NFC Forum Type Tags
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NFC Forum Type Tags

Document Information

Information	Description
Title	NFC Forum Type Tags White Paper V1.0
Audience	Technical and marketing people
Abstract	The NFC Forum is an industry consortium to further develop and improve the Near Field Communication (NFC) technology. NFC is a new short range wireless connectivity technology that evolved from a combination of existing contactless identification and interconnection technologies. NFC enables intuitive and easy to use consumer devices interactions.
	Based on NFC the NFC Forum has created the NFC Data Exchange Format (NDEF) and the NFC Forum Type Tag Operation. NDEF is a data format to encapsulate and identify application data that is exchanged between NFC enabled devices. A type of such device is the NFC Forum Type Tag. The Type Tags are contactless cards based on currently available products capable to store NDEF formatted data.
	NDEF and the NFC Forum Type Tag Operation allow new kind of touch based applications: Smart Poster, automatic wireless communication configuration (e.g. Bluetooth pairing), electronic business card exchange, etc. Such applications can be implemented using already available in the market NFC enabled tag products: MIFARE Ultralight, MIFARE Ultralight C, MIFARE DESFire, SmartMX, Innovision Topaz, and Sony FeliCa.
	This document describes the NFC Forum, NDEF, the NFC Forum Type Tag Operation, the NFC enabled tag products, and several use cases related to the NFC Forum Type Tag Operation. Finally the Type MIFARE Classic Tag Operation based on the NXP family products MIFARE Classic 1k/4k/Mini is also described.
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Change History

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1.0	Approved	Initial Version	2009/04/01

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1. INTRODUCTION

This white paper gives a technical introduction to the NFC Forum Type Tags, the use cases where these devices can be applied and a comparison of currently available products.

The document consists of the following chapters:

- Chapter 2 describes the NFC Forum consortium, the NFC Forum device, and the NFC Forum Tag,

- Chapter 3 describes the storage of application data into the NFC Forum Type Tag platform and the NXP specific Type Tag platform,

- Chapter 4 describes several common use cases such as Smart Poster, Handover, vCard, URL, SMS and Call request,

- Chapter 5 compares based on the use cases of chapter 4 several NFC Forum tag products,

- Appendix A describes the NXP Type Tag Platform based on MIFARE Classic 1K/4K/mini, and

- Appendix B describes best practices.

1.1 References

The following Table 1 contains referenced documents.

Table 1 - Referenced documents.

Reference	Document
[HANDOVER]	Connection Handover, Candidate Technical Specification, NFC Forum, Connection Handover 1.0, April 14, 2008 (downloadable from www.nfc-forum.org/specs/)
[NDEF]	NFC Data Exchange Format (NDEF), Technical Specification, NFC Forum, Revision 1.0, July 24, 2006 (downloadable from www.nfc-forum.org/specs/)
[NFC FORUM]	www.nfc-forum.org
[NFC RTD]	NFC Record Type Definition (RTD), Technical Specification, NFC Forum, RTD 1.0, July 24, 2006 (downloadable from www.nfc-forum.org/specs/)
[NFCIP-1]	ISO/IEC 18092:2004, Information technology – Telecommunications and information exchange between systems – Near Field Communication – Interface and Protocol (NFCIP-1)
[NXP 1K]	MF1 IC S50, Functional Specification, DocNo. 1052 (downloadable from http://www.nxp.com/products/identification/MIFARE/classic/ see "MF1 ICS50 Functional Specification (350kB)")

[NXP 4K]	MF1 IC S70, Standard 4 kByte Card IC Functional Specification, DocNo. 0435 (downloadable from http://www.nxp.com/products/identification/MIFARE/classic/ see "MF1 ICS70 Functional specification (413kB)")	
[NXP DES]	MIFARE DESFire, Contactless Multi-Application IC with DES and 3DES Security, MF3 IC D40, DocNo. 0750 (to be requested from nxp.docu-control@nxp.com)	
[NXP MAD]	AN MAD, MIFARE Application Directory, DocNo. 1830 (downloadable from http://www.nxp.com/products/identification/MIFARE/index.html see "AN MAD MIFARE application directory (763kB)")	
[NXP MFNFC]	Application Note MIFARE Std as NFC Forum Enabled Tag, Revision 1.1, Document Number 130511, NXP Semiconductors, August 21, 2007 (downloadable from www.nxp.com/nfc see "Application Note MIFARE Standard as NFC Forum Tag 1.1 130511")	
[NXP MFTT]	Application Note Type MIFARE 1k/4k Tag, Revision 1.1, Document Number 130411, NXP Semiconductors, August 21, 2007 (downloadable from www.nxp.com/nfc see "Application Note Type MIFARE Standard 1k-4k Tag 1.1 130411")	
[NXP MINI]	MF1 IC S20, Functional Specification, DocNo. 1322 (downloadable from http://www.nxp.com/products/identification/MIFARE/classic/ see "MF1 ICS20 Functional Specification (372kB)")	
[NXP T2T]	Application Note MIFARE Ultralight as Type 2 Tag, Revision 1.2, Document Number 130312, NXP Semiconductors, May 15, 2008 (downloadable from www.nxp.com/nfc see "Application Note MIFARE Ultralight as Type 2 Tag 1.2 130312")	
[NXP T4T]	Application Note MIFARE DESFire as Type 4 Tag, Revision 1.1, Document Number 130211, NXP Semiconductors, August 21, 2007 (downloadable from www.nxp.com/nfc see "Application Note MIFARE DESFire as Type 4 Tag 1.1 130211")	
[NXP UL]	MF0 IC U1, Functional Specification Contactless Single-trip Ticket IC, DocNo. 028632 (downloadable from http://www.nxp.com/products/identification/MIFARE/ultralight/index.html see "MF0 ICU1 Functional specification contactless single-trip ticket IC (358kB)")	
[NXP ULC]	MF0 ICU2 Functional specification contactless single-trip ticket IC, DocNo. 1376 (to be requested from nxp.docu-control@nxp.com)	
[RFC 2425]	MIME Content-Type for Directory Information, RFC 2425, IETF, September 1998	
[RFC 2426]	vCard MIME Directory Profile, RFC 2426, IETF, September 1998	
[SP RTD]	Smart Poster Record Type Definition, Technical Specification, NFC Forum, SPR 1.1, July 24, 2006 (downloadable from www.nfc-forum.org/specs/)	
[TEXT RTD]	Text Record Type Definition, Technical Specification, NFC Forum, RTD-Text 1.0, July 24, 2006 (downloadable from www.nfc-forum.org/specs/)	
[TYPE 1 TAG]	NFC Forum, Type 1 Tag Operation Specification, July 9, 2007 (downloadable from www.nfc-forum.org/specs/)	

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[TYPE 2 TAG]	NFC Forum, Type 2 Tag Operation Specification, July 9, 2007 (downloadable from www.nfc-forum.org/specs/)
[TYPE 3 TAG]	NFC Forum, Type 3 Tag Operation Specification, August 16, 2007 (downloadable from www.nfc-forum.org/specs/)
[TYPE 4 TAG]	NFC Forum, Type 4 Tag Operation Specification, March 13, 2007 (downloadable from www.nfc-forum.org/specs/)
[URI RTD]	URI Record Type Definition, Technical Specification, NFC Forum, RTD-URI 1.0, July 24, 2006 (downloadable from www.nfc-forum.org/specs/)
[VCARD21]	vCard, The Electronic Business Card, Version 2.1, Versit Consortium Specification, September 18, 1996

1.2 Abbreviations

For the purposes of this document the following abbreviations in Table 2 apply.

Table 2 - Abbreviations

Acronym	Description
LAN	Local Area Network
MIME	Multipurpose Internet Mail Extensions
NDEF	NFC Data Exchange Format
NFC	Near Field Communication
PDA	Personal Digital Assistant
PIN	Personal Identification Number
SMS	Short Message Service
SSID	Service Set Identifier
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
WEP key	Wired Equivalent Privacy key

2. NFC FORUM

The NFC Forum is an industry consortium to further develop and improve the Near Field Communication (NFC) technology guaranteeing interoperability among devices and services. NFC is a new short range, low power contact-less technology. NFC enables intuitive and easy to use communications. The NFC technology can be applied to consumer electronics, mobile devices, and PCs.

For more information see [NFC FORUM].

2.1 The NFC Forum Device

The NFC Forum distinguishes between NFC Forum Devices and NFC Forum Tags.

An NFC Forum Device is a device that implements at least the mandatory parts of the NFC Forum Protocol Stack and complies with the NFC Forum interoperability requirements. An NFC Forum Device may support different NFC Forum Operating Modes: NFC Forum Peer Mode (mandatory), NFC Forum Reader/Writer Mode (mandatory), and NFC Forum Card Emulation Mode (Optional). The NFC Forum Device can be a mobile phone, a Personal Digital Assistant (PDA), a PCs or a consumer electronic device.

An NFC Forum Tag is a contactless tag compatible to one of four NFC Forum Tag platforms (see section 2.3 and chapter 3) or a Target according to ISO/IEC 18092 (see [NFCIP-1]).

Table 3 - Communication links (indicated with "✓") between an NFC Forum Devices and either an NFC Forum Device, NFC Forum Tag or a Reader/Writer Terminal.

			Communication link between an NFC Forum Device in…		
			…NFC Forum Peer Mode…	…NFC Forum Reader / Write Mode…	…NFC Forum Card Emulation Mode…
… and …	…an NFC Forum Device in …	…NFC Forum Peer Mode	✓	-	-
		…NFC Forum Reader/Write Mode	-	-	✓
		…NFC Forum Card Emulation Mode	-	✓	-
	…an NFC Forum Tag …	…operating as ISO 18092 Target	-	(✓)*	-
		…operating as one of the NFC Forum Type Tag platforms	-	✓	-
	…a Reader / Writer Terminal	-	-	-	✓

* This document focuses on this communication link.

Table 3 shows the possible communication links between the NFC Forum Device (in different Operating Modes) and either an NFC Forum Device, NFC Forum Tag or a Reader/Writer Terminal. Note that an NFC Forum Device in the NFC Forum Card Emulation Mode can communicate with a Reader/Writer Terminal.

This document focuses on the communication link highlighted in Table 3 with the symbol (✓)*, in particular: The "Communication link between an NFC Forum Device in NFC Forum Reader/Writer Mode and an NFC Forum Tag operating as one of the NFC Forum Type Tag platforms".

2.2 The NFC Forum Device in Reader/Writer Operating Mode

In NFC Forum Reader/Writer Mode, an NFC Forum Device shall have the capability to communicate with the NFC Forum Tags reading or writing data into it.
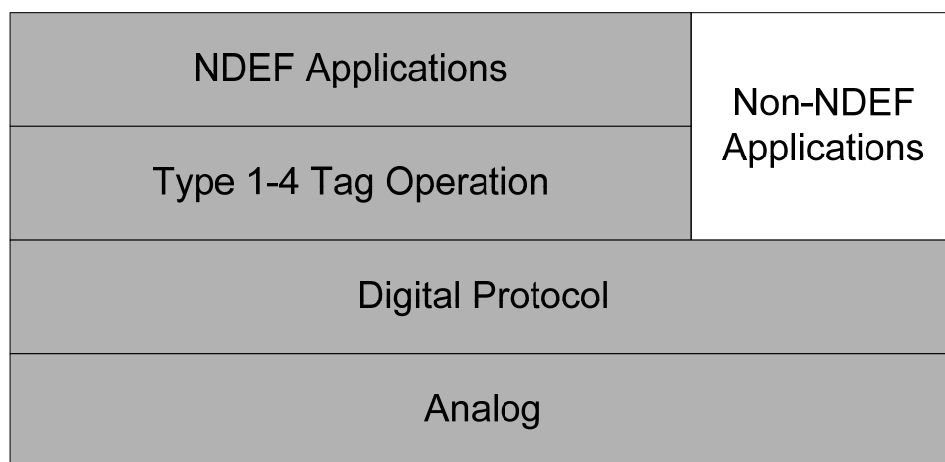
Figure 1 - NFC Forum Device Architecture in Reader/Writer Operating Mode. The Protocol Stack elements in the gray rectangles are the ones described by this document.

The NFC Forum Device Architecture in Reader/Writer mode is described in Figure 1 and consists of the following Protocol Stack elements:

- *Digital Protocol, Analog*: lower protocols e.g. [NFCIP-1].

- *Type Tag 1-4 Operation*: commands and instructions used by an NFC Forum Device (see [TYPE 1 TAG, TYPE 2 TAG, TYPE 3 TAG, TYPE 4 TAG]) to operate the NFC Forum Tag that is based on the NFC Forum Type 1-4 Tag Platforms.

- *NDEF Applications*: applications like Smart Poster, v-Card…based on NDEF (see [NDEF] and chapter 4).

- *Non-NDEF Applications*: vendor specific applications that are not based on NDEF.

The Protocol Stack elements in the gray rectangles are the ones described by this document.

Note : *NXP has also specified the Type MIFARE Classic Tag Operation to operate the NXP MIFARE Classic 1K/4K/Mini Tag, see Appendix A.*

2.3 The NFC Forum Tag

The NFC Forum Tag is a contactless tag that can operate according to one of the four NFC Forum tag platforms called NFC Forum Type 1-4 Tag Platforms (see chapter 3). Note that the NFC Forum does not specify the NFC Forum Tag, but how to operate them from the NFC Forum device in Reader/Writer mode perspective.

The application data that can be stored inside the NFC Forum Tag are described in the following chapter 3.

3. STORAGE OF APPLICATION DATA

This chapter describes how application data is stored inside an NFC Forum Tag (also called product).

The application data stored inside an NFC Forum Tag is encapsulated firstly into an NDEF message and secondly into the data structure specified by the NFC Forum Type Tag Platform. The NDEF message and the NFC Forum Type Tag Platform encapsulations are used to identify the type of application data e.g. an URL, a v-Card or a Jpeg image (see label "text/x-vCard" in Figure 2) and to guarantee the interoperability and the co-existence between applications.

Figure 2 shows an overview of the following 4 elements and how they are encapsulated into each other:

- the application data: the v-Card on the left-hand side,

- the NDEF Message: the parcel,

- the NFC Forum Type Tag Platform (data structure): the container with the text "Type 2 Tag", and

- the Product (NFC Forum Tag): for example the NXP MIFARE Ultralight card.

These 4 elements are going to be described in the following sections.
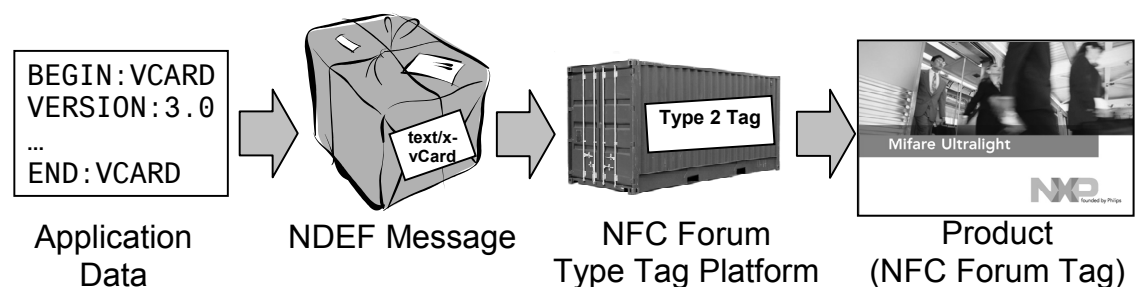
Figure 2 - Overview of the Application Data, NDEF, the NFC Forum Type Tag Platform and the Product.

3.1 The Application Data

The application data is any kind of information that can be stored into a NFC Forum Tag. Examples of available application data are shown below:

- URI:
    - URL: "http://www.nxp.com"
    - Telephone Number: "tel:+49 40 5613 5013"
    - SMS: "sms:+494056135013?Body=Ciao!"
    - E-mail: "mailto:nfc@nfc.com"
- Text:
    - "Hello World!", "Morjens, maailma"
    - "NXP web-site"
- Smart Poster = Text + URI +…
    - "NXP web-site" + "http://www.nxp.com"
- Handover Parameters
    - Bluetooth parameters: PIN, Bluetooth address…
    - WiFi parameters: SSID, WEP key…
- Business Card
    - vCard
- Signature

The number of different application data types that can be stored into an NFC Forum Tag (if we do not consider the available memory space) is unlimited thanks to the flexible identification system provided by NDEF. For more information see next section 3.2.

3.2 NDEF

The NDEF specification (see [NDEF]) defines a message encapsulation format to exchange information between an NFC Forum Device and another NFC Forum Device or an NFC Forum Tag.
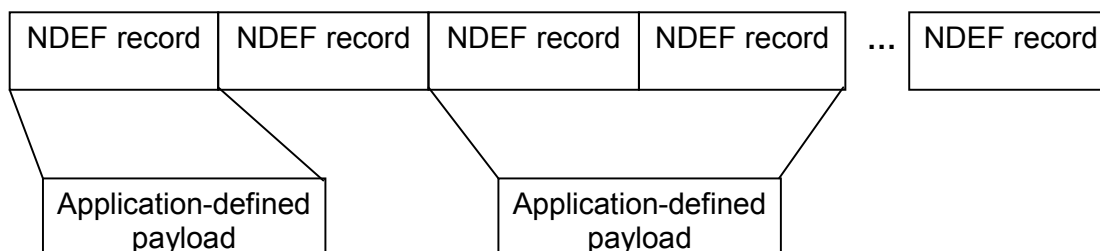

Figure 3 - NDEF Message.

NDEF is a lightweight, binary message format that can be used to encapsulate one or more application-defined payloads of arbitrary type and size into a single construct called NDEF message (see Figure 3). An application-defined payload is encapsulated inside one single NDEF record, or chunked into two or more NDEF records. One or more application-defined payload contains the Application Data.

Each application-defined payload is described by a *Type*, and an *Optional Identifier*:

- *Type* identifiers may be URIs, MIME media types, or NFC-specific types (see [NDEF, NFC RTD]).

- *Optional Identifier* enables association of multiple payloads and cross-referencing between them.

Examples of *Type* identifiers based on MIME Media Types are the following:

application/acad	application/xml	application/x-tar	message/partial
application/applefile	application/x-bcpio	image/cis-cod	message/rfc822
application/astound	application/x-compress	image/cmu-raster	text/css
application/dsptype	application/x-cpio	image/fif	text/html
application/dxf	application/x-csh	image/gif	text/javascript
application/futuresplash	application/x-director	image/ief	text/plain
application/gzip	application/x-dvi	image/jpeg	text/richtext
application/listenup	application/x-envoy	image/png	text/rtf
application/mac-binhex40	application/x-gtar	image/tiff	text/tab-separated-values
application/mbedlet	application/x-hdf	image/vasa	text/vnd.wap.wml
application/mif	application/x-httpd-php	image/vnd.wap.wbmp	text/vnd.wap.wmlscript
application/msexcel	application/x-javascript	image/x-freehand	text/xml
application/mshelp	application/x-latex	image/x-icon	text/x-setext
application/mspowerpoint	application/x-macbinary	image/x-portable-anymap	text/x-sgml
application/msword	application/x-mif	image/x-portable-bitmap	text/x-speech
application/octet-stream	application/x-netcdf	image/x-portable-graymap	text/x-vcard
application/oda	application/x-nschat	image/x-portable-pixmap	text/xvcal
application/pdf	application/x-sh	image/x-rgb	video/mpeg
application/postscript	application/x-shar	image/x-windowdump	video/quicktime
application/rtc	application/x-sprite	image/x-xbitmap	video/vnd.vivo
application/rtf	application/x-stuffit	image/x-xpixmap	video/x-msvideo
application/studiom	application/x-supercard	message/external-body	
application/toolbook	application/x-sv4cpio	message/http	
application/xhtml+xml	application/x-sv4crc	message/news	

3.3 The NFC Forum Type Tag Platform

The NFC Forum Type Tag platform is a container to store NDEF messages that guarantees co-existence with already existing product applications. The NFC Forum Type Tag platform is product independent although there are products compatible with it (NFC Forum Tag like Innovision Topaz, NXP MIFARE Ultralight and Sony FeliCa see next section 3.4).

The NFC Forum Type Tag Platform shall not be confused with the NFC Forum Type Tag Operation Specifications (see [TYPE 1 TAG, TYPE 2 TAG, TYPE 3 TAG and TYPE 4 TAG]). These four documents describe how an NFC Forum Device operates the NFC Forum Type 1-4 Tag platform ensuring that the user experience for the service initiation of e.g. Smart Poster is consistent.

Note :   *Similarly to the NFC Forum Type Tag Platform, NXP has also specified an additional Type Tag Platform based on the MIFARE Classic family. The NXP specific Type Tag Platform can store NDEF Messages guaranteeing the co-existence with already existing product applications related to the MIFARE Classic family products. For more information see Appendix A.*

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3.4 The Product (NFC Forum Tag)

Each NFC Forum Type Tag Platform has been build on top of existing available off the shelf products. These products are usually contactless tags referred in the NFC Forum terminology as NFC Forum Tags.

Table 4 describes the relationship between the NFC Forum Type Tag Platforms and the compatible and available products at the time of writing of this document.

Table 4 - NFC Forum Type Tag Platforms and related products.

#	NFC Forum Platform	Compatible Products
1	NFC Forum Type 1 Tag	Innovision Topaz
2	NFC Forum Type 2 Tag	NXP MIFARE Ultralight
		NXP MIFARE Ultralight C
3	NFC Forum Type 3 Tag	Sony FeliCa
4	NFC Forum Type 4 Tag	NXP DESFire
		NXP SmartMX with JCOP or other compatible contactless products

Note : *For the NXP specific Type Tag Platform for MIFARE Classic family products, see Appendix Section A.1.*

A comparison of the different products compatible with the NFC Forum Type Tag Platforms is shown in Table 5. In Table 5 the following terminology is used:

- *Active Content*: the content of the NFC Forum Tag can be modified not only by the NFC Forum Device, but also by the NFC Forum Tag itself. A typical example is an NFC Forum Tag based on the Java Card technology that is able to change the NDEF content to implement a self-incremental counter. This counter may be incremented by 1 during each read access.

- *Operation Specification*: the NFC Forum documents [TYPE 1 TAG, TYPE 2 TAG, TYPE 3 TAG, TYPE 4 TAG] made to describe how to operate the NFC Forum Type 1-4 Tag platforms.

- *NXP Supporting Documents*: NXP Application Notes [NXP T2T, NXP T4T] describing:

  o how to set the NXP products to be compliant to the NFC Forum Type Tag Operation Specifications.

  o how to use the additional NXP product features remaining compatible with the NFC Forum Type Tag Operation Specifications.

- *NXP Product Datasheet*: Datasheets specific to the NXP products.

Table 5 - Comparison of the different products compatible with the NFC Forum (Type Tag) Platforms.

	NFC Forum Platform			
	Type 1 Tag	**Type 2 Tag**	**Type 3 Tag**	**Type 4 Tag**
Compatible Products	Innovision Topaz	NXP MIFARE Ultralight / NXP MIFARE Ultralight C	Sony FeliCa	NXP DESFire / NXP SmartMX-JCOP
Memory Size	96 Bytes	48 Bytes / 144 Bytes	1, 4, 9 KB	4 KB / 32 KB
Unit Price	Low	Low	High	Medium / High
Data Access	Read/Write or Read-only	Read/Write or Read-only	Read/Write or Read-only	Read/Write or Read-only
Active Content	✗	✗ / ✗	✗	✗ / ✓
Operation Specifications	[TYPE 1 TAG]	[TYPE 2 TAG]	[TYPE 3 TAG]	[TYPE 4 TAG]
NXP Supporting Documents	-	[NXP T2T]	-	[NXP T4T]
NXP Product Datasheets	-	[NXP UL, NXP ULC]	-	[NXP DES]

Note : *For comparison of the different products including the NXP Specific Type Tag Platform for MIFARE Classic family products, see Appendix Section A.1.*

4. USE CASES

The NFC Type tags enable many kinds of use cases. In the next sections the following use cases are described in details: Smart Poster, Handover, vCard, URL, SMS and Call Request.

4.1 Smart Poster Use Case

A typical example of Smart Poster use case is when the user touches with an NFC Forum Device (e.g. mobile phone) the NFC Forum Tag integrated into a poster and reads out the application data stored into it. The application data of the NFC Forum Tag can be e.g. the web-page address of the concert advertised by the poster. In this case the NFC Forum Device may open a browser window and connect to the Internet to retrieve the web-page.

For more technical information see [SP RTD, TEXT RTD, and URI RTD].

4.2 Handover Use Case

The handover use case consists in exchanging of configuration information via the NFC link to easily establish a connection over e.g. Bluetooth or Wireless LAN. A typical example of Handover use case is: the user touches with his NFC Forum Device (e.g. a Personal Digital Assistant, PDA) the NFC Forum Tag attached on top of a WiFi router. The NFC Forum Tag contains the configuration data that is used by the PDA to setup the Wireless LAN interface and to establish the wireless connection to the WiFi router.

For more technical information see [HANDOVER].

4.3 vCard Use Case

The vCard use case consists of an NFC Forum Tag embedded into a business card that contains an electronic vCard (see [VCARD21, RFC 2425, and RFC 2426]) with the person details. Reading the tag using an NFC Forum device like a mobile phone or a notebook, the user can retrieve and save the vCard information into his address book. This saves the user from manually typing the person details of the business card. If the memory space of the NFC Forum Tag is big enough even a Jpeg image can be stored in the electronic vCard.

4.4 URL Use Case

The URL use case consists on reading an NFC Forum Tag that is integrated into a leaflet or into a credit-card size label. The NFC Forum Tag contains a NDEF message with stored the URL address of a web-page. The label or the leaflet may be read using a notebook or a mobile device both equipped with the NFC interface. As soon as the notebook has read the label, it opens automatically the web-browser on the indicated URL address.

For more technical information see [URI RTD, SP RTD, and TEXT RTD].

4.5 SMS Use Case

The SMS use case consists on reading an NFC Forum Tag that is integrated into for example a credit-card size label. The NFC Forum Tag contains an SMS that can be read by a NFC enable device e.g. mobile phone. The user reading this label sends the predefined SMS either retrieving the ring tone shown by the label or activating any of nowadays SMS services.

For more technical information see [URI RTD, SP RTD, and TEXT RTD].

4.6 Call Request Use Case

The Call Request use case is the call of the phone number stored into an NFC Forum Tag. The phone number may be written by the user into the NFC Forum Tag by means of an NFC enabled mobile phone. Afterwards reading the NFC Forum Tag the user can make a call request on the stored phone number. For example my grandma can touch with her NFC enabled mobile phone her grandson's photo. The photo has embedded an NFC Forum Tag from where the mobile phone gets and calls automatically the grandson's phone number without any further complicated actions needed from my grandma.

For more technical information see [URI RTD, SP RTD, and TEXT RTD].

5. USE CASES VS. PRODUCTS

Table 6 provides a comparison between the use cases and the different products complaint to the NFC Forum Type Tag Platforms. In particular it is shown:

- the possibility to use the product in combination with a specific use case,

- the limitations of the product in combination with a specific use case, and

- the advantages of the product in combination with a specific use case.

Table 6 - Comparisons between Use Cases and NFC Forum Type Tag Platforms compatible Products.

Use Case	NFC Forum Platform Compatible Products			
	Type 1 Tag *Innovision Topaz*	Type 2 Tag *NXP MIFARE Ultralight / NXP MIFARE Ultralight C*	Type 3 Tag *Sony FeliCa*	Type 4 Tag *NXP DESFire / NXP SmartMX-JCOP*
Smart Poster	(✓)*	✓	✓	✓
- Limitations	Memory Size	-	-	-
- Advantages	Price	Price	Memory Size	Memory Size, ISO APDU, Speed
Handover	(✓)*	✓	✓	✓
- Limitations	Memory Size	-	-	-
- Advantages	Price	Price	-	ISO APDU
vCard	✗	✗	✓	✓
- Limitations	-	-	-	-
- Advantages	-	-	Jpeg Image	Jpeg Image, ISO APDU, Speed
SMS	(✓)*	✓	✓	✓
- Limitations	Memory Size	-	-	-
- Advantages	Price	Price	140 octets len	ISO APDU, 140 octects len
URL	✓	✓	✓	✓
- Limitations	-	-	-	-
- Advantages	Price	Price	Memory Size	Memory Size, ISO APDU, Speed
Call Request	✓	✓	✓	✓
- Limitations	-	-	-	-
- Advantages	Price	Price	-	ISO APDU

* Due to not sufficient memory size the product has strong limitation to be used in combination with the use case

Note : *For a comparison with the NXP specific Type Tag Platform, see Appendix Section A.2.*

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APPENDIX A. NXP SPECIFIC TYPE TAG PLATFORM

Similarly to the NFC Forum Type Tag Platform, NXP has also specified in the Type MIFARE Classic Tag Operation how to operate a Type Tag Platform based on the MIFARE Classic family. This NXP specific Type Tag Platform can store NDEF Messages guaranteeing the co-existence with already existing product applications related to the MIFARE Classic family products.
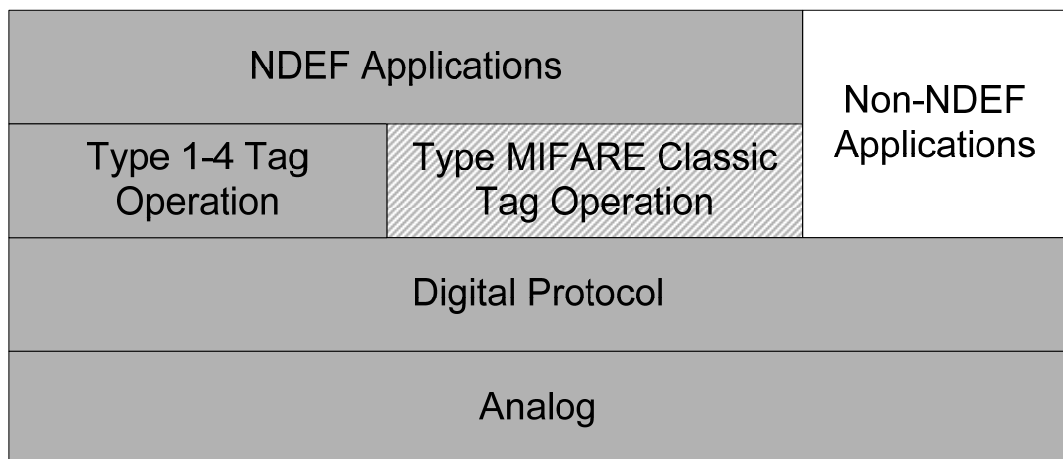

Figure 4 - NFC Forum Device Architecture in Reader/Writer Operating Mode.

In order to operate the NXP specific Type Tag Platform based on the MIFARE Classic family, the NFC Forum Device Architecture in Reader/Writer mode (see Figure 1) must be modified to include an additional Protocol Stack element called Type MIFARE Classic Tag Operation. The resulting NFC Forum Device Architecture in Reader/Writer mode is described in Figure 4 and consists of the following Protocol Stack elements:

- *Digital Protocol, Analog*: lower protocols e.g. [NFCIP-1]

- *Type Tag 1-4 Operation, Type MIFARE Classic Tag Operation*: commands and instructions (see [TYPE 1 TAG, TYPE 2 TAG, TYPE 3 TAG, TYPE 4 TAG, NXP MFTT]) to operate the NFC Forum Tag based on the NFC Forum Type 1-4 Tag Platforms, and to operate the NXP MIFARE Classic 1K/4K/Mini Tag based on Type MIFARE Classic Tag Operation.

- *NDEF Applications*: applications like Smart Poster, v-Card…based on NDEF (see [NDEF] and chapter 4).

- *Non-NDEF Applications*: vendor specific applications that are not based on NDEF.

In Figure 4 the Protocol Stack element called Type MIFARE Classic Tag Operation has been highlighted in white and gray, for comparison see Figure 1.

A.1 The Product (NXP Specific Type Tag)

Each NXP specific Type Tag Platform has been build on top of existing available off the shelf products.

Table 7 describes the relationship between the NXP specific Type Tag Platform and the compatible and available products at the time of writing of this document.

Table 7 - NXP Specific Type Tag Platform and related products.

#	NXP Specific Platform	Compatible Products
1	Type MIFARE Classic Tag	NXP MIFARE Classic 1k
		NXP MIFARE Classic 4k
		NXP MIFARE Classic Mini

Similarly to Table 5, a comparison of the different products compatible with the NFC Forum Type Tag Platforms and additionally the NXP Specific Type Tag Platform is shown in Table 8. In Table 8 the following terminology is used:

- *Active Content*: the content of the NFC Forum Tag can be modified not only by the NFC Forum Device, but also by the NFC Forum Tag itself. A typical example is an NFC Forum Tag based on the Java Card technology that is able to change the NDEF content to implement a self-incremental counter. This counter may be incremented by 1 during each read access.

- *Operation Specification*: the NFC Forum documents [TYPE 1 TAG, TYPE 2 TAG, TYPE 3 TAG, TYPE 4 TAG] and the NXP Application Note [NXP MFTT] made to describe how to operate respectively the NFC Forum Type 1-4 Tag platforms and the MIFARE Classic 1k/4k/Mini tag to store NDEF messages.

- *NXP Supporting Documents*: NXP Application Notes [NXP T2T, NXP T4T, NXP MFNFC] describing:

  - o how to set the NXP products to be compliant to the NFC Forum Type Tag Operation Specifications.

  - o how to use the additional NXP product features remaining compatible with the NFC Forum Type Tag Operation Specifications.

- *NXP Product Datasheet*: Datasheets specific to the NXP products.

	NFC Forum Platform				NXP Specific Platform
	Type 1 Tag	**Type 2 Tag**	**Type 3 Tag**	**Type 4 Tag**	**Type MIFARE Classic Tag**
Compatible Products	Innovision Topaz	NXP MIFARE Ultralight / NXP MIFARE Ultralight C	Sony FeliCa	NXP DESFire / NXP SmartMX-JCOP	NXP MIFARE Classic 1k / NXP MIFARE Classic 4k / NXP MIFARE Classic Mini
Memory Size	96 Bytes	48 Bytes / 144 Bytes	1, 4, 9 KB	4 KB / 32 KB	768 Bytes / 3584 Bytes / 192 Bytes
Unit Price	Low	Low	High	Medium / High	Low
Data Access	Read/Write or Read-only	Read/Write or Read-only	Read/Write or Read-only	Read/Write or Read-only	Read/Write or Read-only
Active Content	✗	✗ / ✗	✗	✗ / ✓	✗ / ✗ / ✗
Operation Specifications	[TYPE 1 TAG]	[TYPE 2 TAG]	[TYPE 3 TAG]	[TYPE 4 TAG]	[NXP MFTT]
NXP Supporting Documents	-	[NXP T2T]	-	[NXP T4T]	[NXP MFNFC]
NXP Product Datasheets	-	[NXP UL, NXP ULC]	-	[NXP DES]	[NXP 1K, NXP 4K, NXP MINI, NXP MAD]

A.2 Use Cases vs. Products

Table 9 provides a comparison between the use cases and the different products complaint to the NFC Forum Type Tag Platforms and the additionally NXP specific Type Tag Platform. In particular it is shown:

- the possibility to use the product in combination with a specific use case,

- the limitations of the product in combination with a specific use case, and

- the advantages of the product in combination with a specific use case.

Table 9 - Comparisons between Use Cases and NFC Forum Type Tag Platforms and NXP Type Tag Platform compatible Products.

Use Case	NFC Forum Platform *Compatible Products*				NXP Specific Platform *Compatible Products*
	Type 1 Tag *Innovision Topaz*	**Type 2 Tag** *NXP MIFARE Ultralight / NXP MIFARE Ultralight C*	**Type 3 Tag** *Sony FeliCa*	**Type 4 Tag** *NXP DESFire / NXP SmartMX-JCOP*	**Type MIFARE Classic Tag** *NXP MIFARE Classic 1k / NXP MIFARE Classic 4k / NXP MIFARE Classic Mini*
Smart Poster	(✓)*	✓	✓	✓	✓
- Limitations	Memory Size	-	-	-	-
- Advantages	Price	Price	Memory Size	Memory Size, ISO APDU, Speed	Memory Size, Price
Handover	(✓)*	✓	✓	✓	✓
- Limitations	Memory Size	-	-	-	-
- Advantages	Price	Price	-	ISO APDU	Price
vCard	✗	✗	✓	✓	✓
- Limitations	-	-	-	-	-
- Advantages	-	-	Jpeg Image	Jpeg Image, ISO APDU, Speed	Price
SMS	(✓)*	✓	✓	✓	✓
- Limitations	Memory Size	-	-	-	-
- Advantages	Price	Price	140 octets len	ISO APDU, 140 octects len	Price, 140 octets len
URL	✓	✓	✓	✓	✓
- Limitations	-	-	-	-	-
- Advantages	Price	Price	Memory Size	Memory Size, ISO APDU, Speed	Memory Size, Price
Call Request	✓	✓	✓	✓	✓
- Limitations	-	-	-	-	-
- Advantages	Price	Price	-	ISO APDU	Price

* Due to not sufficient memory size the product has strong limitation to be used in combination with the use case

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APPENDIX B. BEST PRACTICES

The NXP products MIFARE Ultralight, MIFARE Ultralight C, MIFARE DESFire and MIFARE Classic 1k/4k/Mini shall be formatted to be compliant with the NFC Forum Type Tag Platform or to the NXP Specific Type Tag Platform. The formatting is a procedure that consists of sending a sequence of commands to the contactless tags in order to configure the functionalities and the internal data structures. This is necessary to set the contactless tags to be compliant with the NFC Forum Type Tag Platform or to the NXP Specific Type Tag Platform.

For the NXP products the formatting procedures use mainly specific commands. The general formatting procedures are described in the following Application Notes:

- [NXP T2T] for MIFARE Ultralight and MIFARE Ultralight C,

- [NXP T4T] for MIFARE DESFire, and

- [NXP MFNFC] for MIFARE Classic 1k/4k/Mini.

The formatting procedure can be integrated in the tag production or it can be implemented in an NFC Forum Device e.g. mobile phone to format tags at their first use. The following sections describe some more details of the formatting procedure in these two cases.

B.1 Formatting procedure during the Tag's first use

When a tag is presented in front of an NFC Forum Device (e.g. mobile phone), the NFC Forum Device does not know how to format it being not aware a priori of the tag specific information like the type of product (i.e. MIFARE Ultralight, MIFARE Ultralight C, MIFARE DESFire, MIFARE Classic 1k/4k/Mini) and the product settings. This information is fundamental for conducting successfully the formatting procedure and it shall be automatically detected by the NFC Forum Device.

Due to the previous issues before formatting a product the NFC Forum Device uses specific command sequences (for more information see [NXP T2T, NXP T4T, NXP MFNFC]) to be able to:

- identify the type of product: MIFARE Ultralight, MIFARE Ultralight C, MIFARE DESFire, …,

- detect the product settings,

- if it is the case, exclude from formatting:

    o products already set to be complaint with the NFC Forum Type Tag Platform or to the NXP Platform, or

    o products containing data for applications different from the NFC Forum Type Tag one e.g. ticket of an already existing infrastructure.

Finally if the product type and settings are correct, the product can be formatted accordingly.

B.2 Formatting procedure during Tag Production

During tag production the formatting procedure can be drastically simplified due to the knowledge a priori of the tag specific information. The specific command sequences to get this information can be simplified or may not be needed at all. In this way the tag may be directly formatted.

B.3 Samples

NXP provides the following sample sets of already formatted tags:

- 5 tags MIFARE Ultralight (OM5591) – NFC Forum Type 2 Tag platform,

- 5 tags MIFARE DESFire (OM5594) – NFC Forum Type 4 Tag platform,

- 5 tags MIFARE Classic 1k (OM5592) – NXP Type MIFARE Classic 1k Tag platform,

- 5 tags MIFARE Classic 4k (OM5593) – NXP Type MIFARE Classic 4k Tag platform, or

- the previous 4 tag sets all together in a single kit (OM5595).

To request the samples please contact the NXP Sales representatives.

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[NXP](#):
[OM5591/MF0U10,699](#) [OM5592/MF1S50,699](#) [OM5593/MF1S70,699](#) [OM5594/MF3D40,699](#) [OM5595,699](#)