Near Field Communication

White paper

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1 Introduction

The current state of the consumer electronics can be characterized by moving from a single purpose device to multifunctional devices and by moving from an isolated device to networked devices. In this last respect, it is important that people do not face the complexities of setting up network connections between devices. Cumbersome network settings can possibly be dealt with in the computer world but certainly not in the consumer electronics world.

This is the main driver for the Near Field Communication Interface and Protocol (NFCIP-1), which is targeted towards the consumer electronics users that will be able to use the secure means of communication between various devices without exerting much intellectual effort in configuring their "network". The concept is strikingly simple: in order to make two devices communicate, bring them together or make them touch. This will engage the NFCIP-1 wireless devices' interfaces and configure them to link up in a peer-to-peer network. Once the configuration data has been exchanged using NFC, the devices can set up and continue communication for longer range and faster protocols like Bluetooth or Wireless Ethernet (WiFi).

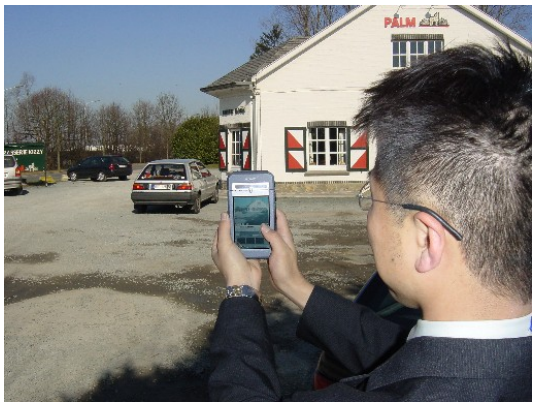
2 The stage

Let's start off with some use cases of NFC devices to illustrate the concepts. The examples presented here are for direct data transfer between devices and for communication set up in conjunction with another wireless protocol.

2.1 Transfer of content

Let's say you went somewhere on a trip and you took lots of pictures with your PDA with a built-in camera and you want to show them to your friends on a big screen TV.

We take a picture…



And show it on the TV by touching the "hot spot" of the TV with the PDA.

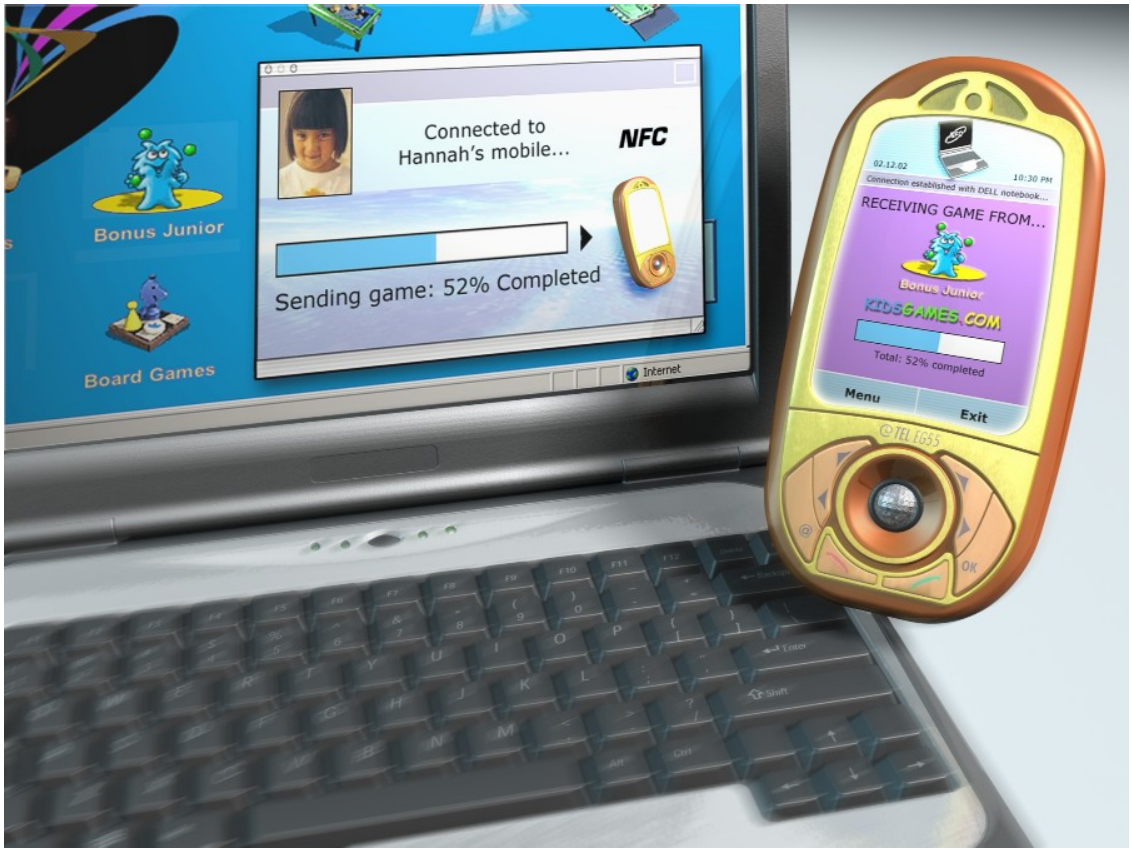
Let’s say you want to see the world from the point of view of our Aibo here:

Here is the Aibo:

And here is what it sees:

So all we need to do is to give the Aibo a command to take a picture and transfer it to the Clie by touching the Aibo:

Let's take another example. If you have a PC and a mobile phone equipped with NFC, you can easily download a new game from a website directly onto this mobile phone for your kid using NFC:

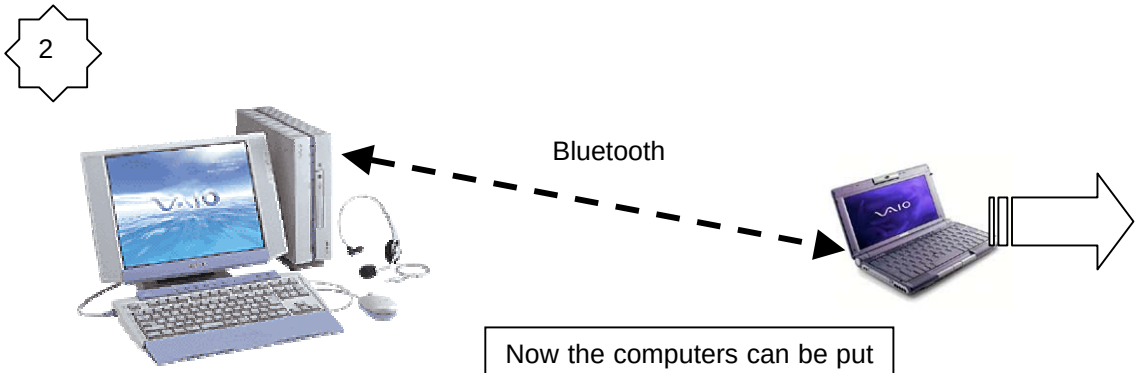


And this same principle will work for any sort of data transfer between two pieces of equipment when they support NFC. There is no need to set up communication manually provided that the applications are capable of handling the communication. This opens countless possibilities for content transfer and management of personal data stored within different types of consumer electronics equipment.

2.2 Set up of communication for other protocols

Imagine that you would like to transfer a large amount of information between two computers – a desktop and a laptop. Let's say you want to transfer a presentation file. Using NFC may be slow and we decide to use something with more bandwidth. Let's say for this example we use Bluetooth. Now, to set up Bluetooth communication between two computers we would need to set it up manually with a password to protect the communication. Using NFC we can set up this communication by simply touching the two computers:

Touch the computers at the "hot spot". They will open a connection to exchange the parameters of the Bluetooth communication and establish a secret key. The Bluetooth communication is established as a second step of this procedure without any human interference using the exchanged parameters.



Now the computers can be put away from each other but the communication continues using the session of Bluetooth that was established previously.

The same procedure can be used to establish a wireless (Bluetooth, WiFi etc.) link between two pieces of computer or consumer electronics equipment like TVs, laptop computers, PDAs, mobile phones and so on.

3 The protocol

The protocol is based on a wireless interface. There are always two parties to the communication; hence the protocol is also known as peer-to-peer communication protocol. The protocol establishes wireless network connections between network appliances and consumer electronics devices.

The interfaces operate in the unregulated RF band of 13.56 MHz. This means that no restrictions are applied and no licenses are required for the use of NFC devices in this RF band. Of course, each country imposes certain limitations on the electromagnetic emissions in this RF band. The limitations mean that in practice the distance at which the devices can connect to each other is restricted and this distance may vary from country to country. Generally speaking, we consider the operating distances of 0~20 cm.

As is often the case with the devices sharing a single RF band, the communication is half-duplex. The devices implement the “listen before talk” policy – any device must first listen on the carrier and start transmitting a signal only if no other device can be detected transmitting.

NFC protocol distinguishes between the Initiator and the Target of the communication. Any device may be either an Initiator or a Target. The **Initiator**, as follows from the name, is the device that initiates and controls the exchange of data. The **Target** is the device that answers the request from the Initiator.

NFC protocol also distinguishes between two modes of operation: Active mode and Passive mode. All devices support both communication modes. The distinction is as follows:

> In the **Active mode of communication** both devices generate their own RF field to carry the data.
>
> In the **Passive mode of communication** only one device generates the RF field while the other device uses load modulation to transfer the data. The protocol specifies that the Initiator is the device responsible to generate the RF field.

The application sets the initial communication speed at 106, 212 or 424 kbit/s. Subsequently the application and/or the communication environment may require speed adaptation, which can be done during communication.

NFCIP-1 uses different modulation and bit encoding schemes depending on the speed. While establishing the communication, the Initiator starts the communication in a particular mode at a particular speed. The Target determines the current speed and the associated low-level protocol automatically and answers accordingly.

The communication is terminated either on the command from the application or when devices move out of range.

4 Unique features

What makes the communication between the devices so easy is that the NFC protocol provides some features not found in other general-purpose protocols.

First of all, it is a very short-range protocol. It supports communication at distances measured in centimetres. The devices have to be literally almost touched to establish the link between them. This has two important consequences:

1) The devices can rely on the protocol to be inherently secured[1] since the devices must be placed very close to each other. It is easy to control whether the two devices communicate by simply placing them next to each other or keeping them apart.

2) The procedure of establishing the protocol is inherently familiar to people: you want something to communicate – touch it. This allows for the establishment of the network connection between the devices be completely automated and happen in a transparent manner. The whole process feels then like if devices recognize each other by touch and connect to each other once touched.

Another important feature of this protocol is the support for the passive mode of communication. This is very important for the battery-powered devices since they have to place conservation of the energy as the first priority. The protocol allows such a device, like a mobile phone, to operate in a power-saving mode – the passive mode of NFC communication. This mode does not require both devices to generate the RF field and allows the complete communication to be powered from one side only. Of course, the device itself will still need to be powered internally but it does not have to "waste" the battery on powering the RF communication interface.

Also, the protocol can be used easily in conjunction with other protocols to select devices and automate connection set-up. As was demonstrated in the examples of use above, the parameters of other wireless protocols can be exchanged allowing for automated set-up of other, longer-range, connections. The difficulty in using long-range protocols like Bluetooth or Wireless Ethernet is in selecting the correct device out of the multitude of devices in the range and providing the right parameters to the connection. Using NFC the whole procedure is simplified to a mere touch of one device to another.

The NFC protocol is also compatible with the widely used contactless smart card protocols FeliCa ™ and Mifare ™. The NFC devices are able to work with the smart cards and smart card readers conforming to these protocols in a seamless manner. Not only a card may be viewed with an NFC device but also an NFC device can be used instead of a card.

PT[1]TP Here we refer to the avoidance of unintended connections rather than protection against malicious intent. For protection against eavesdropping or connections with malicious intent traditional security measures should be implemented at the network protocol layer and above.

5 Related standards and references

The NFC protocol requires standardization in order to be accepted fully by the industry and provide for compatibility between the devices produced by different manufacturers. The standardization also means keeping the specification open and accessible for everybody, facilitating the analysis of the protocol and adaptation of the devices for various needs.

The work on standardization is done within Ecma International, a standards organisation with a long history of successful projects. The standards are published by Ecma International and, consequently, become also ISO/IEC and ETSI standards. Sony Corporation and Royal Philips Electronics are the founders of this work. The group working on the standards within Ecma is growing constantly; more companies are joining the effort to enhance the NFC standards. Ecma invites all interested parties to join the working group.

Standards published as of December 2004:

- ECMA-340 “Near Field Communication – Interface and Protocol (NFCIP-1)” (ISO/IEC 18092)
- ECMA-352 “Near Field Communication Interface and Protocol – 2 (NFCIP-2)” (ISO/IEC 21481)
- ECMA-356 "NFCIP-1 - RF Interface Test Methods" (ISO/IEC 22536)
- ECMA-362 "NFCIP-1 - Protocol Test Methods" (ISO/IEC DIS 23917).

5.1 Other references

1) Ecma International: http://www.ecma-international.org
2) Press release regarding the NFC standardisation http://www.ecma-international.org/news/Ecma-340-NFCIP-1.htmT