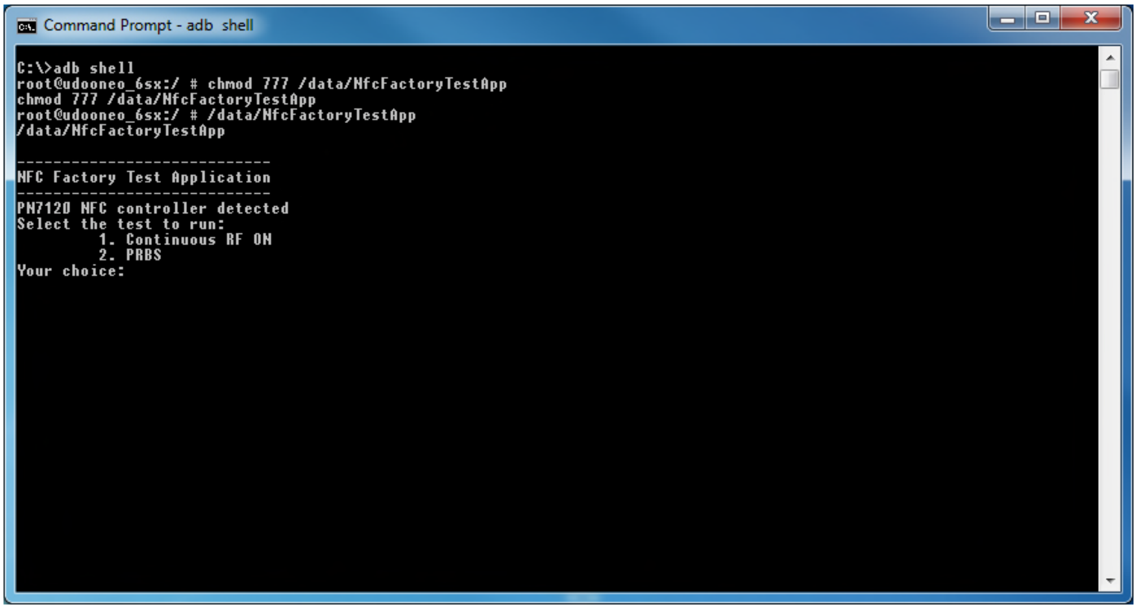
- **Android Oreo and later release:**

```
$ mmm NxpNfcAndroid/FactoryTestApp
```

Then copy the binary file (*out/target/product/**platform**/system/bin/NfcFactoryTestApp)* to the Android target, using adb tool for instance:

```
$ adb push NfcFactoryTestApp /data
```

On the Android target, update the file rights to allow execution and, after making sure the NFC service is disabled (in “Settings” app NFC must be off), run the application:



```
C:\>adb shell
root@udooneo_6sx:/ # chmod 777 /data/NfcFactoryTestApp
chmod 777 /data/NfcFactoryTestApp
root@udooneo_6sx:/ # /data/NfcFactoryTestApp
/data/NfcFactoryTestApp

----------------------------
NFC Factory Test Application
----------------------------
PN7120 NFC controller detected
Select the test to run:
         1. Continuous RF ON
         2. PRBS
Your choice:
```

Fig 2. Running Factory Test native application on Android target

6. Troubleshooting

The following items may help figuring out what is going wrong in case NFC is not working as expected when starting the Android device.

6.1 Device node rights

The following ADB logs may indicate a wrong setting of the kernel module related device node access rights:

```
…
D/NxpTml  (  894): Opening port=/dev/pn544
E/NxpTml  (  894): _i2c_open() Failed: retval ffffffff
D/NxpTml  (  894): phTmlNfc_i2c_reset(), VEN level 0
E/NxpHal  (  894): phTmlNfc_Init Failed
D/NfcAdaptation(  894): NfcAdaptation::HalDeviceContextCallback: event=0
I/BrcmNfcNfa(  894): nfc_main_hal_cback event: HAL_NFC_OPEN_CPLT_EVT(0x0), status=1
D/NxpHal  (  894): Failed to deallocate (list empty)
D/NxpHal  (  894): Node dump:
D/NxpHal  (  894): Failed to deallocate (list empty)
D/NxpHal  (  894): Node dump:
…
```

The pn5xx_i2c device node should usually appear with the following rights:

```
$ adb shell ls -als /dev/pn544
crw-rw---- nfc      nfc       10,  54 2016-05-03 13:05 pn544
```

If this is not the case, refer to related procedure chapter 3.3.5, 3.4.5, 3.5.5, 3.6.5 or 3.7.5.

Additionally, in case the platform implements Security-Enhanced Linux in Android, pn5xx_i2c device node must be declared as NFC device. This is done adding the following definition inside *device/**brand**/**platform**/sepolicy/file_contexts* file:

```
/dev/pn544          u:object_r:nfc_device:s0
```

6.2 Configuration files

The following ADB logs may indicates the absence of the configuration files:

```
…
D/BrcmNfcJni(  893): PowerSwitch::initialize: level=PS-FULL (1)
D/NfcAdaptation(  893): bool CNfcConfig::readConfig(const char*, bool) Cannot open config file
/etc/libnfc-brcm.conf
D/NfcAdaptation(  893): bool CNfcConfig::readConfig(const char*, bool) Using default value for all
settings
D/BrcmNfcJni(  893): PowerSwitch::initialize: desired screen-off state=1
D/NfcAdaptation(  893): NfcAdaptation::Initialize: enter
E/NfcAdaptation(  893): NfcAdaptation::Initialize: ver=NFCDROID-AOSP_L_00.01 nfa=NFA_PI_1.03.66+
D/BrcmNfcJni(  893): initializeGlobalAppLogLevel: level=5
D/NfcAdaptation(  893): NfcAdaptation::NFCA_TASK: enter
I/BrcmNfcNfa(  893): GKI_run(): Start/Stop GKI_timer_update_registered!
D/NfcAdaptation(  893): NfcAdaptation::Thread: enter
I/BrcmNfcNfa(  893): NFC_TASK started.
D/NfcAdaptation(  893): NfcAdaptation::InitializeHalDeviceContext: enter
E/NfcAdaptation(  893): No HAL module specified in config, falling back to BCM2079x
E/NfcAdaptation(  893): NfcAdaptation::InitializeHalDeviceContext: fail hw_get_module
nfc_nci.bcm2079x
D/NfcAdaptation(  893): NfcAdaptation::InitializeHalDeviceContext: exit
D/NfcAdaptation(  893): NfcAdaptation::Initialize: exit
I/BrcmNfcNfa(  893): NFA_Init ()
I/BrcmNfcNfa(  893): nfa_dm_init ()
…
```

They should usually be installed in */etc* android target directory:

```
$ adb shell ls -als /etc/libnfc*.conf
-rw-r--r-- root     root         3146 2016-03-11 23:07 libnfc-brcm.conf
-rw-r--r-- root     root         3738 2016-03-11 23:07 libnfc-nxp.conf
```

If this is not the case, refer to related procedure 3.2.4, 3.6.4 or 3.7.6.

6.3 NXP’s NFC library

The following ADB logs may indicates missing NXP’s NFC specific library:

```
…
I/BrcmNfcNfa( 2609): NFC_TASK started.
D/NfcAdaptation( 2609): NfcAdaptation::Thread: exit
D/NfcAdaptation( 2609): NfcAdaptation::InitializeHalDeviceContext: enter
D/NfcAdaptation( 2609): const CNfcParam* CNfcConfig::find(const char*) const found
NCI_HAL_MODULE=nfc_nci.pn54x
E/NfcAdaptation( 2609): NfcAdaptation::InitializeHalDeviceContext: fail hw_get_module nfc_nci.pn54x
D/NfcAdaptation( 2609): NfcAdaptation::InitializeHalDeviceContext: exit
D/NfcAdaptation( 2609): NfcAdaptation::Initialize: exit
…
```

The library should be located under */system/lib/hw* android target sub-directory:

```
$ adb shell ls -als /system/lib/hw/nfc*
-rw-r--r-- root  root   119188 2016-03-14 13:55 nfc_nci.pn54x.default.so
```

If this is not the case, insure it is properly built:

```
$ mmm external/libnfc-nci/ - snod
```

You can then either flash the newly created *system.img* or just copy the library to the android target:

```
$ adb push nfc_nci.pn54x.default.so /system/lib/hw/
```

6.4 NFC Controller choice

The following ADB logs may indicates a wrong adaptation of the NFC libraries to the NFC controller integrated (PN7120 or PN7150):

```
…
D/NxpTml  (25279): PN54X - Write requested.....
D/NxpTml  (25279): PN54X - Invoking I2C Write.....
D/NxpTml  (25279): PN54X - Read requested.....
D/NxpTml  (25279): PN54X - Invoking I2C Read.....
D/NxpNciX (25279): len =  10 > 20020702310100380101
D/NxpTml  (25279): PN54X - I2C Write successful.....
D/NxpTml  (25279): PN54X - Posting Fresh Write message.....
D/NxpTml  (25279): PN54X - Tml Writer Thread Running................
D/NxpHal  (25279): write successful status = 0x0
D/NxpTml  (25279): PN54X - I2C Read successful.....
D/NxpNciR (25279): len =   4 > 40020106
D/NxpTml  (25279): PN54X - Posting read message.....
D/NxpHal  (25279): read successful status = 0x0
D/NxpHal  (25279): > Deinit for LLCP set_config 0x0 0x0 0x0
D/NxpHal  (25279): phNxpNciHal_print_res_status: response status =STATUS_OK
…
```

If this is the case, refer to related procedure chapter 3.2.2, 3.6.2 or 3.7.3.

7. Legal information

7.1 Definitions

7.2 Disclaimers

7.3 Licenses

7.4 Trademarks

8. Contents

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