



## Near Field Communication in the real world – part III

Moving to System on Chip (SoC) integration

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# 1 Introduction

The success of Near Field Communication (NFC) across a broad range of applications depends on its large-scale adoption by enterprises and consumers. This implies the need for simple, low-cost implementation of the technology in a wide variety of devices, from mobile phones and laptops to point-of-sale terminals and ticket machines.

One way NFC technology can be integrated cost-effectively in mass-market electronic devices is through System on Chip (SoC) implementation in other common chipsets, including those for Bluetooth, WiFi and UWB. In high-volume products, SoC implementation of NFC offers significant unit-cost savings and very efficient integration, with lower overall space, processing and power requirements – while adding great value.

This paper outlines the business case for NFC integration and highlights the key considerations that need to be taken into account when implementing a custom NFC design.

## 2 Integration – it's only natural

Integration is an established 'fact of life' in the consumer electronics product lifecycle. Usually, the first products to market are built from discrete components, and their typically high sale price reflects the high production costs and small production volumes. As a product becomes more popular and successful, manufacturers can begin to invest in progressively greater integration of components to drive down manufacturing costs as volumes increase.

The trend towards integration can be seen at a macro level too. For example, car audio equipment was almost always an after-market purchase, with separate components coming in standard sizes, with standard interfaces, they could be 'mixed and matched'. Now it would be rare for a new car to be sold without an in-car entertainment system that integrates one or more media formats, radio tuner and speakers.

In the case of consumer electronic devices, integration of a new technologies follows a well-trodden path. When a new technology comes along, the first products might be external devices that can be connected via a cable to, say, a PC, digital camera or mobile phone. Next there are card accessories that can be plugged into the PC or phone. Then comes a chipset that sits on the motherboard. And finally there could be even closer integration of the technology with other functionality on the motherboard, where this makes technical and economic sense.

Technologies undergo a similar process of integration within the devices themselves, of course. A prime example is the development of the GSM mobile phone from single-band (900MHz) only operation, through multi-band GSM (900MHz, 1800MHz, 1900MHz) operation to multi-mode (GSM/WCDMA) operation. As these new capabilities were introduced, multi-band and multi-mode blocks were typically added for the digital logic and signal processing parts.

Initially, however, the different RF parts were implemented as separate blocks, as digital logic and RF technology were developing at different rates, and market demand for the different combinations of RF bands was not well established. Today, RF design and market acceptance have moved on to the point where the RF part is common for all frequencies, and even the previously separate antennas for the different bands have become integrated into one planar design.

In other words, over time, it has become possible and desirable to move commonality further down the mobile phone functionality stack.

The key issue facing electronic product designers and manufacturers today is where, and how closely, NFC should be integrated into their products.

## 3 How and when should NFC SoC be implemented?

When to integrate NFC with other technologies, and which interfaces to provide to the host system, are key considerations. Integrate too early, and you could have an expensive white elephant on your hands that proves difficult to update in line with changing market demands. Integrate too late and you could be left behind in the race to meet volume demand from a mass market cost-effectively.

The choice of interface point is a key market success factor, especially when different technologies are developing at different speeds. If integration is performed with interfaces at the wrong point – with stable technologies integrated with less mature ones – adding or developing capabilities on the ‘integrated’ side of the divide could become much more costly than if they had been left on the other side of the interface.

The integration point shifts with time and changing market conditions. The trick is to know when to move to the next level of integration.

### 3.1 The NFC integration story

As with other technologies, NFC is going through a classic integration process. The first prototype implementations of NFC in mobile phones were as cover units that clipped on to the back of the phone – analogous to a plug-in line card. While these devices were useful for accessing and testing the market for NFC-enabled mobile phones, they were unlikely to take off as a mass-market consumer product, as the NFC covers cost about the same for 10,000 units as complete phones cost for 10 million units.

Now, as NFC moves to the next level of integration, designers have the choice of developing NFC chipsets to sit on electronic device motherboards, or moving to SoC implementations.

The benefit of greater integration is a significant cost benefit in high-volume production, which should more than cover the up-front design and development costs. But before jumping in and choosing one route or another, designers and engineers should consider what role NFC will play in the device, and whether there are ‘overlap’ areas with other circuitry on the host device’s existing silicon.

## 3.2 The SoC opportunity

So is there circuitry already available on the typical electronic device motherboard for NFC to 'piggy-back' on to? Like any RF-based technology today, NFC requires a certain amount of analogue circuitry for transmitting and receiving analogue radio waves. Around 99 per cent of silicon today is purely digital (mostly memory), and there is little scope for building extra processes on this. But luckily, there are several areas of combined digital/analogue circuitry in devices like mobile phones, PDAs, digital cameras and payment terminals, which provide ideal hosts for NFC processes. Chief among these are Bluetooth, WiFi and UWB chipsets, and there are several other candidates.

Using such hosts for SoC implementations of NFC makes a lot of sense financially. The additional cost of including a stand-alone NFC chipset on the typical electronic device motherboard can be US\$3–5 per unit, and requires 25–30 connector pins. Implementing the same NFC functionality as a custom IP block on a Bluetooth chipset typically adds much less than US\$1.00 per unit (and only a few tens of cents in sufficient volumes), requires only 6–8 connector pins (including test pins) and, obviously, needs no separate chip. The NFC IP block can be placed in the corner of the Bluetooth chipset using on-chip connections.

The financial attractions of SoC are clear when addressing a mass market. Of course, there are up-front costs for developing custom IP for SoC implementations, but these will quickly be repaid through bill of materials and production savings in high volumes. When one considers that there are 300 million Bluetooth chipsets sold annually, the time taken to recoup even a US\$1 million development investment would not be significant if the manufacturer can charge an extra US\$0.50 per unit for built-in NFC capability.

The reduction in pin connectors is also significant. In electronic devices like mobile phones, digital cameras and payment terminals, motherboard 'real estate' is very limited and expensive.

Integrating NFC with Bluetooth, WiFi or UWB chipsets also makes a lot of sense from a technical perspective. Many of the processes and components needed by these RF-based technologies are the same: antenna, power, clock, data bus, to name a few. Having the NFC IP block on-chip also avoids the need for it to have its own ESD protection and drivers to ensure it works over the distances involved.

As with its host chipset, NFC can be implemented as a 'clever peripheral' with its own microprocessor, so that it does not need to wake up the main processor each time there is NFC activity – only when 'real' data is passed does the host processor get involved. What's more it means the NFC element avoids becoming part of the main device development programme.

## 3.3 Design and implementation issues

The choice between a custom IP block for SoC and a custom chip implementation is determined by the emphasis of the project – whether it is on memory, size, power requirement, for example – or if additional functionality is required for an existing SoC.

For example, to add NFC capability to a Bluetooth SoC, the challenges stem from the fact that different semiconductor vendors use different SoC design practices and procedures. Some emphasize memory optimization; others focus on size, layout or power consumption. Providing an NFC IP block that is optimized for use across these different environments requires extensive experience of the fab industry tools, each vendor's procedures, an in-depth understanding of the customer requirements and design-flow.

Another key point is that the process geometry used for the NFC implementation must be the same as that of the semiconductor vendor's SoC. This demands a robust NFC architecture and design that can be migrated to different geometries – and producing these takes experience.

The design-flow starts with the specification, and then moves on to architecture, comprising both analogue and digital elements. Successfully combining both elements into a customized solution requires highly specialized expertise in both analogue and digital design.

Once the analogue and digital components of the design have been integrated, this element of the design can be fed back into the specification to enable productization.

### 3.4 Custom design advantages

Assuming there is sufficient volume to justify the development costs, custom IC design – whether for stand-alone or SoC implementations – offers the advantage of enabling the designer to focus on meeting customer requirements in a way that cannot be achieved using standard products.

In a nutshell, custom IC design optimizes the cost of IP ownership and – as it is tailored specifically for purpose – it contains exclusively non-recurrent engineering. This means that for a given application, power usage, silicon area and memory can be optimized to a specific requirement. Using custom IC design for NFC SoC implementations also means the host chipset designers do not need to become experts in a new area.

Typical implementations of custom IC design for NFC would be for mobile handsets, smart posters, smart business cards, and consumer electronics.

Innovision Research and Technology plc is already deploying its proven analogue and digital design capability to custom NFC IC design for a broad range of clients. The company can help its clients manage the complexity of navigating areas such as RFID IP patents and meeting the requirements of mandated NFC tag types, across a number of industries with differing needs.

## 4 Summary

As NFC becomes more widely adopted as a mass-market technology, the advantages of SoC implementations become more compelling. Bluetooth chipset manufacturers have already shown that Bluetooth/FM integration provides a successful business model in the mobile phone market. If anything, the business case for Bluetooth/NFC integration is even better, across a broader range of applications – and this model applies equally well to other chipsets.

Designing and implementing NFC SoC circuitry requires detailed knowledge and experience. Mistakes or late changes in the design of a Bluetooth or WiFi chipset could cost hundreds of thousands of dollars to put right.

It therefore makes sense for chipset manufacturers considering on-chip implementations of NFC to seek expert help and guidance in the design process. Innovision Research & Technology has been in the business of developing NFC IP for many years – since its inception, in fact – and is now helping several key industry players add integrated NFC to their offerings.

## 5 Glossary

Bluetooth	Short-range (10–100m) wireless communication protocol
GSM	Global System for Mobile communication
NFC	Near Field Communication
PDA	Personal Digital Assistant
RF	Radio Frequency
RFID	Radio Frequency Identification
SoC	System on Chip
UWB	Ultra Wide Band
WCDMA	Wideband Code Division Multiple Access
WiFi	Wireless Fidelity – wireless networking technology based on IEEE 802.11 standards

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