NFC USE CASES FOR INDUSTRIAL APPLICATIONS

December 2016

Training Mobile Knowledge

NXP SECURE CONNECTIONS FOR A SMARTER WORLD

Agenda

Session 1st December:

NFC use cases for industrial applications

- NFC technology essentials
- NFC Forum specifications
- Application examples
- NFC functionalities for industrial applications
- Product portfolio and support package

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NFC TECHNOLOGY ESSENTIALS

RFID, proximity cards and NFC

RFID

Generic term for
contactless technology

Wide reading range
(few cm to several meters)

Standardized in
ISO/IEC 18000

Proximity cards

Subset of RFID
HF 13,56 MHz

Short reading range
(few cm)
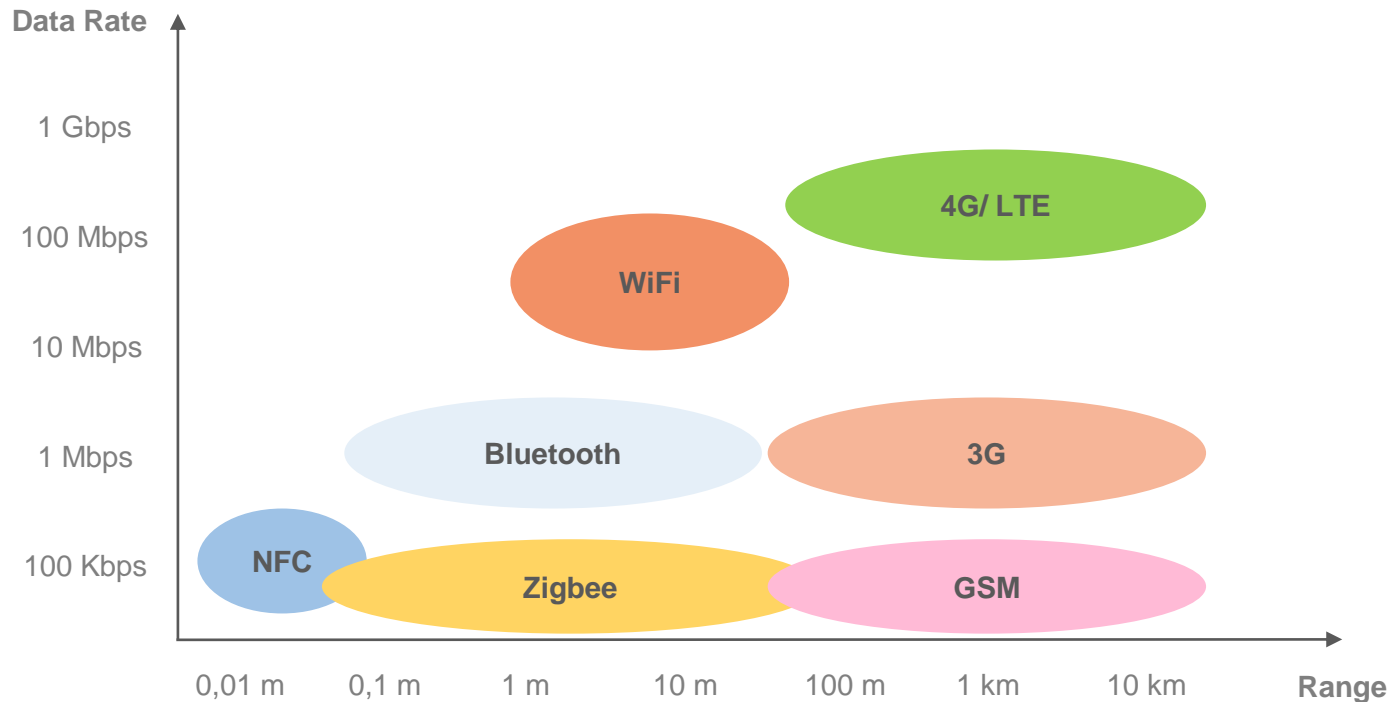
Standardized in
ISO/IEC 14443

NFC

Adds a **two-way** communication
between NFC-enabled devices

NFC-enabled device can behave as
a contactless smartcard

Standardized in
ISO/IEC 18092 and **ISO/IEC 21481**

How is NFC different from or related to other wireless technologies

Near Field Communication

Initiate interactions with a simple touch

Technology at a glance:

- Contactless proximity technology

- Standardized under ISO/IEC 18092 and ISO/IEC 21481

- Operating frequency: 13.56 MHz

- Operating range: 10 cm (4 in)

- Max. speed: 424 Kbps

- Co-developed by NXP and Sony

- Origins in payment and access control

- Works with existing contactless infrastructure

Unique benefits:

- Easy to use ("Tap to initiate an action")

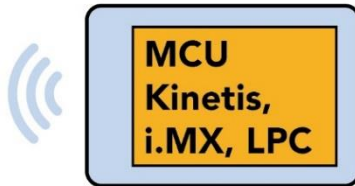- Act of will

- Zero-power

- Highest security

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With NFC, you can interface any device to…

Any Device

- Powered by battery or mains
- Can initiate NFC connection
- Reads data in from device or writes data out
- Small: typically ~25 mm² IC, 40x30mm antenna
- Many form factors

MCU Kinetis, i.MX, LPC
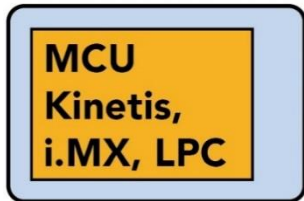
Another Device

- Even battery-less devices

MCU Kinetis, i.MX, LPC

An NFC-enabled phone

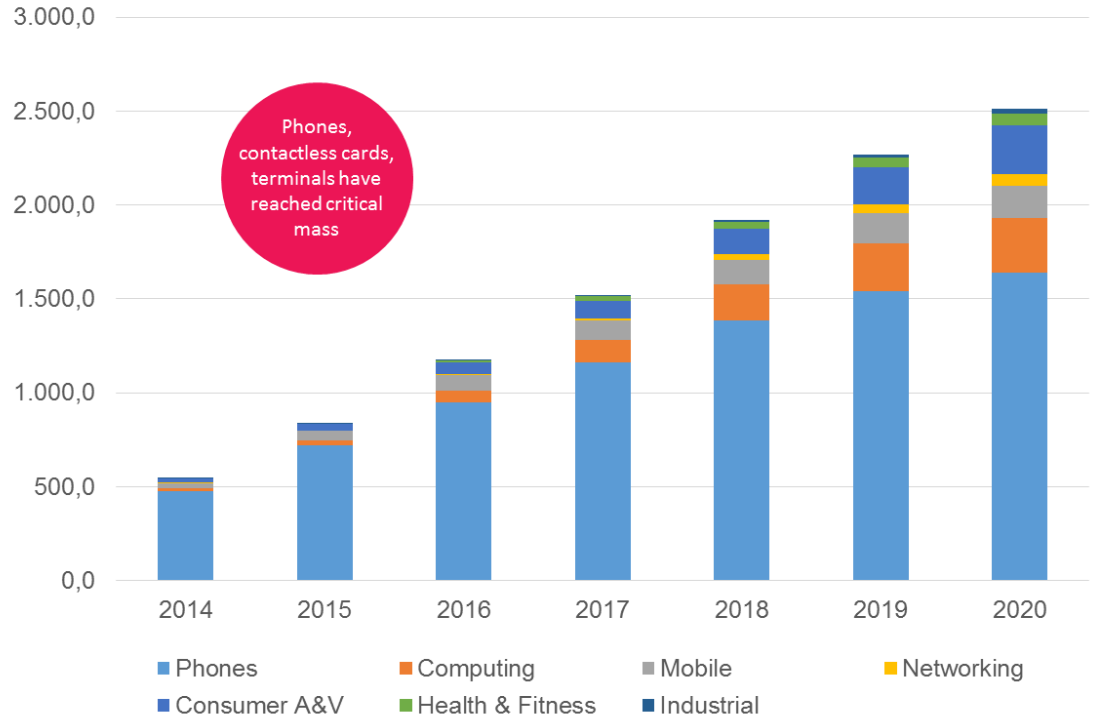- >1 billion NFC phones on the market (end of 2015)

NFC card or tag

- More than 2 billion pieces produced per year

NFC is ramping up

- **>1 billion NFC phones installed base (end of 2015)**

- **Smartphone share** expected to continue growing: **3 in 4 mobile phones** to come **with NFC by 2018**

- **> 5 billion NFC handsets** will ship before **2019**

- **>2 billion NFC cards and tags** per year

Source: NXP, ABI Research

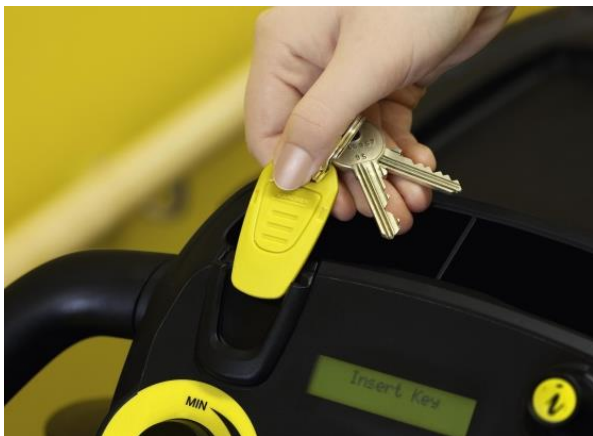**NFC Market outlook**
(MPc, ABI Research 2016)

Phones, contactless cards, terminals have reached critical mass

Legend: Phones, Computing, Mobile, Networking, Consumer A&V, Health & Fitness, Industrial

The three modes of NFC: a tap is all it takes

Read/write

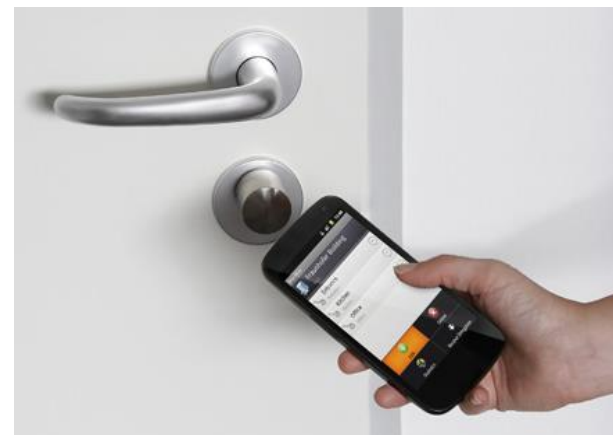The system performs the functions of a contactless reader

Peer-to-peer

Establishes a two-way communication channel between a pair of NFC devices
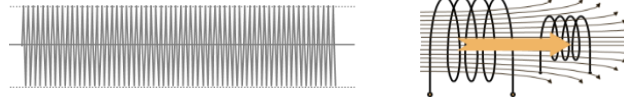
Card emulation

The system behaves as a contactless smartcard
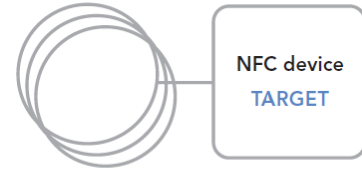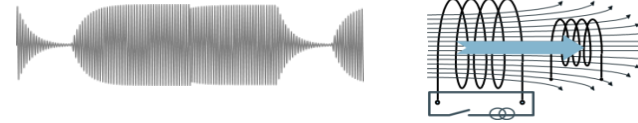
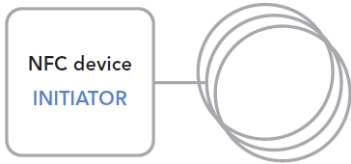# NFC passive communication scheme

1. The initiator produces a 13.56 MHz carrier field
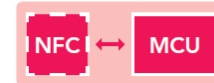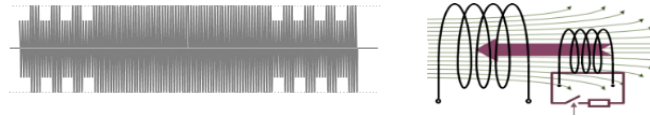The field enables data exchanges and sends energy to the target

2. The initiator sends commands
The initiator transfers data by directly modulating the field

3. The target responds
The target transfers data by load-modulating the field

NFC device
INITIATOR

MCU ↔ NFC

NFC device
TARGET

NFC ↔ MCU

NFC active communication scheme

1. The initiator sends commands
The initiator generates a 13.56 MHz carrier field, uses Amplitude Shift Key (ASK) modulation to send commands, then cuts the field

NFC device
INITIATOR

MCU ↔ NFC

2. The target responds
Once the initiator cuts its field, the target generates its own and uses ASK modulation to send responses

NFC device
TARGET

NFC ↔ MCU
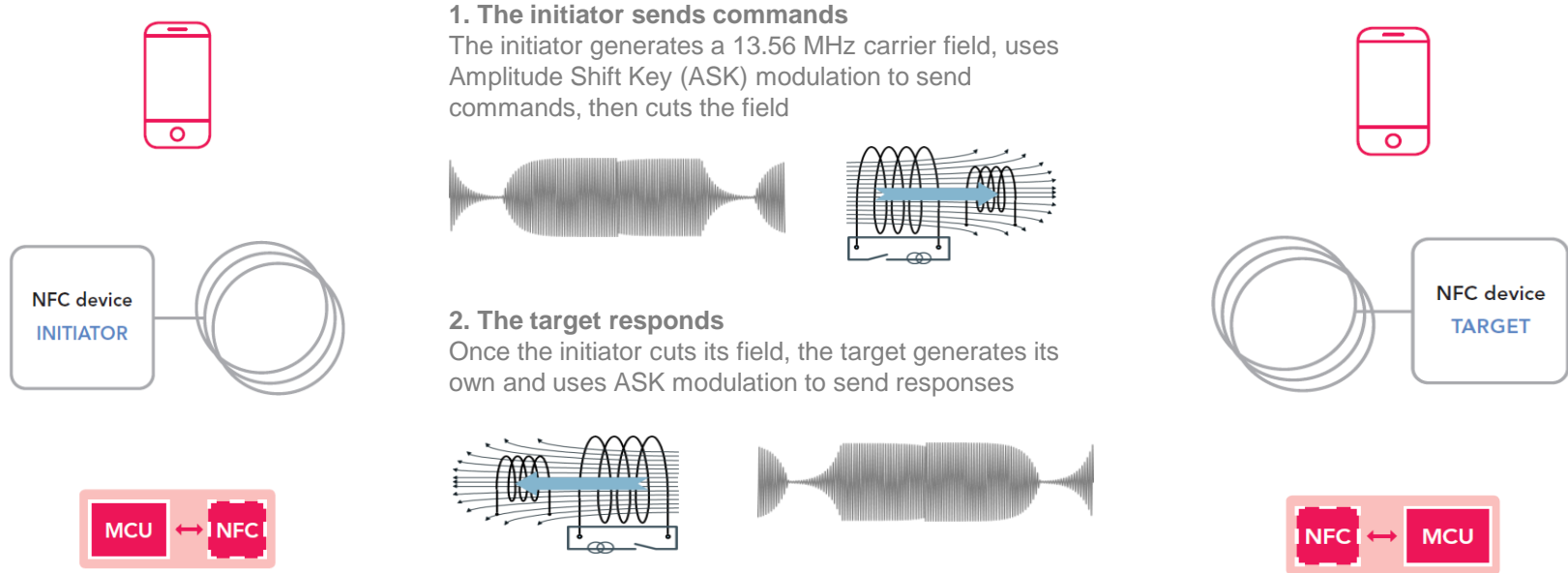
To avoid collisions, only the sending device emits an electromagnetic field. The send / receive roles are reversed as needed to support the transaction

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NFC Forum

Leading the way to NFC innovation

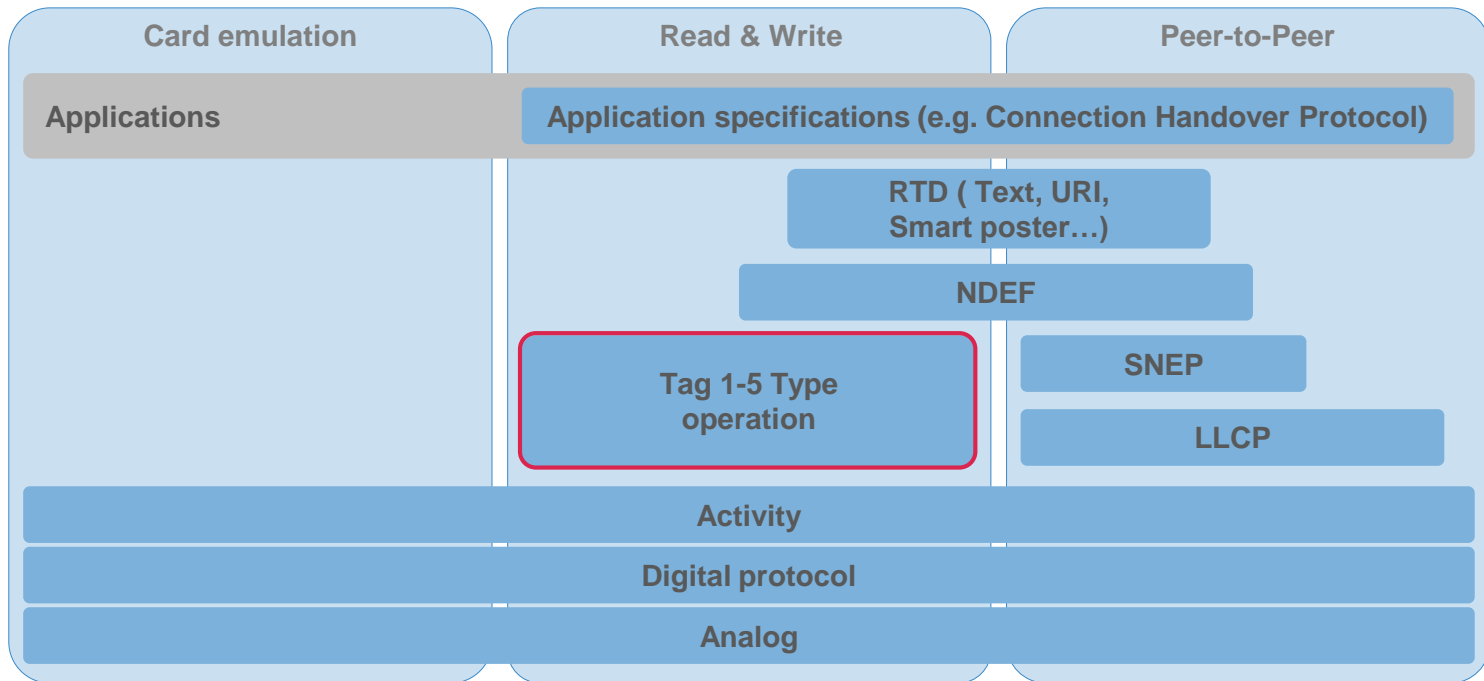- The NFC Forum is a non-profit organization established to promote the use of NFC technology in consumer electronics, mobile devices, PCs, and more.

- The NFC Forum represents all of the world's major:
  - Chip vendors.
  - Payment service providers.
  - Smart phone manufacturers.
  - Mobile operating system providers.

- The NFC Forum missions are:
  - Develop standards-based NFC specs.
  - Encourage the development of products based on NFC Forum specifications.
  - Work to ensure that products claiming NFC capabilities comply with NFC Forum specs.
  - Educate consumers and enterprises globally about NFC.

NFC Forum specification architecture
Build solutions and ensure the global interoperability

Card emulation	Read & Write	Peer-to-Peer

Applications — Application specifications (e.g. Connection Handover Protocol)

RTD (Text, URI, Smart poster…)

NDEF

Tag 1-5 Type operation

SNEP

LLCP

Activity

Digital protocol

Analog

The 5 NFC Forum Tag Types

NFC-Forum compliant device

Read & Write

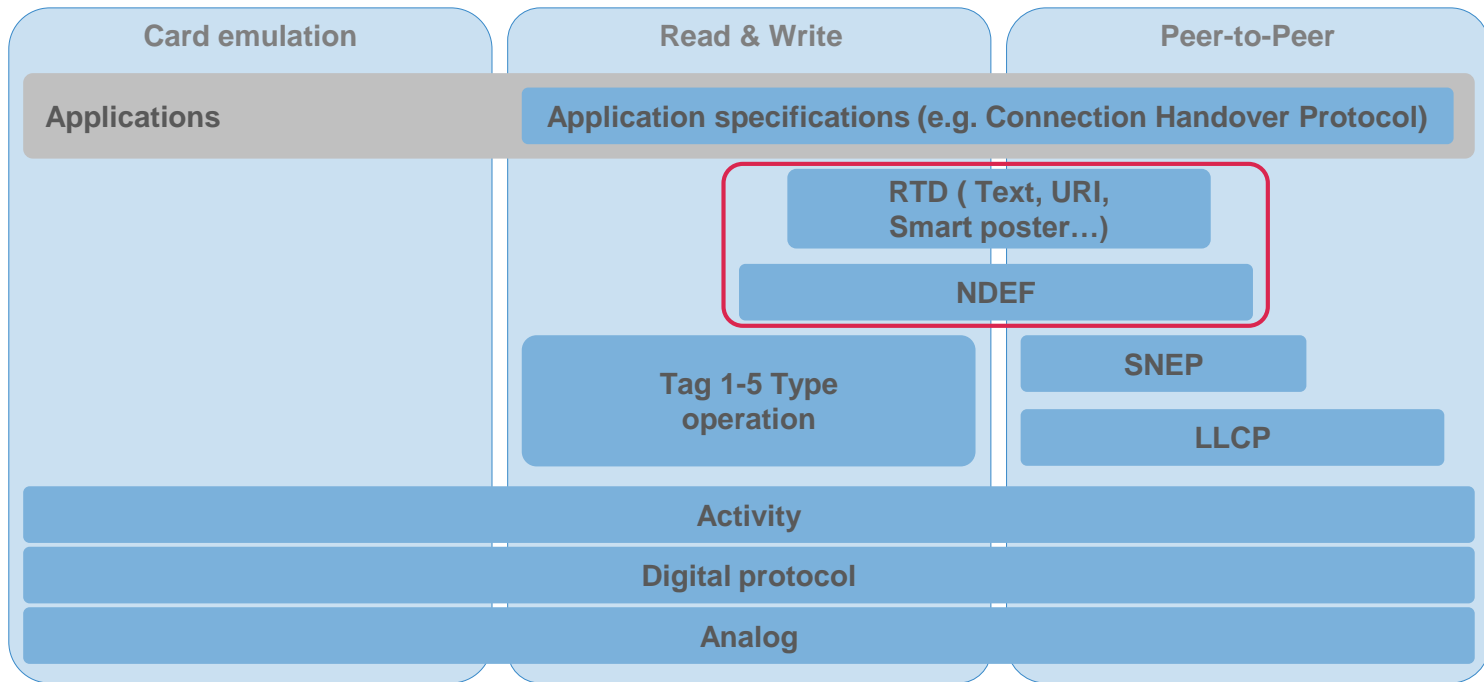| Type 1 Tag	Type 2 Tag	Type 3 Tag	Type 4 Tag	Type 5 Tag
ISO14443-3A	ISO14443-3A	JIS X 6319-4	ISO/IEC14443-4	ISO/IEC15693
(Broadcom Topaz)	(MIFARE Ultralight & NTAG)	(Sony FeliCa)	(MIFARE DESFire)	(ICODE)

NFC Forum specification architecture
Build solutions and ensure the global interoperability

Formats for data exchange
NFC data exchange format (NDEF)

- Specifies a common data format for NFC Forum-compliant devices and NFC Forum-compliant tags.

- It is used to describe how a set of actions are to be encoded onto a NFC tag (e.g. open a URL, create an SMS, create an email, etc.).

- The benefit of using NDEF is that you do not need to have custom software running on the touching device.
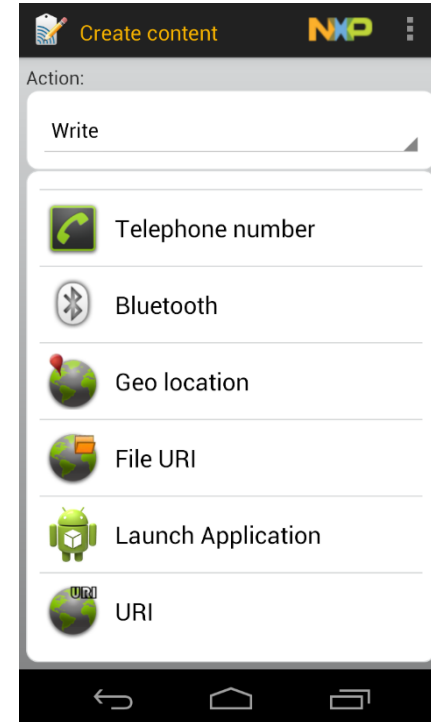
NFC FORUM

Training Mobile Knowledge

Formats for data exchange
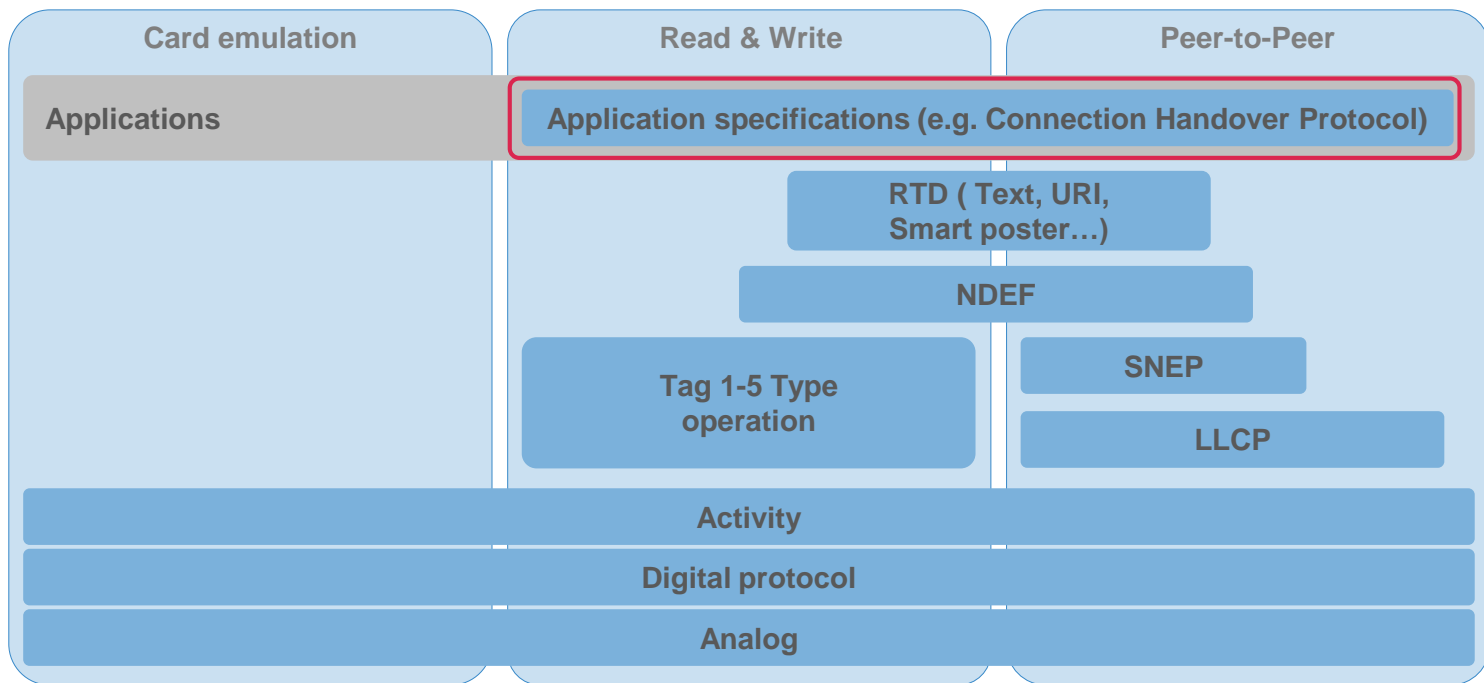## NFC record type definition (RTD)

- Specifies the format and rules for building standard record types used by NFC Forum application definitions and third parties that are based on the NDEF data format.

- Common NFC record types:
  - **vCard**: Stores contact information (e.g. electronic business cards)
  - **URI:** Stores Universal Resource Identifiers (URIs), which include web addresses and other network resources and files
  - **Text:** Stores text strings in multiple languages.
  - **Smart poster:** Stores text strings, URLs, SMS or phone numbers.
  - **Connection handover:** Stores pairing with Bluetooth, Wi-Fi or other protocols
  - **Device information**: Stores basic details about the device mode and its identity.
  - **Signature:** Provides an algorithm or certificate type for use as a digital signature

* For more on these formats, check the NFC Forum website (nfc-forum.org)

NFC Forum specification architecture

Build solutions and ensure the global interoperability

Card emulation	Read & Write	Peer-to-Peer
Applications	**Application specifications (e.g. Connection Handover Protocol)**	
	RTD (Text, URI, Smart poster…)	
	NDEF	
	Tag 1-5 Type operation	**SNEP**
		LLCP
Activity		
Digital protocol		
Analog		

NFC Forum Connection Handover Protocol (CHP)

Making device pairing with NFC really easy

Without NFC

1. Keep the sensor power-on button pressed

2. Browse phone menu for Bluetooth or Wi-Fi settings

3. Find Bluetooth device and write passcode or write Wi-Fi network credentials
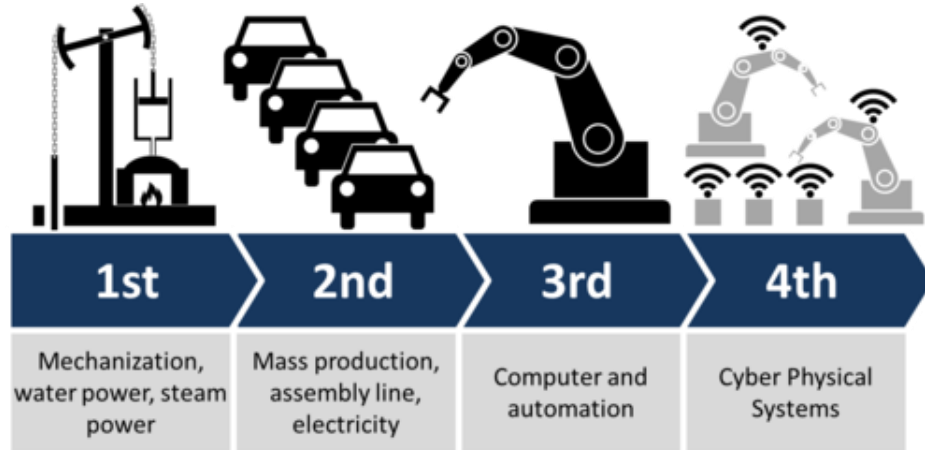
4. Paired!

With NFC

1. Tap phone to the sensor.

2. Paired!

Pairing credentials are encoded and exchanged using NDEF messages as defined by NFC Forum specifications

APPLICATION EXAMPLES

NFC place in the Industry 4.0 picture

1st	2nd	3rd	4th
Mechanization, water power, steam power	Mass production, assembly line, electricity	Computer and automation	Cyber Physical Systems

- Industry 4.0 relies on a number of technologies that add intelligence to production, inspection, security, service support and business operations.

- NFC is a welcome addition to the industrial environment, because it delivers new levels of convenience, communication, and configurability, such as:

  - Better man-machine interfaces.

  - Easy maintenance.

  - Pairing, commissioning and parametrization of machinery and sensors.

  - Authenticated tools.

  - Late customization.

  - Device-to-device communication, e.g. communication with battery-less or galvanicaly-isolated devices.

  - Controlled access to restricted facilities and devices.

NFC for machinery access rights control

Use cases

▸ Tap-and-authenticate to machines.
▸ Restrict logical access to specialized machinery to only trained or skilled employees.

Benefits

▸ Set up individual profiles, personalize settings and adjust preferences.
▸ Varying levels of authorized access.
▸ Increase productivity with faster access to specialized machinery.

NFC solutions

▸ NFC frontends: **CLRC663**.
▸ NFC controller: **PN7462**, **PN736x**.
▸ Contactless card/token: **MIFARE DESFire EV2, MIFARE Plus EV1.**

Fig. Cleaning machine for professional use enabled with NFC technology. More info

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NFC for access control into restricted areas

Use cases

▸ Securing and protecting access to an installation, warehouse, assembly line plant, datacenter, etc.

Benefits

▸ Time & attendance logging for secure areas.

▸ Remote key distribution management.

▸ Time-limited access for temporary personal.

▸ Reduce maintenance and replacement costs, with fewer lost or damaged keys, cards or badges.

NFC solutions

▸ NFC frontends: **CLRC663.**

▸ NFC controller: **PN7462**, **PN736x**.

▸ Contactless smartcard: **MIFARE DESFire EV2, MIFARE Plus EV1.**
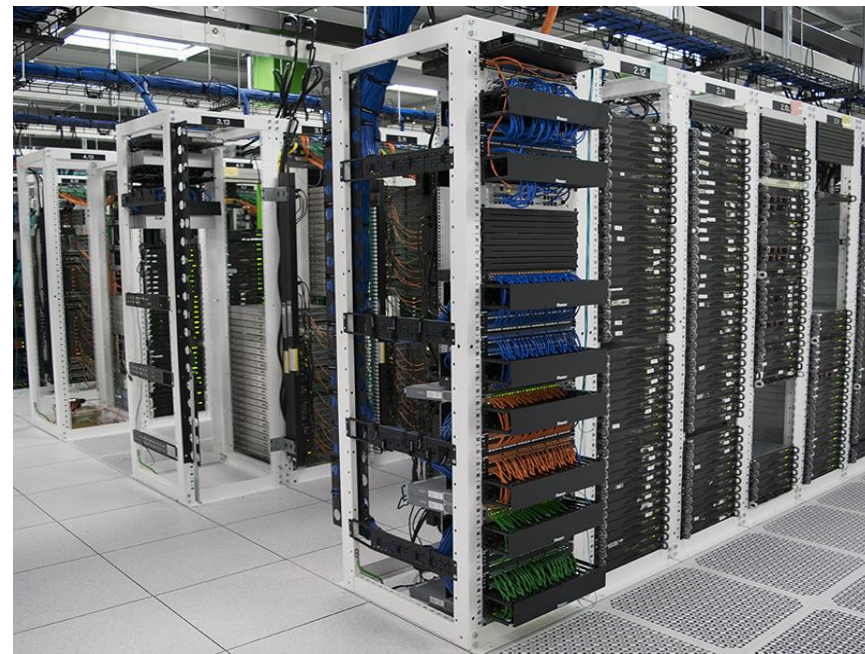
Fig. Physical access control into datacenter facilities.

NFC for extended user interface, parametrization and zero-power configuration

Use cases

▶ Use your smartphone as the configuration interface for products with rudimentary interface or completely sealed without user interface at all.
▶ Customize and personalize product settings with a single tap (e.g. adjust country settings, feature sets or firmware versions at the store).

Benefits

▶ Handle complex device settings easily on the phone/tablet touchscreen.
▶ Better accuracy adjustments than mechanical controls.
▶ Zero-power operation, the device can be unpowered.

NFC solutions

▶ NFC connected tags: **NTAG I²C plus.**

Fig. NFC-enabled timer relay. More info

NFC for easy troubleshooting and product diagnostics

Use cases

▸ Upgrade device firmware using the phone/tablet connection.
▸ Identify breakdown issue and bring the appropriate replacements.
▸ Check warranty or product registration.
▸ Read product diagnostics before powering up the machinery.

Benefits

▸ Easy maintenance. No contact interface needed.
▸ Easily obtain product serial numbers, firmware version, repair history.
▸ Error logs or activity statistics can be read even when the device is completely dead and does not boot up anymore.
▸ UART service port replacement.

NFC solutions

▸ NFC connected tag: **NTAG I²C** *plus*

Fig. Use of a phone touchscreen for sealed device diagnostics

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NFC for easy commissioning of nodes to a wireless network

Use cases

▸ Commissioning of sensors and other nodes to a wireless network so they can be remotely managed and controlled.
▸ Configure sensors to trigger an alert when certain threshold is reached.

Benefits

▸ Faster device pairing, avoiding manual settings, cumbersome button combinations or entering long codes.
▸ Make devices easier to use and reduce tech-support costs.
▸ Exchange credentials securely, just by tapping.
▸ Use NFC to pair any wireless networking standard.

NFC solutions

▸ NFC connected tags: **NTAG I^{2}C *plus***
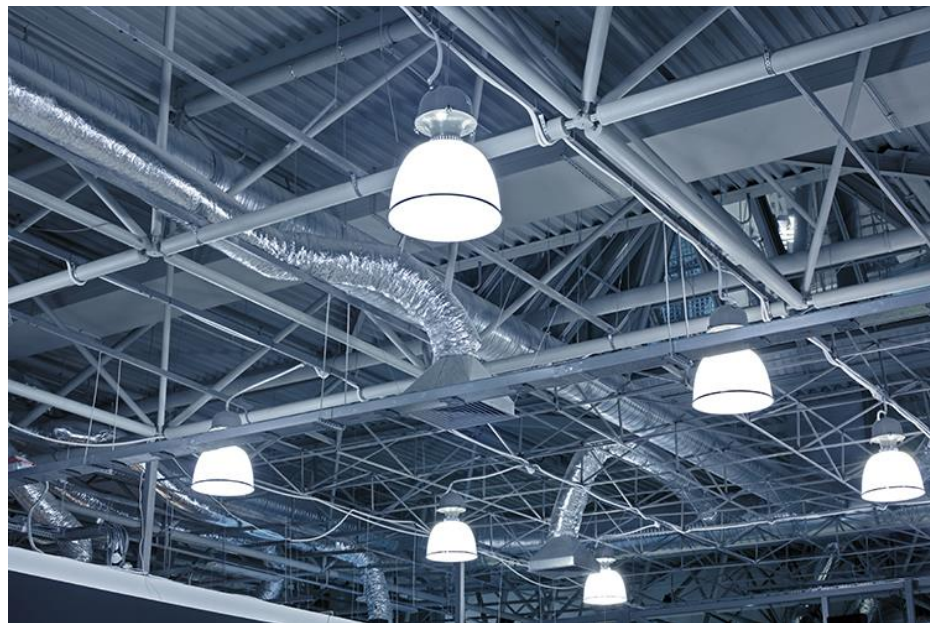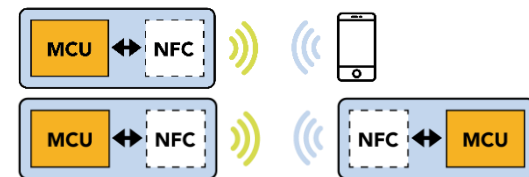
Fig. Smart lighting system in a factory facility.

NFC for authenticated tools and consumables

Use cases
▸ Authenticate replacement parts and automatically adjust settings of the main unit based on the accessory attached.
▸ Protect correct device functioning making sure that only original consumables or tools are used for a given task.
▸ Identification of robot attachment.

Benefits
▸ Ensure authenticity and combat counterfeits of accessories or consumables.
▸ Boost manufacturing by automatically choosing the right tool every time.

NFC solutions (shorter distances)
▸ NFC tags: **NTAG21x, MIFARE Ultralight C.**
▸ NFC frontends: **MFRC630.**

NFC solutions (larger distances)
▸ NFC tags: **ICODE SLIX, ICODE DNA.**
▸ NFC frontends: **SLRC610.**

Fig. Robotic arm authenticating the right tool for each given task.

NFC for device-to-device communication

Use cases

▶ Let a fully sealed, battery-free sensor unit interact with the meter housing.
▶ Record mechanical-stress readings on moving parts.
▶ Avoid galvanic connections by letting machines talk without wires.
▶ Devices next to each other with a need to communicate without cables.

Benefits

▶ The device can remain completely sealed (e.g. water proof, dust proof, etc).
▶ Communication with sensors, parts or devices which can not be connected through wires to the main unit (replaces cables for moving, rotating or sealed parts).

NFC solutions

▶ NFC connected tag: **NTAG I²C** *plus*
▶ NFC frontends: **MFRC630**

Fig. NFC-enabled wireless charger

NFC for reading product details, user manuals or emergency instructions

Use cases

▸ Staff access to important hazardous information by tapping their NFC devices against products.
▸ Read emergency instructions in case of accident.
▸ Get access to machinery instructions or user manuals.

Benefits

▸ Save time in the operating processes.
▸ Reduce the cost of identifying items, goods, inventories, etc .
▸ Increase the reliability of the data collected.
▸ Reduce the time and training costs.

NFC solutions

▸ NFC tag: **NTAG21x**
▸ NFC connected tags: **NTAG I²C** *plus*
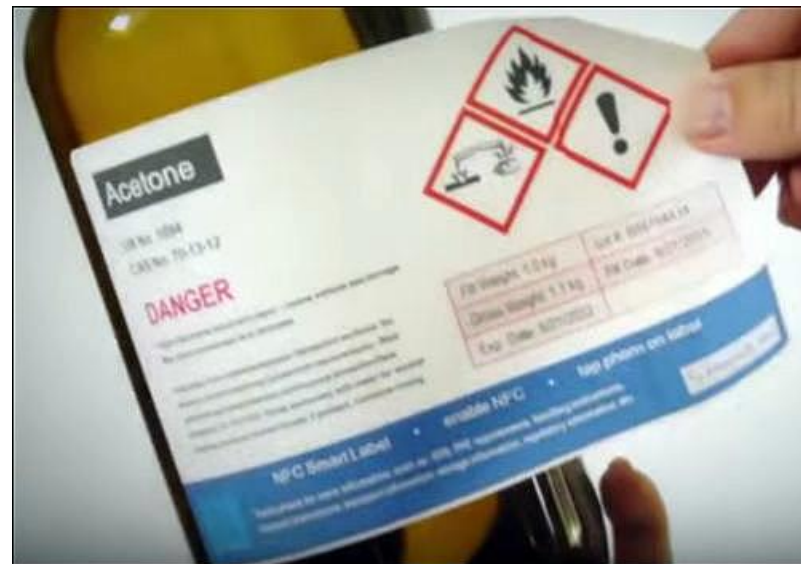
Fig. NFC label encoding chemical handling information. More info.

Long range UHF RFID for industrial applications

Use cases

▸ Track & trace spare parts, PCBs and finished products throughout the supply chain
▸ Inventory management
▸ Production control and variant management
▸ Brand protection
▸ Recycling management

Benefits

▸ Increased production efficiency and flexibility
▸ One tag providing identification and authentication at the same time
▸ UHF allows long read ranges up to 10 m
▸ Bulk reading of many items in a box or on a pallet

UHF solutions

▸ **UCODE 7, UCODE 7xm, UCODE 7xm+** with digital signature**, UCODE DNA** with authentication

NFC FUNCTIONAL BLOCK CONCEPT

NFC functionalities for industrial applications

NDEF: vCard Service Contact
Get in touch with the service support team in case of system malfunctioning.

NDEF: URL User Manual
Quick referrals to operating manuals and other kinds of assistance.

NDEF: Product information
Reduce the cost of identifying items, goods, inventories, etc.

NDEF: URL Emergency info
Use your phone to read emergency instructions in case of accident at the workplace in any given moment.

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NFC functionalities for industrial applications (II)

Energy Harvesting

Communicate with battery-less or unpowered devices.

Galvanic isolated Power Supply

Communicate with galvanicly isolated sensors which can not be connected through wires to the main unit.

Wireless Display/HMI

The worker's tablet or phone can be used as the man-machine interface to verify or change parameters, refine settings or monitor activity.

Access to machinery

Identify users and immediately provide personalized settings and preferences. Better equipment uptime with fast access to specialized machinery.

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NFC functionalities for industrial applications (III)

Pairing to wireless networks
Add new nodes to a wireless network avoiding wasting time entering password and setting configurations.

Authenticated tools
Ensure that machinery only uses branded and certified tools for a given task.

Brand protection
Ensure that customers can validate that your products and accessories are original and genuine.

Identification of attachment
Boost manufacturing by automatically choosing the right tool every time

Training Mobile Knowledge

NFC functionalities for industrial applications (IV)

Wireless Troubleshooting

Check history and machinery usage, perform maintenance operations or calibration tasks without any contact interface needed. UART service port replacement

Wireless Software Update

Update firmware version wirelessly without un-mounting the device.

Wireless Interface

Cable replacement. Enable communication with moving, rotating or hermetically sealed devices.

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NFC functionalities for industrial applications (V)

Controlled environment
Control access to sensitive or restricted areas to only authorized employees.

Wireless Parametrization
Use the phone / tablet touchscreen for parametrization or for better accuracy adjustments than mechanical controls.

Late customization
Change particular product settings before being shipped to a certain region or customize settings at the store.

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Application Industrial Control

Wireless parametrization

Energy Harvesting

Wireless Display/HMI

NDEF: URL User Manual

NDEF: vCard Service Contact

NFC READER PORTFOLIO
&
SUPPORT MATERIAL

Your partner in every step of a reader design

- Independent Design Houses certified by NXP NXP IDH partner: www.nxp.com/partners, select "HW/SW engineering service"
- Technical NFC Community https://community.nxp.com/community/nfc

Evaluate functionality & choose an NFC product
Investigate which NFC functionality you need and choose one NFC solution from our broad portfolio

Evaluate features
Explore the possibilities with one of our development boards, then use the same board to start prototyping

Start prototyping
Re-use design of NXP development boards and sample code examples

Test & debug
We use standard-based design and support the most popular development tools to make it easy to fine-tune performance and catch errors

Get certified
Our solutions are designed to meet CE and FCC, and make it easier to pass EMVCo certification

We reduce complexity, streamline tasks, and add flexibility at every point of the product development process

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NFC focus products for each application need

Features and price (vertical axis)

High end

One chip system, freely programmable NFC controller with DPC
PN7462/PN736x

High-perf full NFC with DPC
PN5180

All round

High-perf multi-protocol reader
CLRC663

Plug&Play NFC for Linux, Android, Win
PN7150

Entry level

High-perf proximity&vicinity readers
MFRC630
(ISO14443A – MIFARE/NTAG reader)
SLRC610
(ICODE ISO15693 and ISO18000-3M3)

NTAG I²C *plus*

Connected tag solutions
NFC tags with non-volatile memory and host connection

NFC Frontend solutions
NFC reader with NFC Reader SW Library

NFC controller solutions
NFC reader with integrated
32-bit Cortex MCU and either integrated
firmware or freely programmable memory

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NXP

The product selection path

Passive solution → I will interact only with NFC phones → NTAG I²C *plus*

Active solution → What OS requirements do you have?

- Linux Android Windows → **PN71xx** NFC controller with integrated FW
- Own application code → **PN746x_736x** NFC controller with customizable FW
- RTOS NullOS
  - I will talk to any NFC-enabled system → High performance full NFC with DPC → **PN5180** NFC frontend
  - I will interact with contactless cards
    - High performance multi-protocol reader → **CLRC663** NFC frontend
    - High performance ISO/IEC14443 reader → **MFRC630** NFC frontend
    - High performance ISO/IEC15693 and ISO/IEC18000-3M3 reader → **SLRC610** NFC frontend

Our demokits are comprehensive packages with extensive support material

Hardware PCBs

Reference source code and tools

IC samples

Documentation
Application notes, User Manuals, Quick start guides

Support for **connected tags**

PC tools

- Windows application for NTAG I2C plus Explorer board
- Peek and Poke
- RFID discover

Development kit

- NTAG I²C plus Explorer Kit

Android applications

- NTAG I²C demo app
- TagInfo
- TagWriter

Source code examples

- NTAG I²C Explorer board C firmware
- NTAG I²C demo app Android app source
- NTAG I²C PC app source code
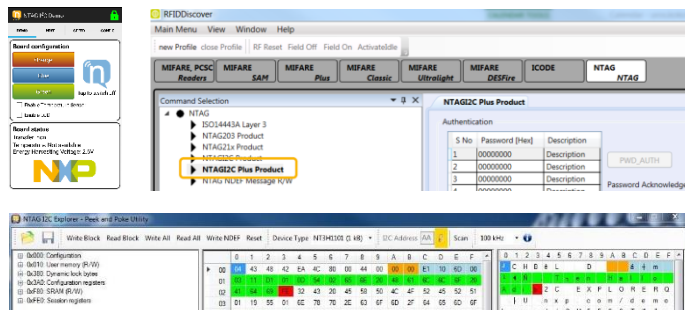
Documentation

- Application notes
- User Manuals
- Getting started guides

Development environment

- LPCXpresso IDE for LPC MCUs
- MIFARE SDK

Support for **NFC frontend & NFC controllers with customizable firmware**

NFC Reader Library

- Software support for NFC frontend solutions:
- Available for: PN512, CLRC663, PN5180, PN7462 and Linux

Development kits and demoboards

- CLEV663B
- OM25180FDK
- OM27462CDK
- PNEV512R
- PNEV512B

Source code examples

- SW examples based on NFC Reader Library demonstrating frontend capabilities

Development environment

- LPCXpresso IDE for LPC MCUs
- Keil and IAR tool chain (PN7462)

Documentation

- Application notes
- User Manuals
- Getting started guides

NFC Cockpit

- A PC tool that eases design process, antenna tuning and register configuration (PN5180, PN7462)

Support for **NFC controllers with integrated FW**

Single board computer kits

- SingleBoard Computer (SBC) kits with interface boards for Arduino, Raspberry Pi and BeagleBone Black (OM5578, OM5577)

Compatibility with development boards

- Integration with any boards featuring Arduino-compatible header, including many LPC, Kinetis and i.MxX boards

SW images and SW examples

- For Windows 10 IoT , Android, Linux, RTOS, NullOS together with illustrative NFC SW examples

Documentation

- Application notes
- User Manuals
- Getting started guides

Use our technical community for your questions

Become a registered member and get expert advice from the developer community
https://community.nxp.com/community/nfc

How to get there

- NFC and Reader Ics → NFC Technology hub → NFC support → NFC community
- URL: https://community.nxp.com/community/nfc
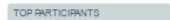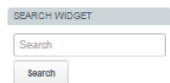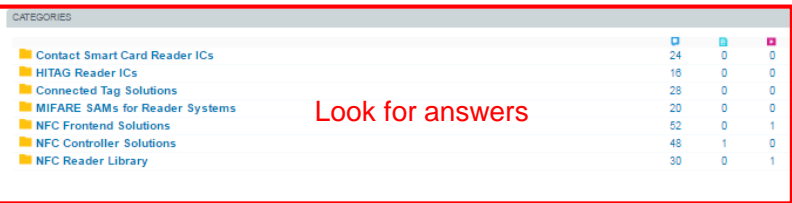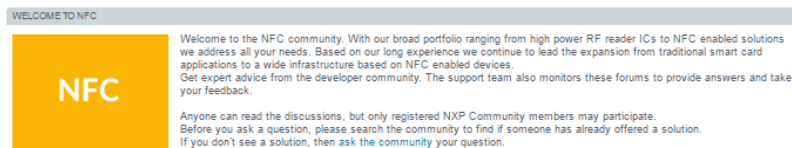
Watch on-demand any recorded session

Tap into our free on-demand training library.

Hundreds of hours of webinars and presentations on NXP products, applications, software, and tools.

Find recorded sessions, among others, for:

- NFC essentials
- NFC use cases
- NFC standards
- NFC reader antenna design (6 sessions)
- NFC reader portfolio
- NFC in smart home, gaming, payments,
- …

How to get there

- NFC and Reader ICs→ NFC Technology hub → NFC support → NFC webinars
- URL: http://www.nxp.com/support/online-academy/nfc-webinars:NFC-WEBINARS

Find the right partner
Independent design houses

Partner List

NXP > Support > NXP Partner Program > Partner List

Partner list (and search for NFC)

How to get there

▪ NFC and Reader ICs→ NFC Technology hub → NFC support → NFC IDH partners

▪ URL: http://www.nxp.com/pages/partner-list:PARTNER-LIST

Software development in Android and iOS

Embedded software for MCUs

JCOP, Java Card operating Systems

Hardware design and development

Digital, analog, sensor acquisition, power management

Wireless communications WiFi, ZigBee, Bluetooth, BLE

Contactless antenna RF design, evaluation and testing

MIFARE applications

End-to-end systems, readers and card-related designs

EMVco applications

Readers, cards, design for test compliancy (including PCI)

Secure Element management

GlobalPlatform compliant backend solutions

Secure services provisioning OTA, TSM services

We help companies leverage the
mobile and **contactless revolution**

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08018 Barcelona
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Get in touch with us
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Training Mobile Knowledge

NXP

NFC use cases for industrial applications

Jordi Jofre (Speaker)
Angela Gemio (Host)

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