NFC-connected Phone as a User Interface? There's an App For That! – Hands On

Class 2: An NFC Primer and Introducing the NXP NTAG

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CEC CONTINUING EDUCATION CENTER

Digi-Key ELECTRONICS

This Week's Agenda

9/23 Introduction to the Project and Development Environment

9/24 An NFC Primer and Introducing the NXP NTAG

9/25 Building an Android Application from Scratch

9/26 Adding NFC Capability and Communications to Our App

9/27 Putting it All Together

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What is NFC?

- Near Field Communication (NFC) is a series of standards for HF communication in both passive and active modes. It is part of a class of devices in RFID (radio frequency identification)
- NFC is defined in three standards:
  - ISO 14443A/B
  - ISO 18092
  - JIS X6319-4

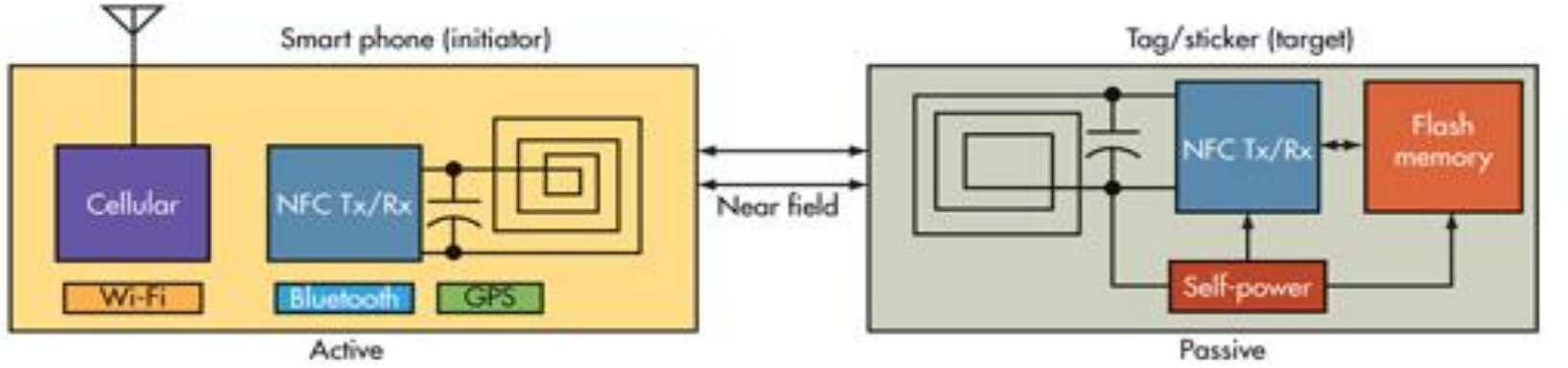
What is NFC?

- NFC is an offshoot of RFID with the exception that NFC is designed for use by devices within close proximity to each other.
- NFC is a short range high frequency wireless technology that carry secure two-way interactions between electronic devices.
- NFC utilizes electromagnetic radio fields while technologies such as Bluetooth and Wi-Fi focus on radio transmissions instead.
- NFC provides contact or contactless communication in a proximity of 1 – 4 centimeters and up to 10 centimeters.
- NFC is mainly aimed for mobile or handheld devices.
- NFC allows communication between:
  - Two powered (active) devices
  - Powered and non self-powered (passive) devices.
- NFC offers the ultimate in security and convenience, and makes new interactions possible.
- NFC combines the interface of a smartcard and a reader into a single device that allows two-way communication between endpoints, where RFID system was one-way only.
- NFC devices operate at 13.56MHz, with a bandwidth 14kHz.
- NFC supports data rates: 106, 212 and 424 Kbits/s
- For two devices to communicate using NFC, one device must have an NFC reader/writer and one must have an NFC Tag.

NFC Time Line

Year	Event
1983	The first patent to be associated with RFID was granted to Charles Walton
2002	NXP Semiconductors and Sony co-invent NFC
2004	Nokia, Phillips and Sony established the NFC forum
2006	Initial specifications for NFC Forum Tags and “Smart Poster” records
2006	Nokia launches the first NFC phone (Nokia 6131)
2009	NFC Forum releases Peer-to-Peer standards
2010	Samsung, Nexus 5: First Android NFC phone shown
2010	AT&T, Verizon, T-Mobile announces Softcard mobile payment joint venture
2011	Google I/O “How to NFC” demonstrates NFC to initiates a game and to share a contact, URL, app, video, …
2011	RIM is 1st company for its devices is certified by Mastercard worldwide, the functionality of PayPass
2012	Samsung introduces TecTile, a set of NFC stickers and a companion App for Android to read/write TecTile
2012	Sony introduces “Smart Tags” using NFC technology to chab=nge modes and profiles on Sony smart phone
2012	Wired US is the 1st mass market publication to feature NFC enable advertisements
2013	Samsung and Vise announces major partnership to develop mobile payments
2014	Apple introduces iPhone 6 with Apple Pay using NFC Tecnology

Active and Passive NFC Devices



- The active device generates the RF field and the passive device uses the field to power itself and communicate.
- The card/tag is self-contained and requires no battery or power supply. If there is enough field to communicate, there is enough field to power the circuit
- We can add this passive tag to a powered circuit (embedded system) if the NFC circuit has provision for external power and communications. An additional output may be provided to allow the detection of the NFC field by the external circuit.
- More on this shortly!

Question 1: What is a practical max data on a QR code?

Operation Of NFC

1. NFC has two communicative terminals :The **INITIATOR** is the one who wishes to communicate and starts the communication. The **TARGET** receives the initiator's communication request and sends back a reply

2. NFC employs two different coding to transfer data. If an active device transfers data at 106 Kbit/s, **a Modified Miller** coding with 100% modulation is used. In all other cases **Manchester coding** is used with a modulation ratio of 10%.

10% ASK modulation means ASK modulation in which modulation index will range between 8% and 14%.

In 100% ASK modulation, unmodulated signal amplitude and modulated signal amplitude is almost equal.

Operation Of NFC

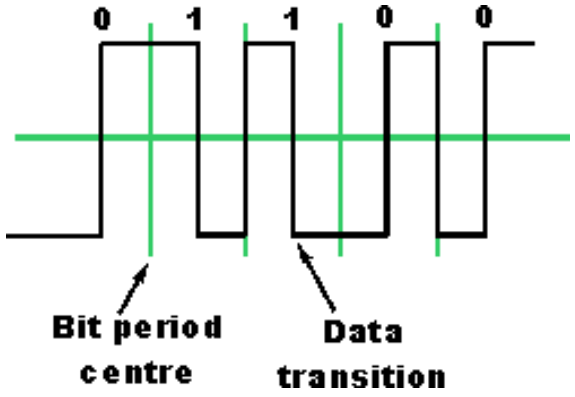
There are two mode of communication

Passive Communication Mode: The Initiator device provides a carrier field and the target device answers by modulating existing field. In this mode, the Target device may draw its operating power from the Initiator-provided electromagnetic field.

Active Communication Mode: Both Initiator and Target device communicate by alternately generating their own field. A device deactivates its RF field while it is waiting for data. In this mode, both devices typically need to have a power supply.

NFC and Manchester coding

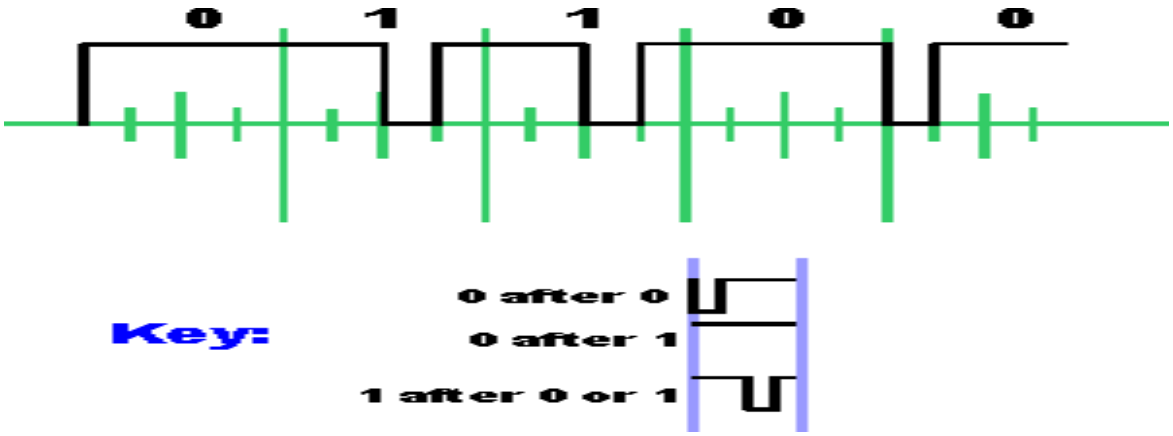
Manchester coding is used for the majority of cases for the NFC communications. The Manchester coding utilizes the two different transitions that may occur at the midpoint of a period. A low-to-high transition expresses a 0 bit, whereas a high-to-low transition stands for a 1 bit.



Manchester coding used for NFC data transfer

NFC and Modified Miller coding

Depending on the information to be transmitted, bits are coded as shown below. A high or "1" is always encoded inth e same way, but a low or "0" is encoded differently dependent upon what preceded it.



Modified Miller coding used for NFC data transfer used for 106 kbps active device transfers

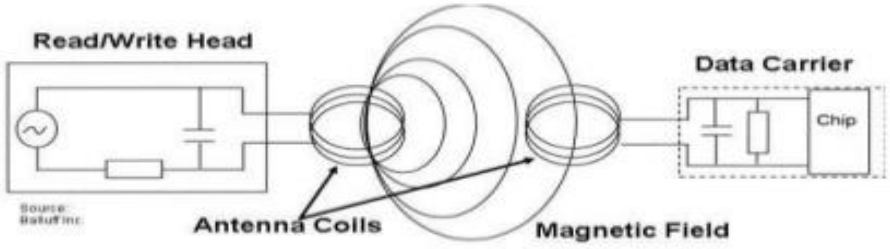
NFC RF signal coding

NFC employs two different coding systems on the RF signal to transfer data. In most cases a level of 10% modulation is used, with a Manchester coding format. However for an active device transmitting data at 106 kbps, a modified Miller coding scheme is used with 100% modulation. In all other cases Manchester coding is used with a modulation ratio of 10%.

DATA RATE KBPS	ACTIVE DEVICE	PASSIVE DEVICE
106	Modified Miller, 100%, ASK	Manchester, 10%, ASK
212	Manchester, 10%, ASK	Manchester, 10%, ASK
424	Manchester, 10%, ASK	Manchester, 10%, ASK

Operation Of NFC

- NFC devices communicate via **magnetic field induction**, where two loop antennas are located within each other's **near field**, effectively forming an **air-core transformer**.
- The reader continuously generates an RF carrier sine wave (at **13.56 MHz**), watching always for modulation to occur. Detected modulation of the field would indicate the presence of a tag.



Example Hotel Room Keys

Operation Of NFC

- A tag enters the RF field generated by the reader. Once the tag has received sufficient energy to operate correctly, it divides down the carrier and begins clocking its data to an output transistor, which is normally connected across the coil inputs.
- The tag's output transistor shunts the coil, sequentially corresponding to the data which is being clocked out of the memory array.
- Shunting the coil causes a momentary fluctuation (dampening) of the carrier wave, which is seen as a slight change in amplitude of the carrier.
- The reader peak-detects the amplitude modulated data and processes the resulting bit stream according to the encoding and data modulation methods used.

Comparison With Existing Technologies

	NFC	RFID	IrDa	Bluetooth
Set –up time	<0.1ms	<0.1ms	~O.5s	~6 sec
Range	Up to 10cm	Up to 3m	Up to 5m	Up to 30m
Usability	Human centric Easy, intuitive, fast	Item centric Easy	Data centric Easy	Data centric Medium
Selectivity	High, given, security	Partly given	Line of sight	Who are you?
Use cases	Pay, get access, share, initiate service, easy set up	Item tracking	Control & exchange data	Network for data exchange, headset
Consumer experience	Touch, wave, simply connect	Get information	Easy	Configuration needed

Question 2: Can you name a practical application for IRDA?

Operating Modes of NFC devices

Reader/writer mode

the NFC device is capable of reading NFC Forum-mandated tag types, such as a tag embedded in an NFC smart poster

Peer-to-Peer mode

Two NFC devices can exchange data. For example, you can share Bluetooth or Wi-Fi link set-up parameters or you can exchange data such as virtual business cards or digital photos.

Card Emulation mode

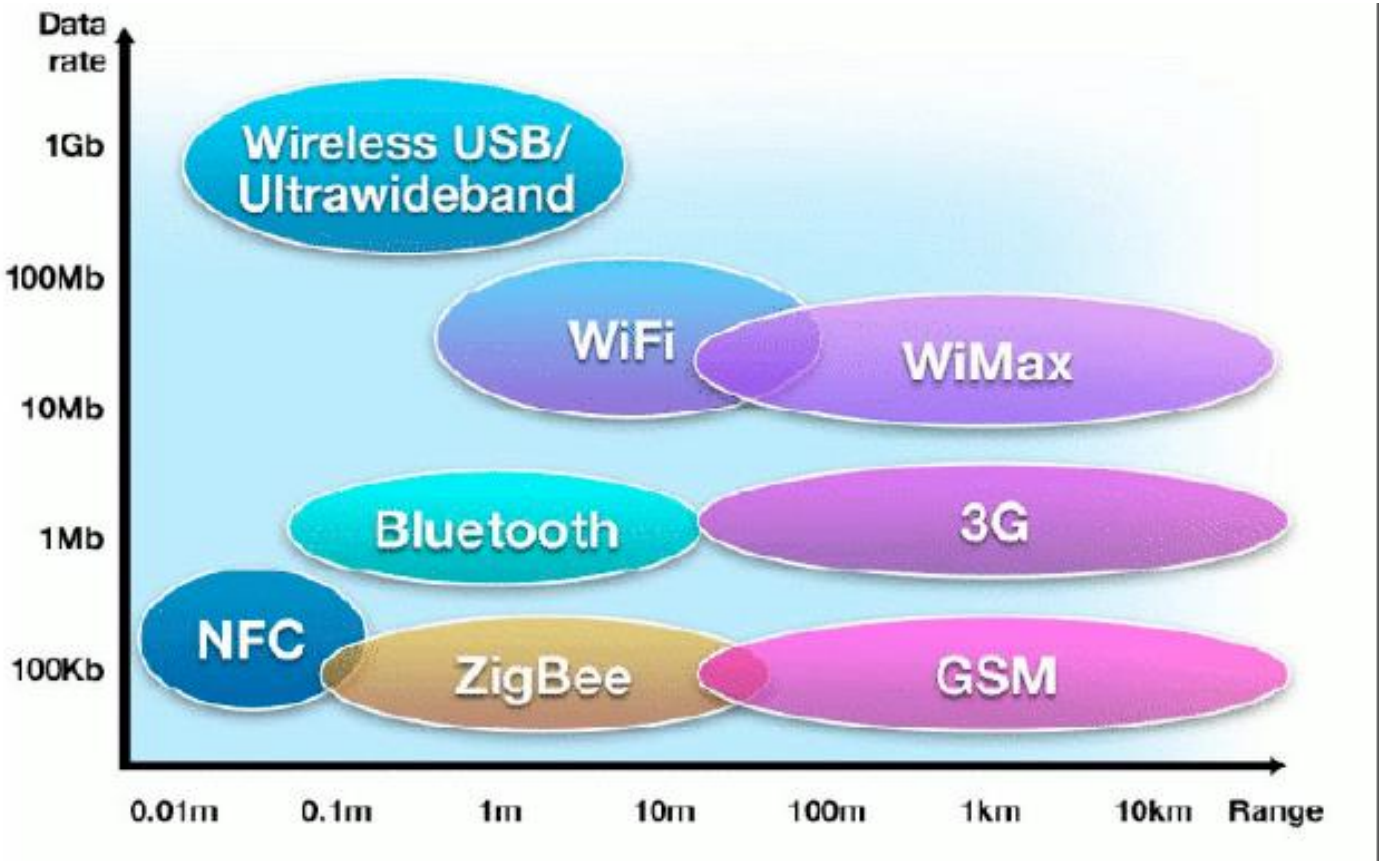
The NFC device appears to an external reader much the same as a traditional contactless smart card. This enables contactless payments and ticketing by NFC devices without changing the existing infrastructure.

Specifications

The NFC Forum has issued various specifications to date:

Specification	Purpose
NFC Data Exchange Format (NDEF)	Defines a common data format between NFC-compliant devices and tags
Record Type Definition (RTD)	Specifies rules for building standard record types Five specific RTDs (**Text, URI, Smart Poster, Generic Control, and Signature**) are used to build standard record types
Logical Link Control Protocol (LLCP)	Defines a protocol to support peer-to-peer communication between two NFC-enabled devices
Connection Handover	Defines how to establish a connection using other wireless communication technologies
Operations Specifications for Four Tag Types (1/2/3/4)	Enable core interoperability between tags and NFC devices

DATA RATE & RANGE



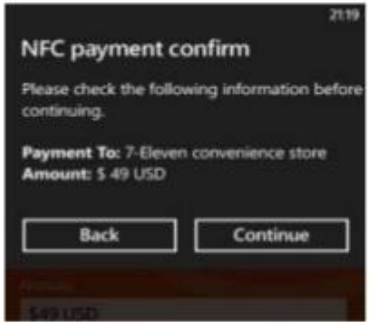
Application of NFC

Application of NFC

NFC and Mobile Payment

A customer makes his payment through mobile phone using NFC

- NFC phone will open **wallet** application
  - Wallet will display product cost when user clicks "Buy"
- At check out, wallet will display all credit/debit cards in wallet for payment
- Customer will select card for payment
- Wallet will show the confirmation page with the check out basket
- Wallet will connect to retailer back end for authorization and display tracking information



Application of NFC

Peer-to-peer

- **Connection Handover :** A handover use case is the exchange of configuration information via the NFC link to easily establish a connection over (for e.g. **Bluetooth or Wi-Fi**) and carry the information to be shared. Connection can be set between NFC devices

Speakers (touch to connect)

- *Home computer components*
- *Home entertainment systems*
- *Cameras and printers*
- *In-car devices*
- *Headsets and handsets*
- *Secure WLAN modem set-up*

Smart Tags

- If the amount of information is relatively small (up to one kilobyte), it is possible to use NFC to transmit the data itself (e.g. **electronic business cards, contacts**).

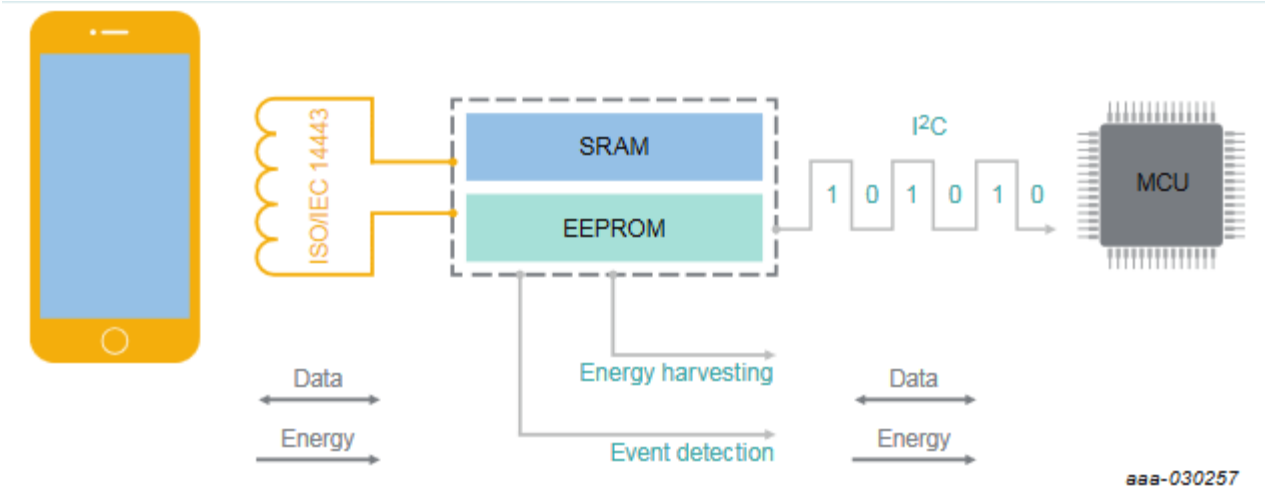
Benefits of NFC

NFC provides a range of benefits to consumers and businesses, such as:

- **Versatile**: NFC is ideally suited to the broadest range of industries, environments, and uses
- **Open and standards-based**: The underlying layers of NFC technology follow universally implemented ISO, ECMA, and ETSI standards
- **Technology-enabling**: NFC facilitates fast and simple setup of wireless technologies, (such as Bluetooth, Wi-Fi, etc.)
- **Inherently secure**: NFC transmissions are secure due to short range communication
- **Interoperable**: NFC works with existing Contactless card technologies
- **Security-ready**: NFC has built-in capabilities to support secure applications

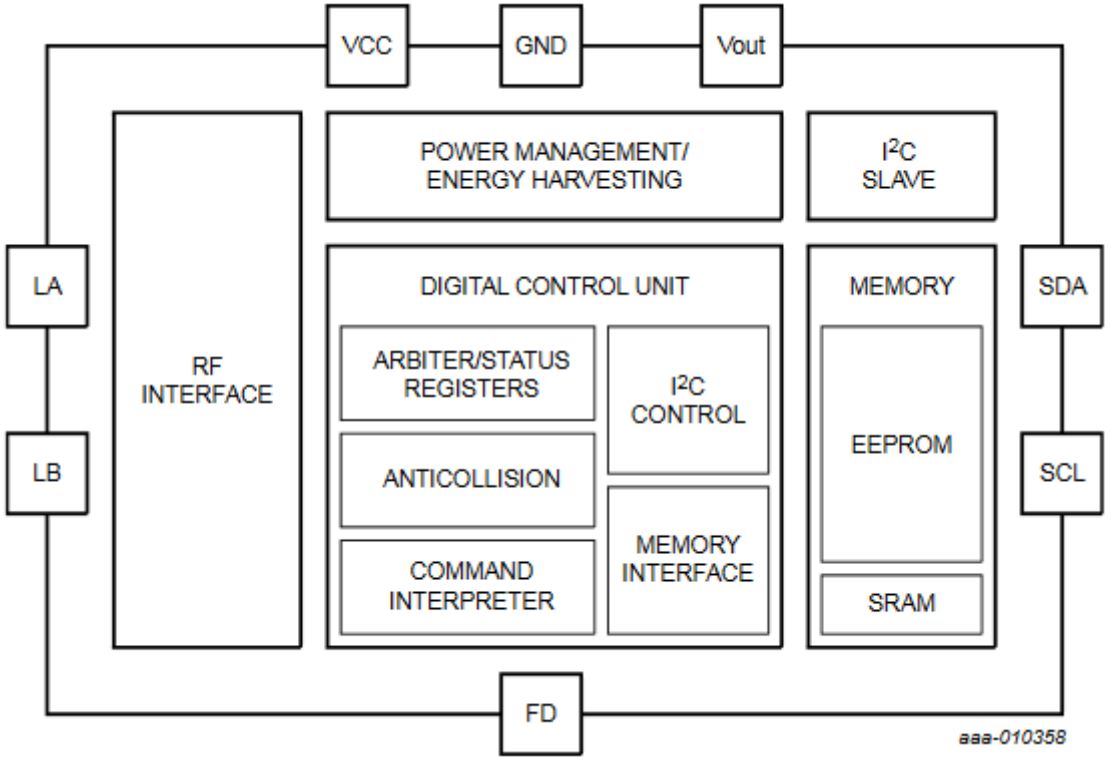
NFC is as simple as a >>  *touch*

NFC as UI



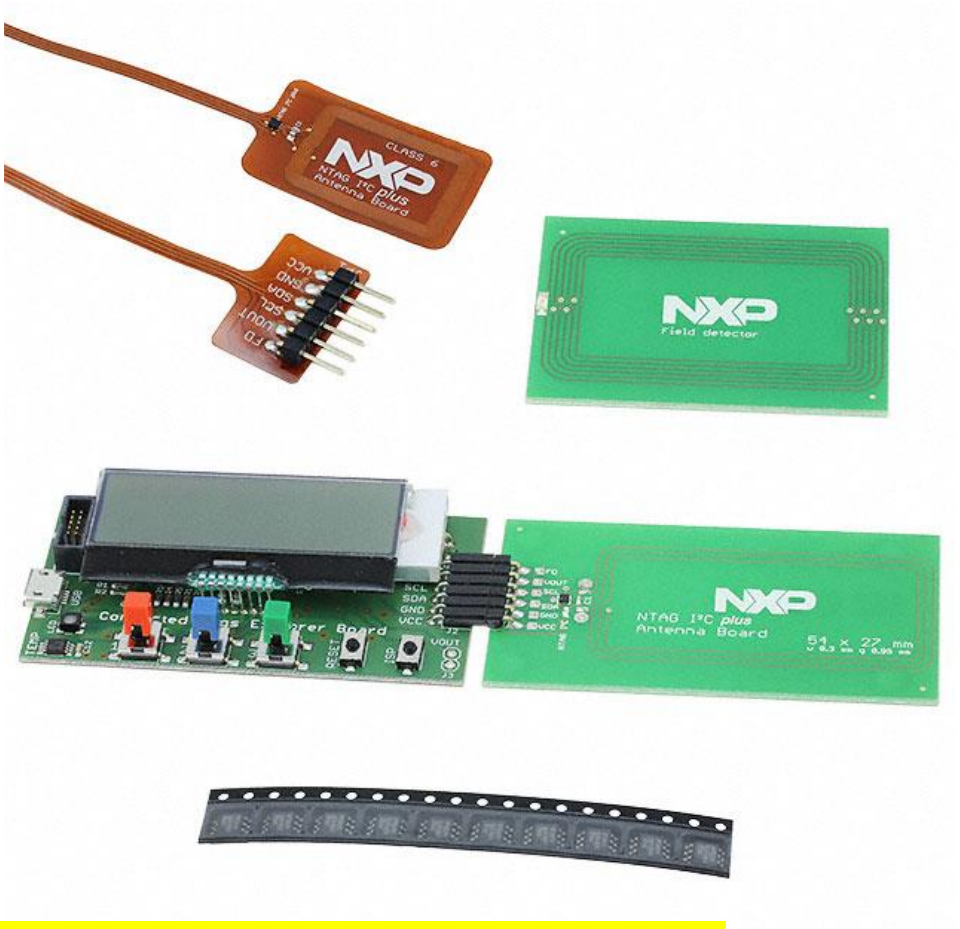
- By adding the MCU interface to our passive NFC card, we can use the contents of the card memory as a communications buffer between the smartphone and our MCU

NXP NT3H2111 Block Diagram



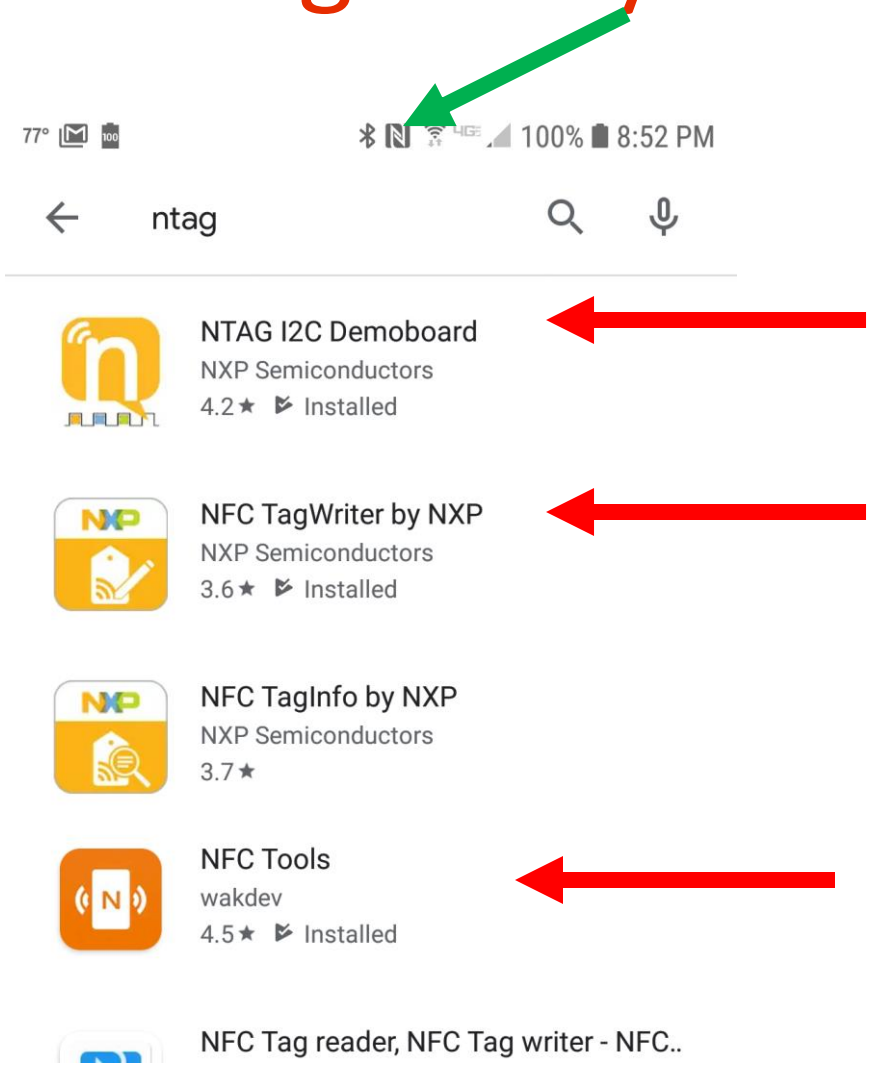
Note that the external Vcc is NOT needed for NFC operation – the chip is self-powered via energy harvesting of the RF field. Vcc is only needed when There is no RF field present.

NXP OM5569 Explorer Kit

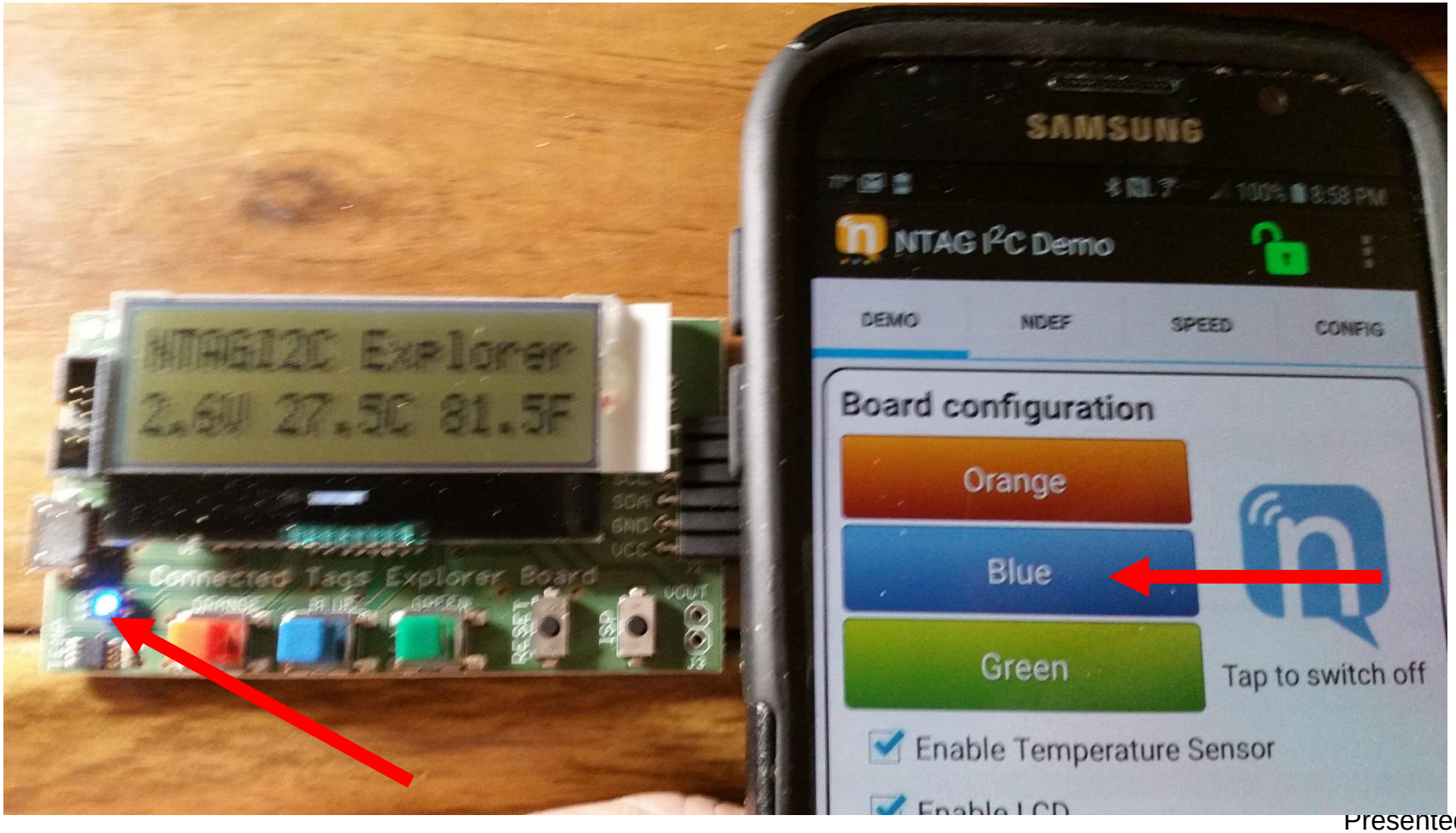


Question 3: Will you be using the NXP NFC kit?

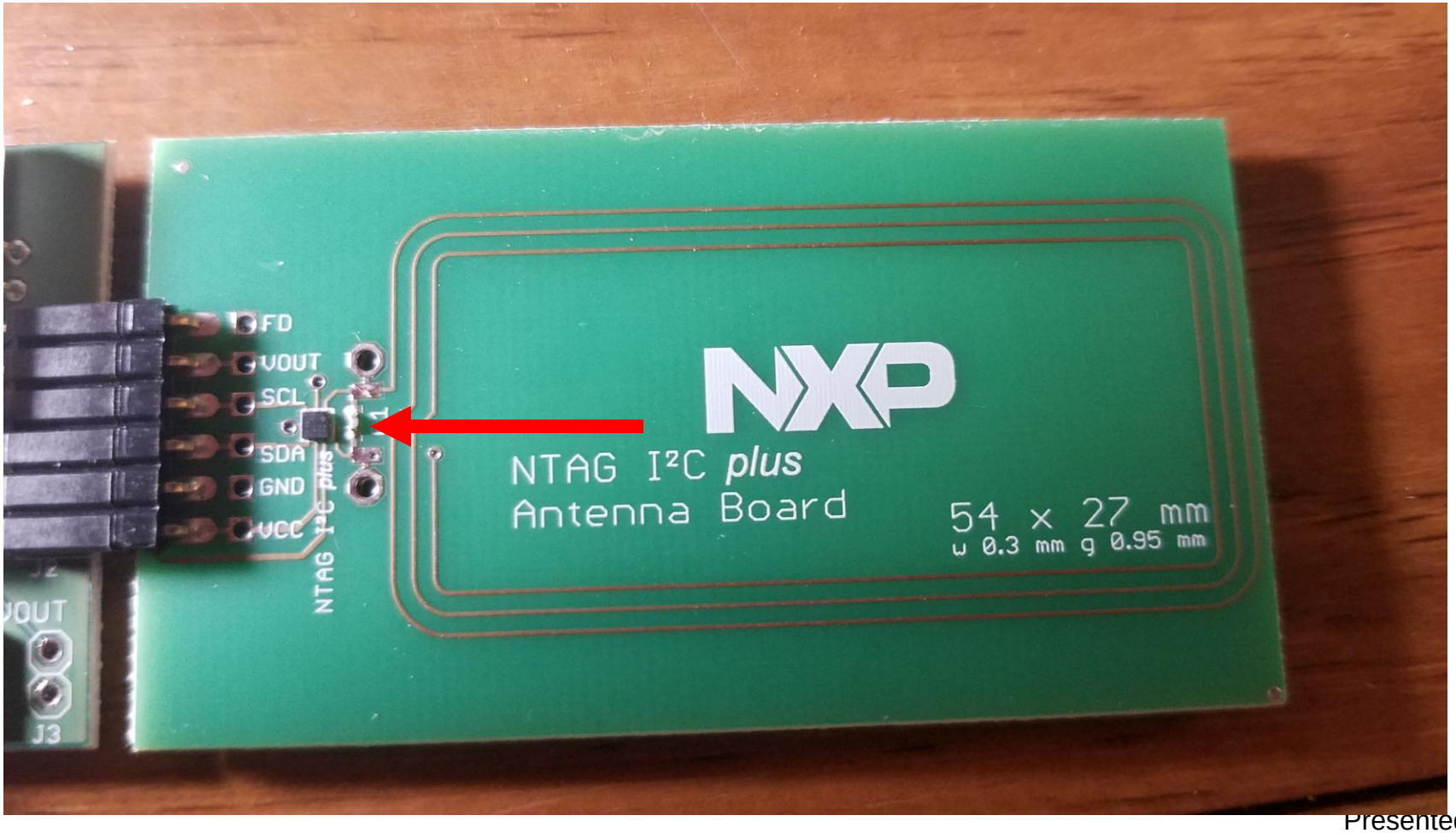
Go To Google Play Store



Test Out Board, Phone, Demo SW



Antenna Board



Getting Started

- User Guide:

https://www.nxp.com/docs/en/user-guide/UM10989.pdf

- FAQ:

https://www.nxp.com/docs/en/engineering-bulletin/TN00042.pdf

- Antenna Design Guide:

https://www.nxp.com/docs/en/application-note/AN11276.zip

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Please stick around as I answer your questions!

- Please give me a moment to scroll back through the chat window to find your questions
- I will stay on chat as long as it takes to answer!
- I am available to answer simple questions or to consult (or offer in-house training for your company)
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