Agenda

► NFC in a nutshell
► NFC technology
► NXP NFC portfolio
► NXP support
► Upcoming Webinars
NFC in a nutshell

*What NFC is, NFC new experiences, market status and adoption*
What is NFC?

Near Field Communication is a short-range wireless connectivity technology *standard*, designed for *intuitive* and *simple* communication between *two* electronic devices.
RFID, Proximity & NFC
We hear often about them, but what is covered with these names

**RFID**: Radio Frequency Identification
- Generic term for contactless technology.
- Always used for applications related to tagging of goods and items.
- Range from few cm to several m – automatic detection of a Unique Identifier (few bytes).
- Based on various technologies: LF (120-150 KHz), HF (13.56 MHz), UHF (433 to 900 MHz).
- Standardized in ISO18000.

**Contactless Proximity technology**
- Subset of RFID, limited to 1 frequency range: 13.56 MHz. Associated to people, active action required (put card in front of reader).
- Use in Access Control, Passport, Payment, Transport.
- More memory, more security.
- Short range (several cm).
- Standardized in ISO14443.

**NFC**: Near Field Communication
- NFC builds on Proximity technology by extending the technology to Peer-to-Peer and Card Emulation.
- Short range.
- Standardized at the NFC Forum.
NFC: opening new experiences

- Before NFC:
  - The physical card

- With NFC:
  - Screen & Keyboard
  - Connectivity
  - Processing Power
  - Battery
NFC at a glance

► Contactless proximity technology
► Operating frequency: 13.56 MHz
► Operating range: 10 cm
► Maximum speed: 424 Kbps
► Standardized in ISO/IEC, ECMA and ETSI.
► Compatible with existing ISO/IEC 14443 and FeliCa contactless cards & reader infrastructure.
► Read/Write, Card Emulation and Peer-to-Peer modes possible in one device.
► Quick, seamless pairing with Bluetooth, WiFi.
► NFC Forum as a key standardization & interoperability group

**Card Emulation mode:** Behaves as a contactless card

**Read/Write mode:** Behaves as a contactless reader

**Peer-to-Peer mode:** Data exchange between NFC devices
NFC connected devices  
Market update – some key figures

► 1.2 billion smartphones shipped in 2014
► Smartphones share expected to continue growing from 67% in 2014 to > 80% or even higher in coming years
► 850 million NFC handsets shipped between 2012 and 2014
► 3 in 4 mobile phones to come with NFC by 2018
► > 5 billion NFC handsets will ship between 2013 and 2018
► Apple confirms NFC and Secure Element in all their device ranges
► NFC-enabled CE devices and tags growing exponentially, IoT wave coming.

* Updated list of NFC phones and tablets available in the market:  

Sources: ABI Research, Sep’14

11.0B+ NFC-enabled devices shipping 2013-2018
Thanks to the versatility of NFC technology, its growth is not only forecasted for NFC-enabled handsets but also for many other NFC-enabled smart devices.
NFC technology

Standards, modes of operation, modes of communication and NFC Forum specs
NFC technology
Modes of operation

Card Emulation
Emulates the behavior of a contactless card.

Peer to Peer
Exchanges data between NFC devices

Read/Write
Reads / Writes data from any tag or contactless card
NFC operation modes vs RFID proximity standards and specs

- **Card Emulation**
  - Sony FeliCa
  - ISO/IEC 14443-A
  - ISO/IEC 14443-B

- **Read/Write**
  - Sony FeliCa
  - ISO/IEC 14443-A
  - ISO/IEC 14443-B

- **Peer-To-Peer**
  - Sony FeliCa
  - ISO/IEC 14443-A
  - ISO/IEC 15693

* ISO/IEC 18092 (NFCIP-1)
* ISO/IEC 21481 (NFCIP-2)
NFC communication modes

**Reader/Card communication mode**

1. **Power**
The RF field oscillates at 13.56MHz. The card is powered through the electromagnetic coupling.

2. **The Reader sends commands**
The Reader modulates its RF field to send commands.

3. **Answering to the Reader**
By modifying its consumption, the chip modifies the RF field, which is detected by the Reader (Load Modulation).
NFC communication modes

P2P passive communication mode

1. **The Initiator generates an RF field**
   This field is used to exchange the data. Both Initiator and Target are powered internally.

2. **The Initiator sends commands**
   The Initiator modulates its RF field to send commands.

3. **The Target responds**
   The target uses backward modulation to transmit the response (Load Modulation).
NFC communication modes
P2P active communication mode

1. The Initiator sends commands
The Initiator generates an RF field, sends commands by modulating its field and then cuts the field.

2. The Target responds
Once the Initiator cuts its RF field, the target generates its own field and uses it to transmit responses.
NFC polling loop
Setting up the communication

- The polling loop manages the communication and mode selection of the NFC device
NFC technology
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NFC Forum
A global, special interest group (SIG)

- The NFC Forum is a non-profit organization aiming at advancing the use of NFC by:
  - Driving the discussion on business models and services
  - Achieving interoperability between NFC-enabled devices and services through
    - Implementation and standardization
    - Compliance testing and device certification
    - Reference designs
  - Developing roadmap for future development of NFC
  - Educating consumers and businesses about NFC

Created in 2004 by founding members Sony, Nokia and NXP Semiconductors, the Forum now has more than 170 members
NFC Read/Write mode

- Analog and Digital Protocol:
  - Based on NFCIP-1 and NFCIP-2

- NFC Forum Type Tag 1-4 Operation:
  - Commands and instructions to operate the four defined NFC Forum Type Tags.

- NFC Data Exchange Format (NDEF):
  - Defines a message encapsulation format to exchange information. Composed of one or NDEF records.
  - Defined supported payload types.
  - Standardized and Interoperable solution

- Record Type Definition (RTD):
  - Defines NFC-specific record types for inclusion in NDEF messages (e.g. Smart Poster, Text, URI etc.)

- Non-NDEF:
  - Proprietary or vendor specific solutions.
  - Not interoperable
### NFC Read/Write mode
NFC Forum Tag Type Platforms

<table>
<thead>
<tr>
<th></th>
<th>Type 1</th>
<th>Type 2</th>
<th>Type 3</th>
<th>Type 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chips</strong></td>
<td>BROADCOM “Topaz”</td>
<td>NXP “MIFARE UL” “NTAG”</td>
<td>SONY “FELICA”</td>
<td>ISO14443-4 “DESFire”, Microcontrollers</td>
</tr>
<tr>
<td><strong>Initialization</strong></td>
<td>ISO/IEC 14443A-3</td>
<td>ISO/IEC 14443A-3</td>
<td>FeliCa</td>
<td>ISO/IEC 4443(A&amp;B)-3</td>
</tr>
<tr>
<td><strong>Bit rate</strong></td>
<td>106 Kbit/s</td>
<td>106 Kbit/s</td>
<td>212/424 Kbit/s</td>
<td>106-424 Kbit/s</td>
</tr>
<tr>
<td><strong>Protocol</strong></td>
<td>Specific command Set</td>
<td>Specific command Set</td>
<td>FeliCa protocol</td>
<td>ISO/IEC 14443-4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ISO/IEC 7816-4</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td><strong>Use cases</strong></td>
<td>Tags with small and fixed memory for single applications</td>
<td>Flexible tags with larger memory offering multi-application capabilities.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Memory type</strong></td>
<td>Memory cards</td>
<td></td>
<td></td>
<td>CPU cards</td>
</tr>
</tbody>
</table>
NFC technology
Modes of operation

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Emulates the behavior of a contactless card.

Peer to Peer
Exchanges data between NFC devices

Read/Write
Reads / Writes data from any tag or contactless card
NFC Card Emulation mode

► In the Smart Card scenario, users typically carry a different contactless card for each service (one card, one chip).

► Mobile Wallet
  ▪ Functionality that allows users to manage and interact with different “cards” in their mobile phone “virtual wallet” and maintain them dynamically.
  ▪ Better interactivity (e.g.: Consult Balance / transactions)
  ▪ Lets us manage:
    ❖ Keys, IDs, coupons, credit cards, transport tickets and so on.

► The NFC handset device can emulate a card using:
  ▪ A Secure Element: High secure tamper resistant device
    ❖ uSD, embedded SE, UICC
  ▪ Host Card Emulation (HCE): Main processor of the device where the OS and applications reside
    ❖ Available on Android v4.4 KitKat (and Blackberry 7 OS).
    ❖ We can only emulate ISO/IEC14443-4 Type A cards compatible with ISO/IEC7816-4 commands
NFC Card Emulation mode
For mobiles … and more

 ► **Use your mobile as a card → not always easy**
   ▪ Secure Element is not easily accessible. Ecosystem challenge (MNO,TSM, OEMs)
   ▪ HCE is not yet present on all Android Phones (only Android 4.4 or more).

 ► **Other Use Cases are possible !**
   ▪ Enable easy communication with a portable reader (NFC and standard RFID readers). E.g.: Maintenance, Sending Files, etc.

 ► **Processing**
   ▪ The portable reader/NFC handset detects the tag and select it to establish the communication
   ▪ Both the portable reader/NFC handset and the electronic device read and write data in the tag, and in this way exchange data
     ❖ NFC Forum-compliant devices support Reader/Writer protocol stack. (e.g: Android OS implements Reader/Writer protocol stack.)
   ▪ The device controller and reader can exchange data easily while implementing a minimum feature set.
     ❖ E.g.: P2P protocol implementation (LLCP & SNEP) requests some amount of memory in the MCU (Flash, RAM)
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NFC Peer-to-Peer mode

▶ LLCP (Logical Link Control Protocol)
  ▪ A connection-oriented protocol (Class 2 Service), somewhat like TCP.
  ▪ In charge of the creation and management of the logical link between peers. This includes link activation/deactivation, data flow control and multiplexing
  ▪ LLCP specifies the procedural means for the transfer of upper layer information units between two NFC Forum devices

▶ SNEP (Simple NDEF Exchange Protocol)
  ▪ The SNEP protocol implements a client/server based architecture. SNEP clients can perform two operations:
    ❖ GET: To retrieve an NDEF message from a SNEP server.
    ❖ PUT: To push an NDEF message to the SNEP server
  ▪ Leverages on LLCP functionalities (connection-oriented Service Class).
  ▪ The protocol handles segmentation and reassembly of large messages as well as early cancellation of transfers that would exhaust receiving capabilities.

☞ LLCP and SNEP enable the exchange of NDEF messages between NFC devices using P2P mode
NXP NFC portfolio

NFC frontends, NFC controllers, Connected NFC tags
NXP portfolio
NFC frontends

► NFC frontends are integrated transceiver ICs performing the contactless communication in charge of the modulation/demodulation, data processing and error detection.
► Standalone NFC frontends are the most flexible way to add NFC to a system.
► Easy to design in through dedicated development boards and SW libraries.
► Broad product portfolio, from high output power reader to full NFC functionality.

* More information: NXP NFC Readers Product Introduction Webinar

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>PN512</td>
<td>Full NFC Forum-compliant frontend</td>
<td>Yes</td>
</tr>
<tr>
<td>PN5180</td>
<td>High-performance multi-protocol full NFC Forum-compliant frontend</td>
<td>Available 2015</td>
</tr>
<tr>
<td>CLRC663</td>
<td>High-performance multi-protocol NFC frontend</td>
<td>Yes</td>
</tr>
<tr>
<td>MFRC631</td>
<td>High-performance ISO/IEC 14443 A/B frontend</td>
<td>Yes</td>
</tr>
<tr>
<td>MFRC630</td>
<td>High-performance MIFARE frontend</td>
<td>Yes</td>
</tr>
<tr>
<td>SLRC610</td>
<td>High-performance ISO/IEC 15693 frontend</td>
<td>Yes</td>
</tr>
<tr>
<td>MFRC523</td>
<td>Standard 3V ISO/IEC 14443A/B frontend</td>
<td>Yes</td>
</tr>
<tr>
<td>MFRC522</td>
<td>Standard 3V MIFARE frontend</td>
<td>Yes</td>
</tr>
</tbody>
</table>
NXP portfolio
NFC controllers

- NFC controller solutions enable higher integration with fewer components, since they combine an NFC frontend with an advanced 32-bit microcontroller.

- Two options:
  - Customizable FW: Ability to load fully-custom applications.
  - Integrated FW: For an easy, standardized interface

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<thead>
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<tbody>
<tr>
<td>PR601</td>
<td>High performance multi-protocol NFC controller with customizable FW</td>
<td>Yes</td>
</tr>
<tr>
<td>PN7120</td>
<td>Full NFC Forum-compliant controller with integrated FW and NCI interface</td>
<td>Available 2015</td>
</tr>
</tbody>
</table>

* More information: NXP NFC Readers Product Introduction Webinar
NXP portfolio
Connected NFC tags

► NXP’s NTAG family fully complies to NFC Forum Type 2 Tag specifications, ensuring universal interoperability with NFC devices

► NTAG F portfolio is particularly well suited for simple WiFi or Bluetooth pairing with Field Detection for waking up electronic devices.

► NTAG I²C portfolio are dual interface tags supporting full interaction between NFC devices and electronic devices for dynamic NDEF message update and direct data transfer.

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<thead>
<tr>
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<th>Description</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>NTAG I²C</td>
<td>Passive NFC tag with I²C interface</td>
<td>Available</td>
</tr>
<tr>
<td>NTAG 213F/216F</td>
<td>Passive NFC tag with field-detection output signal</td>
<td>Yes</td>
</tr>
</tbody>
</table>

* More information: NXP Connected Tags Overview Webinar
NXP support

Hardware and software tools
NXP support
Hardware tools: Demoboards

Demoboards for NFC frontends solutions

<table>
<thead>
<tr>
<th>Product</th>
<th>Board</th>
<th>Photo</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PN512</td>
<td>PNEV512B</td>
<td><img src="PNEV512B.jpg" alt="Photo" /></td>
<td>A two-board combination that stacks a PN512 board on an LPC-Link prototyping board, for use with NXP’s LPC microcontrollers. NFC Forum-compliant reader IC.</td>
</tr>
<tr>
<td>PN512</td>
<td>PNEV512R</td>
<td><img src="PNEV512R.jpg" alt="Photo" /></td>
<td>An expansion board, designed for use with Raspberry Pi, which is a card-sized ARM based computer running Linux.</td>
</tr>
<tr>
<td>CLRC663</td>
<td>CLEV663</td>
<td><img src="CLEV663.jpg" alt="Photo" /></td>
<td>Evaluation board for multi-protocol CLRC663. Testing reader IC functionalities.</td>
</tr>
<tr>
<td>CLRC663</td>
<td>CLEV663B</td>
<td><img src="CLEV663B.jpg" alt="Photo" /></td>
<td>A two-board combination, with a CLRC663 board stacked on an LPC-Link prototyping board for use with NXP’s LPC microcontrollers.</td>
</tr>
</tbody>
</table>

*More information: NXP Development Boards for NFC Readers Webinar*
# NXP support

**Hardware tools: Demoboards**

- Demoboards for NFC controller solutions

<table>
<thead>
<tr>
<th>Product</th>
<th>Board</th>
<th>Photo</th>
<th>Description</th>
<th>More info</th>
</tr>
</thead>
<tbody>
<tr>
<td>PR601</td>
<td>PREV601M</td>
<td><img src="image1.png" alt="Image" /></td>
<td>Microboard with PR601 and 13.56MHz antenna. Powered by a single battery, and supported by the NFC Reader Library</td>
<td><a href="www.nxp.com/demoboard/PREV601M.html">www.nxp.com/demoboard/PREV601M.html</a></td>
</tr>
<tr>
<td>PN7120</td>
<td>In development</td>
<td><img src="image2.png" alt="Image" /></td>
<td>NFC Forum-compliant development board with Raspberry Pi interface</td>
<td>Available in 2015</td>
</tr>
</tbody>
</table>

- Demoboards for connected NFC tag solutions

<table>
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<th>More info</th>
</tr>
</thead>
<tbody>
<tr>
<td>NTAG I²C</td>
<td>NTAG I²C DemoKit</td>
<td><img src="image3.png" alt="Image" /></td>
<td>Hardware board based on LPC812 LED board with a NTAG I²C Class 5 PCB antenna board</td>
<td>Available in 2015</td>
</tr>
<tr>
<td>NTAG I²C</td>
<td>NTAG I²C Basic Explorer Kit</td>
<td><img src="image4.png" alt="Image" /></td>
<td>Hardware board based on LPC11U24 Explorer board with a NTAG I²C Class 4 PCB antenna board</td>
<td>Available in 2015</td>
</tr>
</tbody>
</table>

* More information: NXP Development Boards for NFC Readers Webinar
**NXP support**

**Software tools**

- SW tools for NFC frontends & NFC controller solutions
  - NFC Reader Library (for NFC Frontends and PR601)
  - PN7120 is preconfigured with FW that supports the Linux OS and uses the NCI interface (NFC Forum)

- SW tools for connected NFC tags
  - Android app and source code
  - FW for LPC MCUs
  - MIFARE SDK

*More information: NXP Software Reader Library Webinar*
Further information
NFC Essentials

NFC Technology:
- White papers: http://members.nfc-forum.org/resources/white_papers/
- NFC Trainings http://www.themobileknowledge.com

NFC Product Families:
- MIFARE solutions portfolio: http://www.mifre.net
- LPC microcontrollers http://www.nxp.com/products/microcontrollers
- RFID portfolio http://www.nxp-rfid.com

NFC Community Resources
- NFC Forum Website http://nfcforum.org/
- NFC Community website http://www.nearfieldcommunication.com/
- Google Play http://play.google.com (Search for NTAG I2C Demoboard, NFC TagInfo or NFC TagWriter by NXP)
- Windows Store http://apps.Microsoft.com (Search for NFC TagWriter by NXP)
- MIFARE SDK http://www.mifare.net/en/products/mifare-sdk/
## Upcoming Webinars 2015

<table>
<thead>
<tr>
<th>NFC Standards</th>
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</thead>
<tbody>
<tr>
<td>NFC Reader Design 1: How to build your own reader</td>
</tr>
<tr>
<td>NFC Reader Design 2: Antenna design considerations</td>
</tr>
<tr>
<td>Security on NFC Readers</td>
</tr>
<tr>
<td><strong>NFC Introduction</strong></td>
</tr>
</tbody>
</table>

| NXP NFC Reader Marketing Introduction |
| NXP NFC Reader Product Overview |
| NXP Development Boards for NFC Readers |
| NXP Connected NFC Tags |
| NXP SW Libraries for NFC Readers |
| LPC Portfolio for NFC Readers |
| New product launches |
| **NXP Products and Support Package** |

| NFC Application: Access |
| NFC Application: Wearables |
| NFC Application: Mobile Payments, POS/mPOS |
| NFC Application: Gaming |
| NFC Application: Smart Media |
| **NFC Applications** |

| NFC in Linux |
| NFC in Android |
| NFC in Windows |
| **NFC Application development under main OS** |
We are a global competence team of hardware and software technical experts in all areas related to contactless technologies and applications.

Our services include:
- Application and system Design Engineering support
- Project Management
- Technological Consulting
- Advanced Technical Training services

We address all the exploding identification technologies that include NFC, secure micro-controllers for smart cards and mobile applications, reader ICs, smart tags and labels, MIFARE family and authentication devices.
Thank you for your kind attention!

► Please remember to fill out our evaluation survey (pop-up)
► Check your email for material download and on-demand video addresses
► Please check NXP and MobileKnowledge websites for upcoming webinars and training sessions
  www.themobileknowledge.com/content/knowledge-catalog-0