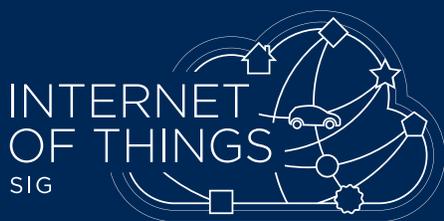


Simplifying IoT: Connecting, Commissioning, and Controlling with Near Field Communication (NFC)

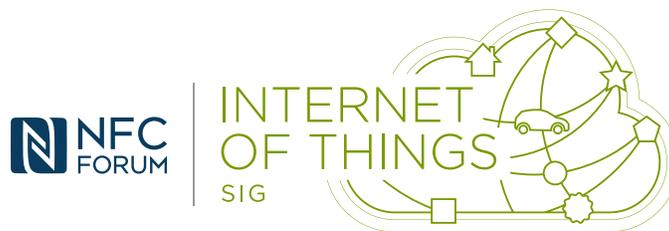
NFC Makes the Smart Home a Reality

White Paper
June 2016



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LEARN MORE. GET INVOLVED!

To learn how to differentiate your product with NFC technology visit our [Internet of Things page](#).

Help chart the course for NFC and the Internet of Things. Email our IoT SIG group at scewg-chair@nfc-forum.org to learn how to get involved.

Smart Environments for Brighter Futures

The media is full of stories about the Internet of Things (IoT). By connecting billions of familiar devices, the IoT promises to improve how we live, work, and play by turning our homes, cars, offices, and cities into smart, interactive environments. These are still early days for the IoT, but the transformation has already started with goals of improved safety, comfort, and efficiency.

The home environment is one of the first targets in this transition.

The smart home ecosystem will learn from our habits and automatically adjust devices by using information from connected processors and sensors in appliances, wearables, and other IoT devices. The intelligent operation of IoT devices in the smart home will leverage cloud-based connectivity with manufacturers, power companies, service providers, and related operational data from IoT devices globally to optimize functionality and the cost-efficient use of resources. Consumers will be the big winners in this ecosystem due to an improved quality of life.

To address this long-term vision, standards organizations like the NFC Forum, are working with developers and manufacturers to develop a wide range of new platforms, applications, and services. Connectivity is the enabler, with IoT devices seamlessly communicating not only with each other in the home but also beyond the walls to cloud computing platforms.

Eventually, most devices will be interconnected to collect sensor data or enable control of the smart home environment. This means that in the future, so-called “rich UI” devices like PCs or mobile phones will be outnumbered by many small “headless” devices with limited or no user interface. This whitepaper describes how Near Field Communication (NFC) specifications will help developers and manufacturers bring the benefits of IoT to where we all live, work, and play.

How NFC Will Benefit Smart Home Devices

With almost 40 billion connected devices expected by 2020 and over one billion NFC-enabled devices already in the market, NFC is a natural connectivity technology for the Internet of Things. NFC can bring user-friendly controls to devices that lack a traditional user interface such as a keyboard or screen. With a single tap, NFC is uniquely positioned to provide:

- **Ease of use** – where a single tap executes a user’s intention even when there is no device interface.
- **Explicit Interaction** – by requiring close proximity for connection and data exchange.
- **Read and write capability** – for interactive data exchange enabling a protocol.

SUMMARY

IoT devices in smart homes promise more safety, comfort, and efficiency

Functionality in smart homes must connect, commission, and control IoT devices

NFC solves many challenges today of connecting, commissioning, and controlling IoT devices in smart homes

- **Communication with powered down devices** – to exchange data irrespective of a device’s power status via embedded NFC tags.
- **Low cost** – a fraction of other connectivity technologies.
- **Low energy** – enabling connectivity without a large power draw.

Figure 1 shows three domains of NFC functionality for IoT devices in the smart home: (1) *Connecting* (pairing devices with different communications technologies), (2) *Commissioning* (installing, logging, maintaining); and (3) *Controlling* (setting and enforcing access).

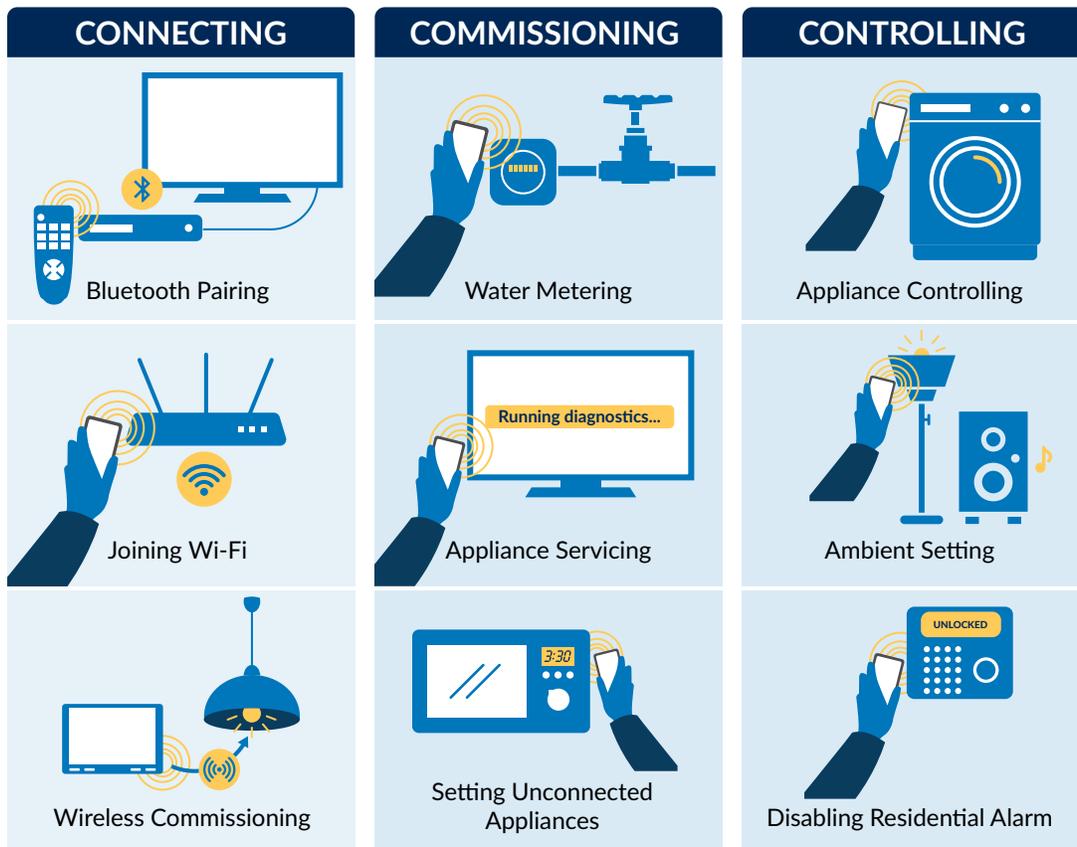


Figure 1:
Connecting,
Commissioning,
and Controlling the
Smart Home with
NFC

How Smart is Smart? The Smart Home Challenge

Enabling a connected smart home poses many challenges. For example:

- How can you ensure a new device is seamlessly and securely introduced to the network?
- How do connected devices know a user’s intent – especially when there is no interface?
- How can you easily remove a device from the network?
- How do you easily replace an old device with a new one?

Existing IoT frameworks do not completely address these challenges. For example, the process of introducing a new device to the network often relies on a proprietary mechanism that is framework specific. Some systems lack a simple mechanism for retiring old devices from the network.

Implementation of device commissioning is especially challenging for manufacturers of small, headless devices that lack a built-in user interface. Procedures are typically multi-step and require manual typing of long passwords or scanning a QR code. IoT home gateways must support multiple connectivity technologies, and this challenges device manufacturers to provide a consistent commissioning experience and guaranteed interoperability.

Currently, consumers aiming to deploy a smart home system face a variety of manufacturer-specific commissioning methods. This causes confusion and frustration while ultimately hampering the use of smart home devices.

In light of these issues, one of the main challenges for providers of smart home devices is providing a unified device commissioning flow that is independent of the underlying communication framework. Usability is another big challenge that should be front and center. Providing a great user experience is essential for consumer applications and services. The use cases below provide examples of how NFC helps solve challenges of connecting, commissioning, and controlling IoT devices in a smart home.

The NFC Opportunity and Use Cases

NFC ensures the successful adoption of IoT services in a smart home. [NFC specifications](#) enable the technology that makes smart home devices “smarter.” NFC’s ability to provide secure ad-hoc communication brings intelligence to physical objects and unlocks the power of other technologies. The primary opportunity provided by NFC, in the context of IoT, is providing a standard secure mechanism for users to introduce easily or onboard new devices to the smart home network or retire existing devices. Without NFC in the smart home, a consumer faces many cumbersome steps to connect devices. These steps risk both user error and frustration. With NFC inside, a consumer can onboard devices with just one tap. NFC also provides confidentiality and convenience to the process.



NFC ensures the successful adoption of IoT services in a smart home

Commissioning Use Case: Commissioning Devices

■ The challenge

There is currently no standard or protocol or framework defining how the commissioning process should work for IoT devices. There are many proprietary, protocol-specific and multistep, solutions for scanning QR-codes or typing in long passwords. As a result, users are often faced with a multiple commissioning flows depending on a type of device intended for new use in the network. Confusion results, especially for devices without a UI.

■ How NFC helps

NFC offers a single step, protocol independent (“tap and go”) experience for commissioning (see Figure 2).

COMMISSIONING

Device commissioning or onboarding is the process of securely introducing a new device to a network. The process exchanges networking parameters and a secret (like password or key), which establishes secure communications with other devices in the network.

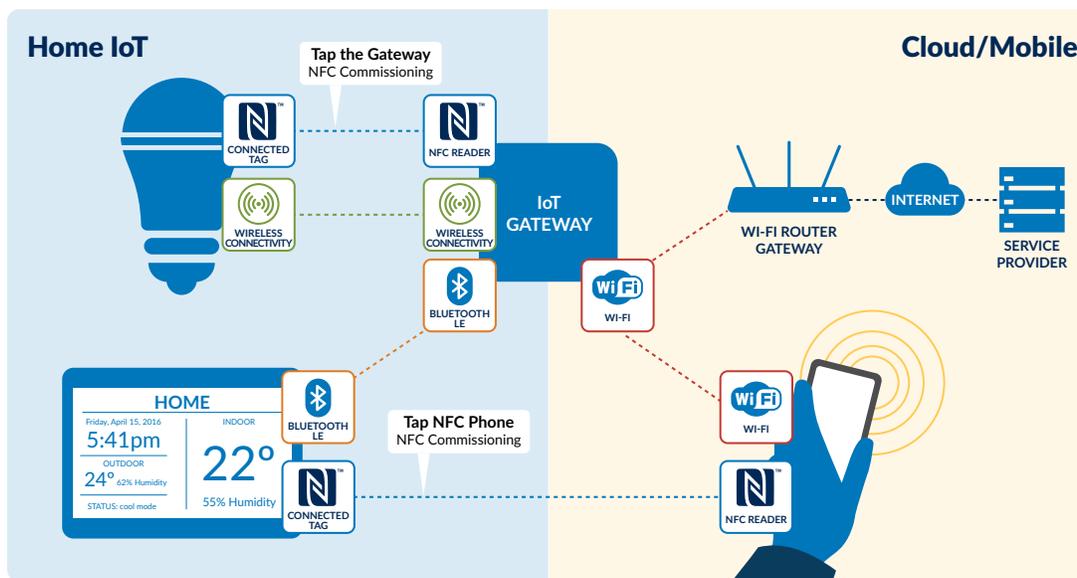


Figure 2:
Commissioning a
Smartphone or IoT
Device in a Smart
Home System

Integrating an NFC reader into an IoT gateway allows all devices to be seamlessly connected to the gateway – regardless of underlying wireless communication technology:

- A small IoT device like an LED light bulb with NFC tag can be tapped against the gateway to connect to the wireless network.
- An NFC-enabled smartphone, once registered with the gateway, can be used as a “magic wand” to tap a thermostat and connect it to the smart home.
- A device can be requested to perform a factory reset, or be de-commissioned from the network by the gateway or mobile phone tap action.
- A configuration of one device can be copied to another, allowing an old device to be easily replaced by a new one.

NFC provides standardized mechanisms enabling all these commissioning scenarios.

Connecting Use Case: NFC-Based Wi-Fi/Bluetooth Pairing

■ The challenge

Many IoT devices use different networking technologies for connectivity – two of the most popular being Bluetooth and Wi-Fi. In a smart home environment, it is critical for all networking technologies to work together seamlessly.

■ How NFC helps

An excellent example of NFC-initiated connectivity in the smart home is pairing Bluetooth and Wi-Fi devices using NFC. These specifications are in use already in some IoT cases:

- Connecting a mobile phone to a Wi-Fi network
- Connecting a mobile phone Bluetooth accessory to the mobile phone

NFC Forum and Bluetooth SIG

From fitness trackers to headsets and speakers, Bluetooth wireless connectivity powers billions of smart electronic objects that we use every day. While Bluetooth technology offers the convenience of always-on, medium-range communication, the act of pairing two devices via Bluetooth can add friction to an otherwise smooth experience. Thanks to close collaboration between the NFC Forum and Bluetooth SIG, NFC can speed up Bluetooth pairing by eliminating the time-consuming and often cumbersome steps of device discovery and device pairing. Now, product manufacturers using Bluetooth can encode standardized Connection Handover information into a thin, flexible NFC tag integrated into the Bluetooth-powered device and enable an instant, secure connection with a single touch of an NFC device. In this way, NFC and Bluetooth work together to bring new devices into the Internet of Things, faster than ever.



NFC Forum and Wi-Fi Alliance

Wi-Fi is one of the world's most commonly used wireless technologies, and close collaboration between the NFC Forum and Wi-Fi Alliance has made it easier to connect to a wireless network at home, at the office, or on the go. In many regions, store and café owners often protect their Wi-Fi networks with a passcode that's known only to their customers. To connect to the Wi-Fi network with a smartphone, tablet, or PC, the user must open the Wi-Fi settings, select the correct network name (SSID), and then enter the passcode. In April 2014, the Wi-Fi Alliance and NFC Forum announced technology enhancements that can eliminate two key points of friction in connecting to a wireless network: the selection of the network name and the entering of the passcode.



To achieve this simplified connectivity, NFC Forum-standardized Connection Handover information is encoded into a thin, flexible NFC tag that's either integrated into the wireless router, mounted on the wall, or even distributed as a business card. Once the user taps their NFC device to the NFC tag for the Wi-Fi network, all the needed configuration information is automatically transmitted from the NFC tag to the mobile device. The mobile device then configures itself to the network and instantly connects. No more manual network selection and no more touch-typing passcodes. With a simple tap of an NFC device, users can surf online faster than ever.

Use Case: Headless Device Commissioning

■ The challenge

Commissioning an LED light bulb is a good example of how a headless IoT device needs to be seamlessly and securely connected to the IoT gateway.

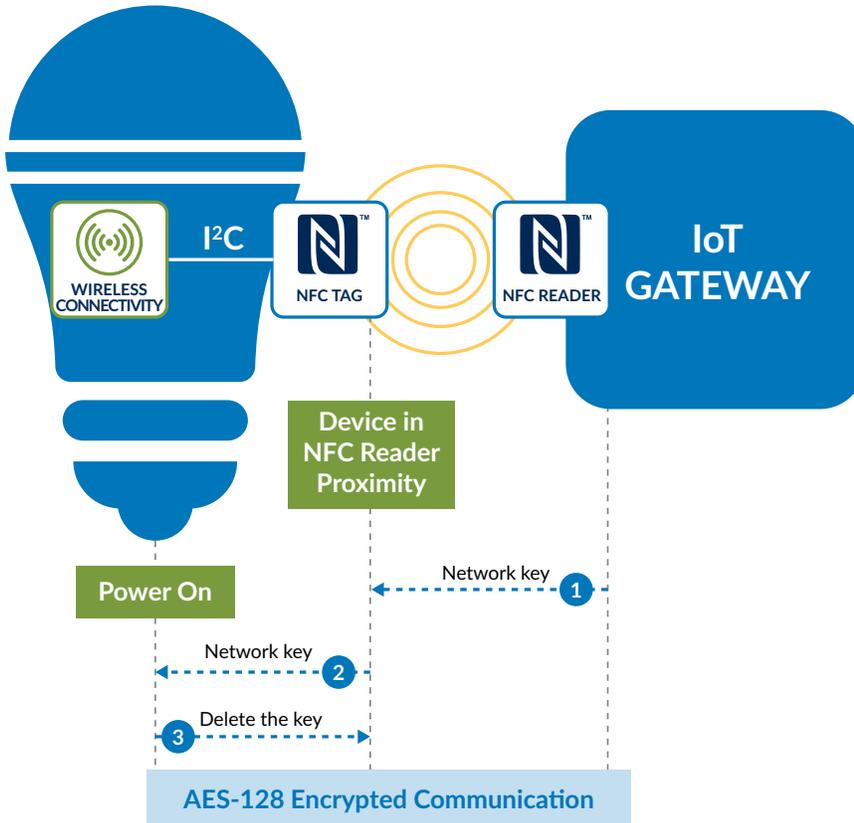


Figure 3: Commissioning a Headless LED Bulb to the IoT Gateway

■ How NFC helps

Figure 3 shows a scenario of using NFC to commission a headless LED bulb to the IoT gateway. A new LED bulb is taken out of the box. Unpowered, it is tapped against the gateway. The networking key is written to the NFC tag. Later on, when the bulb is powered on, the key is read by the wireless technology module and is used to establish secure communications. In the final step, the key is erased from the tag to protect it from being read by an unauthorized person. The networking parameters are transferred to quickly establish a secure network connection.

Control Use Case: Access Control for the Smart Home

■ The challenge

In multi-family dwellings such as a condominium or high-end apartment complexes, mechanical keys are the typical access control mechanism. Distributing these manually to homeowners and leaseholders can be expensive and time consuming for both property managers and tenants. Furthermore, mechanical keys can easily be copied and distributed without notification to the owner, which erodes security.

■ How NFC helps

By using NFC technology, new keys can be securely distributed without requiring actions by the tenants. Consider the following scenario:

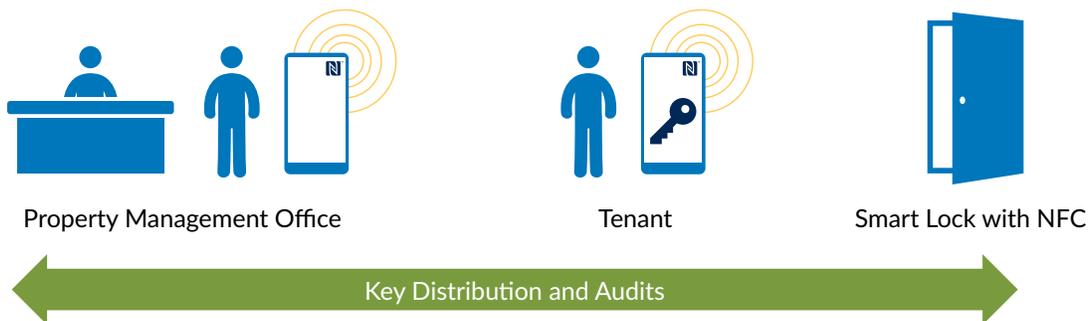


Figure 4:
Commissioning a
Smartphone or IoT
Device in a Smart
Home System

When an owner purchases a condominium or leases an apartment, the property manager gives the tenant a smartcard or a mobile application. These are a welcome convenience for the tenant as contactless smartcards and/or mobile phones with NFC are much easier to use than mechanical keys. There are also several other advantages for the tenant. For example, with a mobile app the tenant can send keys to other friends or family members right from their phone. They can also see the history of who has entered the home and when access occurred.

NFC provides a tremendously flexible and cost effective rekeying solution for property managers and tenants alike.

Property owners simply hand the tenant a smartcard or invite them to download a key. There is no need to send a locksmith out to re-key the home. The smart lock is securely re-keyed using NFC technology when the tenant first accesses the home. In addition, an audit history is securely transferred back to the smartcard or mobile phone. NFC provides a tremendously flexible and cost effective rekeying solution for property managers and tenants alike.

Use Case: Controlling a Device with No User Interface

■ The challenge

Wireless connectivity and sensor integration have enabled a variety of new types of connectable devices in a smart home. Devices are all about interaction: turn on the lights, lower the temperature, check the air quality, etc. When displays aren't appropriate, there are usually few options. In some cases, long range always-on connections like Bluetooth and Wi-Fi can provide interactivity with IoT devices lacking a UI. However, for first-time setup and explicit configuration of specific smart home devices, there remains room for improvement. Several common interactions mandate some user interface:

Inputs

- Network Provisioning – adding the smart object to a network to enable ongoing wireless communication.
- Configuration – altering defaults, setting limits, choosing preferences, specifying if/then logic without a need for an always-on connection like Wi-Fi or Bluetooth.

Outputs

- Reporting – retrieving information, such as sensor data logs, if not done as part of an always-on connection like Wi-Fi or Bluetooth.
- Diagnostics – retrieving information such as fault codes to help diagnose problems known to the IoT device's internal electronics but not transmittable through an always-on connection (including a failure of the connection).

■ How NFC helps

NFC enables each of these steps without the expense of integrating a display on IoT devices. The technology further enables a new class of device with form factors that are not conducive to built-in displays. The enabler is NFC's fundamental bidirectional communication capabilities and availability on a global installed base of one billion smartphones.

Smart home electronics are equipped with powerful embedded controllers, so they often require not only inputs (configuration requests, programming, etc.) but also the ability to communicate back with the user. NFC technology not only eliminates the need for visual technologies such as QR codes but vastly improves the ability to interact with the IoT device.

For security and ease-of-selection, the well-controlled distance of an NFC transmission (on the order of a few centimeters) provides inherent protection from snooping, with the added benefit of being able to select the precise IoT device that is the target of the interaction. Longer-range wireless technologies often lack the selectivity of NFC when it comes to easily addressing specific devices.

WHEN THERE'S NO UI

Not all smart home devices have an integrated visual display.

Examples include:

- Light bulbs
- Security & presence sensors
- Environmental sensors
- Small appliances
- Toys & games
- In-wall electrical outlets
- Garage door openers

NFC provides an easy-to-use, broadly compatible, bidirectional, and secure method for controlling IoT devices without a UI.

For security and ease-of-selection, the well-controlled distance of an NFC transmission (on the order of a few centimeters) provides inherent protection from snooping, with the added benefit of being able to select the precise IoT device that is the target of the interaction.

In some cases, NFC may be used with Bluetooth and Wi-Fi to facilitate Connection Handover. The convenience and selectivity of NFC allow for easy setup and configuration using an NFC smartphone's high-resolution screen, while the battery-free interactivity of passive NFC enables an unpowered node (such as an LED bulb fresh from the package but not yet plugged in) to be set up instantly, ready for connection to an always-on network when connected to the home's electrical wiring.

Conclusion

NFC can enable a wide range of IoT devices and applications in a smart home. Thanks to their unique features, NFC specifications are the foundation for an excellent user experience and extend the smart home ecosystem even to unconnected and unpowered devices at a very low cost.

Smart home pioneers have discovered that one of their biggest challenges is easing the process of connectivity while securing network access for the increasing number of IoT headless devices. NFC provides stakeholders with a big opportunity: proven, globally adopted specifications for the commissioning of IoT devices that may communicate with each other using a wide range of protocols.

NFC is one of the “must have” requirements for commissioning for any connectivity standard or protocol framework. It is widely used now for Wi-Fi and Bluetooth pairing. And as described in this whitepaper, NFC is ideal for many other smart home use cases.

The NFC Forum and the IoT SIG believe that NFC's potential to impact the [Internet of Things market](#) is remarkable. We invite you to [join the NFC Forum to collaborate](#) and help chart the course for NFC and the Internet of Things.

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