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NFC Makes Great Progress In The Wireless World

It's an invisible part of our everyday lives, but in today's world, we can't get by without it. Short-range wireless is one of the most pervasive and important radio communications technologies. Ranging from 125 kHz to infrared (IR), applications are all over the place, from IR remote control to wireless broadband. And that just scratches the surface.

The slew of standards and protocols includes 802.11 Wi-Fi, Bluetooth, ZigBee, Gen2 RFID, Z-Wave, IrDA, and WiMAX, so there's something for everyone. One of the newer options, near-field communications (NFC), fills the gap from 0 to 20 cm and lives up to its designation as a short-range radio technology.

EMFs DEFINE RADIO • The term *near field* refers to the near field of a radio wave. Radio waves comprise electric and magnetic fields at right angles to one another. At a distance of about 10 wavelengths and beyond the antenna, at the operating frequency, radio waves behave the way Maxwell's equations say they would.

The two fields exchange energy and reinforce one another as they travel from the transmitting antenna to the receiving antenna. This is called the far field. Inside that 10 wavelengths is the near field, where you see individual electric and magnetic fields. The electric field isn't too useful, but the magnetic field can be used for short-range communications.

Consider NFC a transformer with a very low coefficient of coupling because of a large distance between primary (transmitter) and secondary (receiver) windings (antennas). The main problem with near-field magnetics is that the signal strength drops off at a rate of about $1/d^6$, where d is the distance or range, truly making it a short-range technology. The far field, what we all know as a radio wave, drops off at a $1/d^2$ rate.

Philips and Sony invented NFC. Ecma International adopted it as a standard first (NFCIP-1 or ECMA-340) and submitted it to the International Organization for Standardization/International Electrotechnical Commission (ISO/IEC), which standardized it as ISO/IEC 18092. The European Telecommunications Standards Institute (ETSI) also has recognized it. Semiconductor companies have since begun making compatible and interoperable chips.

This standard is similar to and compatible with the same NFC technology used in smartcards, whose internal chip lets consumers pay by passing them over a point of sale (POS) terminal reader. In some modes, NFC also resembles radio-frequency identification (RFID). ISO 14443, the well established smartcard standard, is implemented in Philips' MIFARE and Sony's FeliCa products.

The standard specifies an operating frequency of 13.56 MHz, the international no-license band and one of the ISM band Part 15/18 frequencies in the U.S. The data transfer rate is 106, 212, or 424 kbits/s. The speed depends upon the range, which has a maximum of 20 cm or about 8 in. In most cases, the actual range will be only a few inches or no more than 10 cm. Also, the standard specifies several operational modes.

In the active mode, both parties have powered transceivers. Either party may initiate a half-duplex transmission with a "listen before transmit" protocol. This feature prevents collisions when more than one NFC-enabled device tries to access a reader. One of the devices is the initiator, and the other device becomes the target.

In the passive mode, the target is a passive device like an RFID tag. The tag gets its operational power from the field transmitted by the initiator. It then transmits data back to the initiator by modulating the magnetic field (backscatter modulation, a kind of AM).

As with any new wireless technology, security is an issue. But the very short range of NFC devices keeps hackers out. At that distance, all you have to do is show intent and you're safe—for the most part. If you need more security, use NFC with smartcard technology, which has heavy-duty encryption and authentication built in.

NFC APPS • There are three major categories of NFC use: secure transaction or payment, peer-to-peer between two powered units, and service discovery or information transfer.

Secure transaction is expected to be the biggest application, as it extends the already popular automatic payment system that began with smartcards. But instead of a smartcard, the NFC transceiver is built into your cell phone. To buy something, you just tap your cell phone on the reader or pass it within an inch or so of the reader, and zap, your credit card account is automatically billed.

1. Users can pay for train tickets by passing the NFC-equipped cell phone near the reader. Credit cards are billed automatically with full smartcard security.

Imagine using an NFC-enabled cell phone to buy theater tickets or even to pay for a plane, train, or hotel *(Fig. 1)*. Another application that falls into that category is automatic gated entry. Just pass your cell phone near the reader, and you'll be

allowed into a building, parking lot, or other controlled area.

A second proposed application would use NFC to initiate the setup for other forms of wireless. Some short-range wireless modes like Wi-Fi and Bluetooth require the two parties desiring a peer-to-peer (P2P) link to first exchange information to set up the correct protocol. This sometimes is called pairing.

Users simply put their cell phones, laptops, or other devices next to each other, and the NFC technology automatically exchanges the protocol setup information. After that, the devices can communicate via the new wireless mode faster and at a farther distance. People who have had problems linking Bluetooth devices should really appreciate this feature.

Dave Holmes, the business development manager for NFC at Philips, calls this mode the "secret decoder ring" that makes other applications quickly and, best of all, automatically accessible. Similarly, the P2P mode can be used to exchange virtual business cards by "clinking" cell phones against each other.

With the third application, service discovery, service providers can set up displays or posters with built-in NFC. To find out more about the services, users bring their cell phone near the display, and information will pop up on the phone's screen *(Fig. 2)*. The display uses a passive NFC chip, while the cell phone acts as the reader. Sometimes, the phone will download a URL and go directly to that Web site, which will provide the information.

2. Before buying your tickets, get more info about the movie with your cell phone. The poster contains a passive NFC tag that's powered up when the cell phone's NFC chip interrogates it.

PRODUCTS • Innovision Research and Technology recently announced its Topaz chip for the Type 1 tag format as defined by the NFC Forum, the consortium of companies promoting NFC. The chip conforms to all the standards listed earlier. It targets operation with NFC devices in the reader/writer mode. Innovision also sells blocks of intellectual property (IP) that let chip manufacturers build NFC functionality into their wireless transceivers.

Philips has a few products ready to go, making the addition of NFC to any device a snap. Its PN65K module combines a PN531 NFC controller and transceiver chip and a Secure Smart Card controller. It supports all modes with a data rate of 212 or 424 kbits/s. It offers SPI, I^2C, and UART serial interfaces and an 8-bit parallel interface.

The Philips PN531 includes the NFC transceiver along with an 8051 embedded controller that implements all of the smartcard functions, including security. The PN65K can operate as an initiator in active or passive mode. In passive mode, it can operate as a reader/writer for MIFARE or FeliCa smartcards. The P2P functionality is supported in both active and passive modes. And, all of this comes in a 48-pin heatsink very thin quad flat pack (HVQFN) package.

NFC STATUS • With chips and modules available now, NFC is starting to get some recognition. It's already heavily used in Europe. Dozens of feasibility tests are being conducted in Europe, the U.S., and elsewhere. Only a few cell phones have NFC, notably some Nokia and Samsung models. But look for more to come.

With an infrastructure to install along with appropriate back office software, there's still some work to do. But in-place smartcard readers are compatible, so at least there's a good starting point. Rollout isn't expected in the U.S. until sometime later in 2007. Once users experience the convenience and versatility of shopping this way and linking with others, NFC will become addictive, just like the other forms of wireless.

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