Revolutionizing Smart Tagging in IoT Applications with Integrated NFC Technology in Entry-Level MCUs

Overview

Near Field Communications (NFC) technology isn't exactly a household word, even though the wireless technology is incorporated in more than 1.5 billion smartphones*, forms the basis of secure wireless point-of-sale payment systems, and is projected to become a $20 billion market by 2020 and more than twice that by 2024**. This massive growth will come not only from current applications but from hundreds of others yet to be explored.

However, this won't occur unless manufacturers and designers fully understand how the unique attributes of NFC can benefit their products, and it's also essential that incorporating NFC be as simple as possible. For example, it just makes sense that NFC functionality should be integrated within components such as microcontrollers, as they complement each other. NXP has taken a step toward this today with the LPC8N04 MCU, the first broad-market microcontroller to integrate an NFC tag interface within its package. This complements the NFC controller PN7462 family featuring a full NFC reader. To appreciate how NFC and microcontrollers can work together to achieve great things at low cost, it's important to understand what NFC technology is--and what it is not.

NFC is an offshoot of RFID, which was designed to identify objects and gain some information about them without a physical connection between the object and a reader. It can do this even if the distance between the RFID tag that stores information about the object and the device that reads it is tens or hundreds of feet away. In contrast, NFC operates only over very short distances up to about four inches, which not only makes the technology very inexpensive but makes communication between the tag and reader very secure and difficult to intercept. It's also why NFC is the technology of choice for point-of-sale applications and mobile wallets where security is paramount.

NFC was designed to be versatile as it can operate in three modes: card emulation, reader/writer, and peer-to-peer. Card emulation makes NFC-enabled devices such as smartphones act like smart cards, reader/writer mode lets NFC-enabled devices read information stored on tags, and NFC peer-to-peer allows two NFC-enabled devices to exchange information.

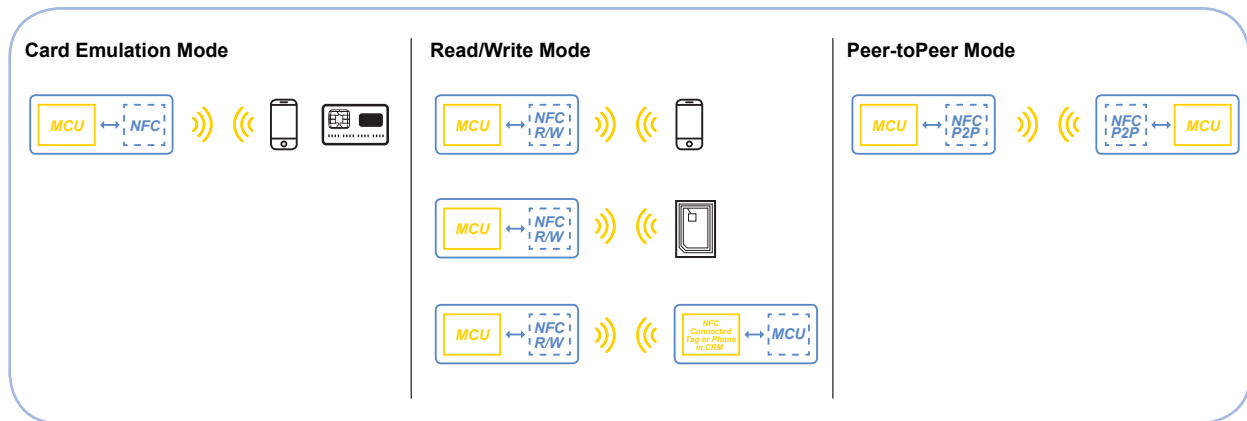| Card Emulation Mode | Read/Write Mode | Peer-toPeer Mode |

Figure 1. NFC Communication Modes

Unlike wireless technologies such as Bluetooth®, there's no need to pair an NFC reader with the tag as communication is automatically established in less than a second and it doesn't require a smartphone app simply to function like QR codes do. It's also the least expensive short-range wireless technology to implement and takes up less space in a product.

A Universal Solution

All but the most rudimentary NFC applications can benefit from a microcontroller and better yet by integrating the two. Together they offer a very appealing solution not only for cost-sensitive consumer products but also for home automation and other IoT applications.

To visualize this, consider the following examples:

- An IoT device is basically a wireless-enabled sensor mounted within a host product that allows it to communicate with other IoT devices as well as to a gateway where its information is sent to the Internet. The host product can be anything from a thermostat to an LED bulb, an industrial component like a pump, or a humidity sensor in the soil. The possibilities are endless.

- However, many of these devices are "headless," that is they have no user interface. This means there's no way to program it or add or remove it from the network (commissioning and decommissioning) except via its primary, always-on wireless technology, usually ZigBee® or other IEEE® 802.15.4 standards. This brings up issues of security, as anything connected to a network is inherently vulnerable.

Even if the host product has some rudimentary interface that allows a password to be entered, technicians must do this manually (assuming they know what it is) and as there is no standard protocol for device commissioning and decommissioning, a large number of proprietary solutions have appeared. Consequently, in a typical manufacturing facility with dozens of components made by multiple manufacturers this process is frustrating, at best.

The LPC8N04 MCU, with integrated NFC technology, dramatically simplifies this process. When integrated within the host product it can store information about the product within its non-volatile memory (EEPROM), and as NFC is inherently bidirectional, which means this information can be sent to and from an NFC-enabled smartphone.

More on the LPC8N04 MCU

The LPC8N04 is a cost-effective microcontroller which serves as an entry-level connectivity solution for embedded applications providing integrated NFC connectivity enabling energy harvesting and wireless communication for a diverse range of tagging and provisioning applications.

The LPC8N04, based on the Cortex-M0+ core, enables a 32-bit solution upgrade from the 8-bit MCU world, thanks to its improved energy efficiency, faster IO access and ease of development while extending the low-price barrier within the 32-bit world.

Key Features:

- 32-bit Cortex M0+ based MCU running up to 8MHZ
- 32KB flash, 8KB SRAM, 4KB of EEPROM
- One 1^2C interface
- One SPI/SSP and 12 GIPO pins
- Featuring NFC tag connectivity in a single chip SoC
- Standard compliant for ISO14443A
- Close proximity, easy-to-use connectivity as BLE alternative
- Small footprint QFN package
- Supported by MCUXpresso, Keil and IAR

Commissioning and decommissioning can be performed almost instantaneously without using the product's primary wireless connectivity solution. Information about this "transaction" is then sent from the smartphone to the Internet.

In addition to being cost-effective, the process is also very secure and doesn't require that the host product have any user interface at all. As the LPC8N04 MCU has PWM outputs, GPIO, and serial interfaces, it offers a variety of ways to connect to the host product, and its Arm® Cortex®-M0+ processor allows computation to be performed as well. The same scenario applies equally well to commissioning any kind of headless device, from "smart" LED light bulbs to industrial, scientific, and medical equipment, to name just a few.
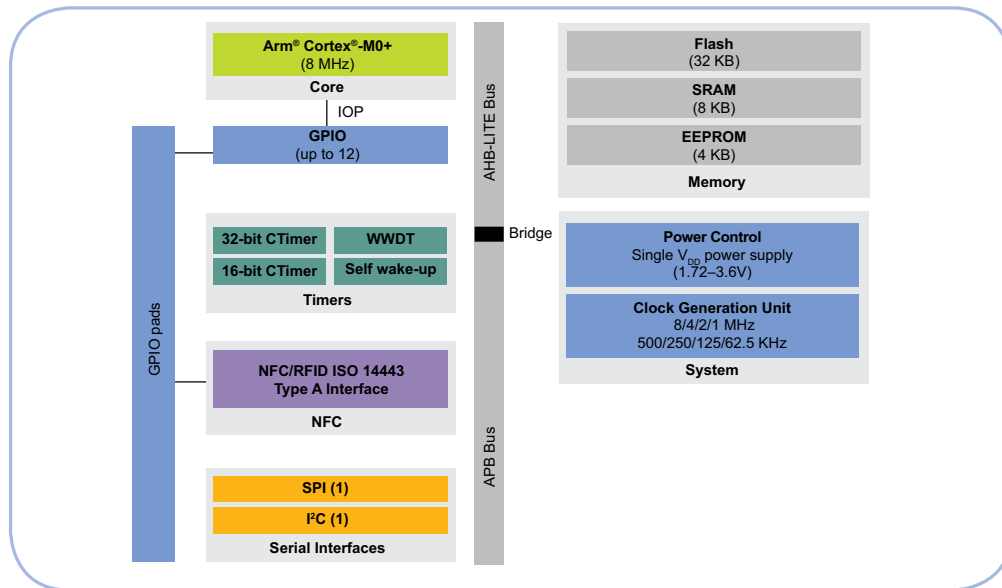

Figure 2. LPC8N04 MCU Block Diagram

Making Product Servicing Simpler

As 8-bit microcontrollers are standard components in even the most basic control systems, upgrading new products with the LPC8N04 MCU not only provides 32-bit performance but it also adds NFC tag capabilities for little or no increase in cost. Consider the typical residential water heater, which uses a microcontroller for various functions. When a service technician comes to a home to inspect it, if the water heater has an integrated LPC8N04 MCU it becomes possible to diagnose its condition simply by transferring data stored on the device to a reader via NFC.

This is also possible for any major home appliance such as a refrigerator, freezer, microwave oven, sprinkler system, or central air conditioner, and no specialized equipment is required. The LPC8N04 MCU also has an integrated temperature sensor, which opens the door to a variety of other possibilities including evaluating the status of almost any type of system in which temperature is a major cause of failure.

The LPC8N04 MCU can also be used as an embedded sensor connected to other sensors to collect data and transmit it via NFC to a phone, and can replace a wired connection in a larger industrial, factory automation system as well. Not only is this more efficient, it eliminates the possibility of failure caused by a poor connection.

The availability of inexpensive, vibrant LEDs has made them more appealing for an enormous number of consumer applications where their incandescent counterparts fall short. The list includes, among other things, Christmas lights and candles whose color and other properties can be varied using a remote control, which typically incorporates an RF transmitter.

As the cost of these products must be very low, the use of such a remote control adds cost to the product. An LPC8N04 MCU embedded somewhere within the light fixtures or strings can perform the same functions at less cost, and as it has the benefit of programmability, the lights can be commanded to perform far more functions as well.
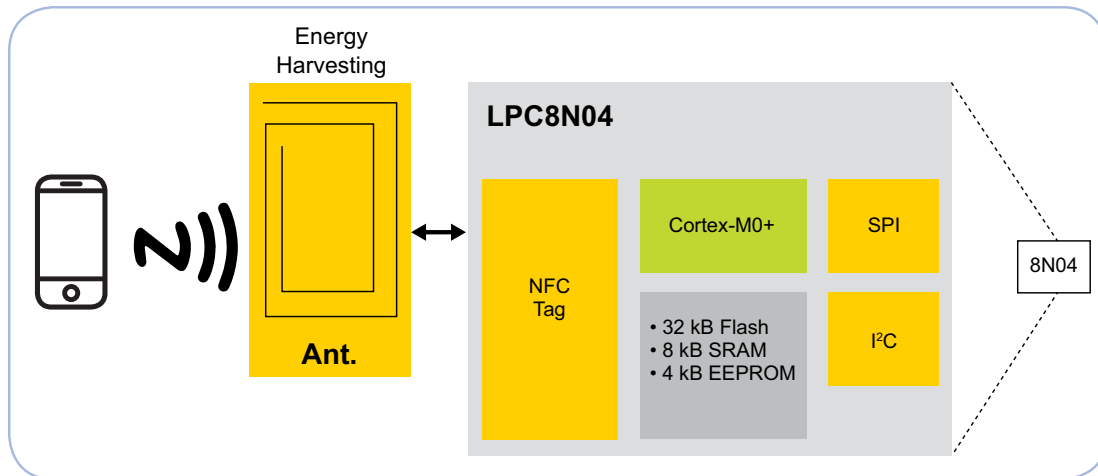
Figure 3. Programmable LED strip via NFC

Another example, as toy trains are a time-honored addition to households with small children (and like-minded adults) how neat would it be to personalize specific tasks such as blowing a whistle when the train reaches a junction, playing a song, or any other function. The LPC8N04 MCU could make this possible as it combines processing and storage with NFC so the owner can create scenarios based on a specific track configuration.

All that's required is a LPC8N04 in the train and a smartphone equipped with the train manufacturer's app that can include preprogrammed functions and allow others to be created as well. These capabilities can be a major differentiator for a manufacturer and can be performed by a device that cost less than a single piece of track.

One major blender manufacturer is using an LPC8N04 MCU to control the motor as well as to configure itself depending on what type of bowl the user has mounted on it. As the microcontroller stores information about all potential containers, and the various bowls have NFC tags, once in place the blender controls the speed required without any intervention from the user.

This eliminates mechanical controls as well as mistakes such as improper installation, and will not allow the blender to operate without a container. In the past, this required attention by the user and a mechanical connection between the bowl and the blender, the former being subject to error and the latter to wear. The microcontroller's memory and programming and processing capability and serial interface provide additional functionality while reducing manufacturing cost.

Universal remote controls have become a mandatory requirement for home entertainment systems that have input sources from different manufacturers, making programming them a frustrating experience. However, the LPC8N04 MCU provides the ability to set up the remote control without knowing the code for each manufacturer or anything else about the system. The remote simply communicates with the components via NFC. As the LPC8N04 stores information about all manufacturers it can configure each component within the remote simply by being placed next to it.

The LPC8N04 MCU in Action – An MCU-based NFC Clock with Integrated Temperature Logging

To better understand the capabilities and benefits of the LPC8N04 device, let's have a look at the button-less NFC clock demo with integrated temperature logging features.

Say your data/temperature logger application requires NFC tagging, data collection, real-time clock display, analog interfaces and processing abilities, all in a low-power environment. How are you going to get this on a single-chip solution? Enter the LPC8N04 MCU – which makes this possible!

The unique functions showcased in this demo include OLED for date and time display with button-less setting and cell-phone pairing via the NFC interface, alarm with vibration notification (sound capabilities would also be available), temperature measurement and history tracking, as well as LED indicators to show the temperature scale. All of this bundled into a battery-powered small and portable case.
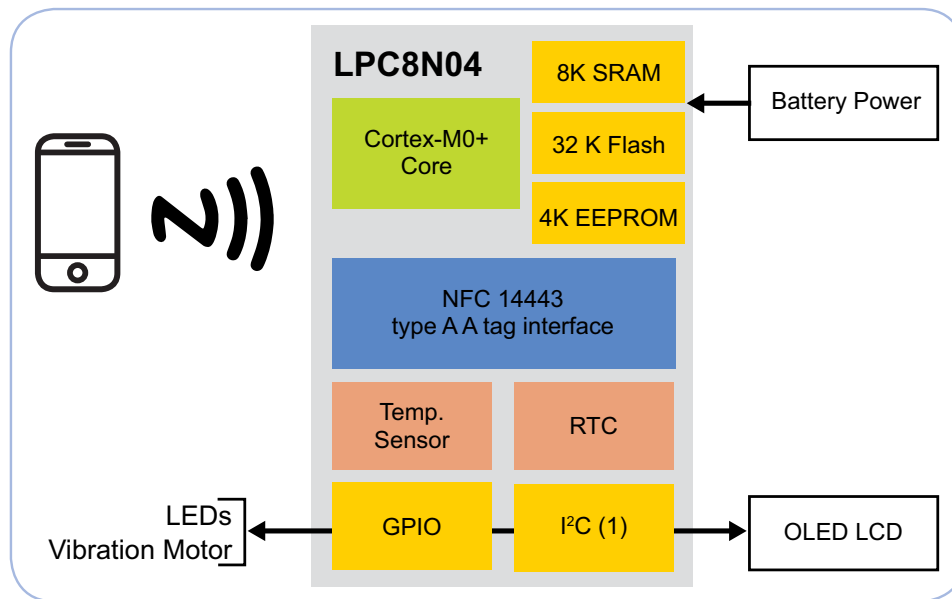

Figure 4. LPC8N04 MCU-based demo and interfaces

The figure above demonstrates the capabilities of the single-chip LPC8N04 solution, including:

- Integrated NFC 1443 type A tag interface, which allows communication using Android phone
- 4kB EEPROM for temperature data log storage
- I²C for OLED LCD control
- Integrated Real-Time Clock (RTC) for accurate timing
- An integrated high accurate temperature sensor
- A set of timers available for vibration motor control
- General purpose Input/Outputs for LED control, while more flexibility is provided by the GPIOs themselves
- Low power modes for power saving

Figure 5. LPC8N04 MCU-based NFC Clock Demo Case

Want to download this demo? Get the details at: **www.nxp.com/LPC8N04-IoTNode**

Summary

Although NFC has been used primarily for point-of-sale and access management applications, its future lies in its ability to perform tasks that are either more difficult or more expensive to perform using other technologies, or both. The examples described in this white paper are just a few of those in which the capabilities of the LPC8N04 microcontroller with its integrated NFC interface can add value to a product, simplify servicing, make configuration of any type of product simpler, perform a variety of functions within the realm of IoT, and many, many others.

NXP designed the LPC8N04 MCU to make incorporating NFC easier in more applications while providing functionality of a microcontroller. Together these capabilities have the potential to allow NFC to fulfill its promise as a simple, cost-effective solution that leapfrog the limitations of other, better known, technologies.

For more information please visit: **www.nxp.com/LPC8N04**

* Statistca.com at:
   https://www.statista.com/statistics/347315/nfc-enabled-phone-installed-base/

** Grandview Research at:
   https://www.grandviewresearch.com/press-release/global-near-field-communication-nfc-market

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