

Cambridge University Press  
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Dean Anthony Gratton  
Excerpt  
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# Part I

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## What’s In Your Area Network?

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# 1 It's a Small Wireless World

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A number of books have often dedicated their first chapter to a narrative covering the historical aspects of wireless technology. It's a process that seemingly brings the reader up to date; a snapshot, if you like, of where we are and how far wireless technology has evolved. Nonetheless, whilst we acknowledge that wireless technology has reached a level of maturity with venture capitalists, product developers, engineers, and consumers alike, this chapter will instead focus on the changing perception of wireless technology and consider how it is fundamentally perceived by consumers. A comprehensive historical introduction to wireless technology would have certainly been relevant 20 years or so, maybe even as little as a decade, ago, but many consumers have now abandoned their cables for the transparency, simplicity, and ease of use that is often purported by advocates of the technology, making such lengthy historical introductions unnecessary.

Anyhow, wireless technology is still a relative newcomer in enabling a wealth of consumer electronic products, although its penetration isn't as pervasive as some would like. In short, we no longer need to dedicate a lengthy introduction and discussion surrounding wireless technology to explain the historical perspective of its conceptualization and ultimately its formation; nor do we need to discuss the ingenuity of the pioneers who were instrumental in paving the way for today's voice and data communication capabilities. Undoubtedly, these pioneers will never be forgotten, and will most certainly be remembered in other various guises and texts. Instead, in this chapter, we may use historical references merely to reinforce models of perception and primarily to illustrate how consumers have adopted wireless technology so comfortably. Likewise, we analyze consumers' perceptions of the small wireless world, offering perspectives from both the consumers themselves and the consumer electronics industry. This will provide you with an insight that will enable you to form a better understanding of consumers and their ability to adapt to the new technologies that are becoming increasingly inherent in today's innovative products. With this in mind, let's jump straight into one of the primary issues that arguably plagued wireless technology from its onset; that is, the attempt to overcome several shortcomings and hopefully become increasingly confident in delivering and architecting better products that continue to support an ethos of transparency, simplicity, and ease of use.

**1.1      Let's Keep It Simple (Stupid!)**

One ingredient that has often escaped the recipe for so many consumer electronic products is *simplicity*. This attribute alone should be instilled, force-fed, and, to be honest, beaten into innovators, developers, manufacturers, or whomever decides to embark upon developing products that are ultimately wireless-enabled. It may be blatantly obvious (to some) that, when you remove the ability to connect using a cable, you inevitably introduce a degree of complexity. If the product is too complex to use, the consumer *will* discard it. Therefore, in a team comprising developers, product engineers, marketers, business managers, and so on, there must be a number of questions that should be debated and addressed prior to embarking upon any product conceptualization, its design and subsequent development, and ultimately its marketing. More specifically, these questions and their associated answers should become a prerequisite of any prospective development life-cycle and should be explored exhaustively. Likewise, during the development life-cycle, progress should be systematically cross-referenced against these answers to ensure that no deviations from the initial objectives have occurred. In the following section, we offer a basic model or, if you like, a “rule of thumb” when embarking upon new wireless product development. The model offered here should be used primarily as a guide when assessing new development for wireless-enabled products.

**1.1.1      Applying ICE to Your Wireless Product Development Life-cycle**

In an attempt to establish a foundation upon which an approach to new wireless product development can be solidified, some basic guidelines are provided here. As part of your conceptualization process, issues surrounding *Interoperability*, *Coexistence*, and *Experience* (ICE) all need to be addressed and clarified. These facets are not new, but are often overlooked, and their purpose here is to enable you to form a better understanding and to encourage you to solidify your product conceptualization.

**1.1.1.1      Interoperability**

Interoperability is a term regularly used to characterize how a product from one manufacturer interoperates with a product from another manufacturer. If a consumer purchases a product that is Wi-Fi- or Bluetooth-enabled, for example, then the consumer will expect that product to interoperate with other like-enabled equipment, irrespective of manufacturer. It's probably an overemphasis, as it is a notion that was established in the very early days of wireless development and can easily be forgotten in a market where manufacturers wish to dominate. Similarly, you should ask whether you require your product to interoperate with other manufacturers or whether you are simply looking to create a standalone or unique ecosystem.

**1.1.1.2      Coexistence**

Interoperability and coexistence were indisputably the “troublesome two” during the early onset of wireless development, and they remain significant factors today. In the

beginning, Wi-Fi and Bluetooth were typically pitted against each other as competing technologies. In fact, the press and many feature articles presented situations where Wi-Fi and Bluetooth endured problems when sharing the same radio spectrum, let alone the same room! Both technologies have advanced suitably and moved amicably forward, and Wi-Fi and Bluetooth now provide effective interference techniques to overcome any coexistence and interference issues. More importantly, they are now seen as two separate, independent technologies offering unique applications. Your choice of short-range RF technology will therefore become a significant consideration when embarking upon new product development.

Nowadays, issues of coexistence and interoperability are well understood, as there are several schemes available that overcome any shortcomings. Nevertheless, whilst this facet of the ICE model reflects the ability to cooperate with multiple manufacturers and their radio spectrums effectively, it's also about ensuring you have selected the right wireless technology for your product. It may be a cliché, but it's a chicken and egg scenario. Undoubtedly, in your technical feasibility you have defined what your intended product will do and specified its future-proofing. Likewise, you have also selected the appropriate technology that will effectively meet your product and marketing requirements; its durability in a potentially harsh environment and other factors, such as battery life and so on, are all key contributors. The wireless personal area networking technologies mentioned in this book all deliver expectations that may suit your intended application and audience, but due diligence should be afforded to the frequency, range, and durability in an environment where other technologies are likely to be present.

1.1.1.3 Experience

The user experience should overwhelmingly form the most important part of your product design. It can't be made any clearer – if questions such as “How will the consumer interact with my product?” and “How should the consumer experience my product?” are not addressed at the product definition or prior to the development onset, then the premise of user interaction and/or its interface merely becomes an afterthought, where potentially you may introduce a degree of complexity that can possibly render the product unusable or too complex to operate. Typically, standards bodies or groups who have defined the technology offer terminology that should remain consistent across manufacturers as well as fulfill expectations at the user interface. That said, a manufacturer should be abundantly aware that a product will be operated more often by a complete novice who has no expertise. The term “out-of-the-box” describes an ideal experience in which the product is unpacked, switched on, and simply operates as intended.

1.1.2 Interference and the Packet-hungry

A cable, as a minimum, offers the consumer a secure, fixed, reliable, and, on occasions, a powered connection. Alas, bestowing a product with wireless technology inevitably results in it falling upon the mercy of an air-interface, which unfortunately becomes subject to a myriad of worldly influential elements. The global nuances that invisibly occupy our space, which, in turn, arguably impose operating conditions that are disruptive

to the wireless communication pathway – more commonly known as interference, are heightened by an ever increasing number of packet-hungry eavesdroppers who, with their hidden agendas, are always too pleased to know more about our wireless-established conversations. An additional factor to consider in making things wireless is, of course, removing the cable; this has resulted in products having to locate a new power source, which is typically derived from batteries.

Naturally, the majority of manufacturers are striving toward the belief that wireless-enabled products should support a mantra of transparency, simplicity, and ease of use, but inescapably our products have become complicated; there's now a degree of unreliability in our air-interface communication: we have to change the batteries regularly to sustain power within the device, and we have introduced a security compromise by removing the cable.

The motivation for innovators differs across industries; however, some tout a tenuous argument that cables are cumbersome, clutter our environment, and are too complicated to use. Installing cables in a large fixed environment can prove to be an arduous task, and we'll come back to this point later on in this chapter. Others may have become privy to the knowledge that wireless technology *is* founded upon a sincere belief – that of affording the consumer the gift of simplicity. Numerous manufacturers continue to develop new silicon, implement enhanced security schemes, devise new low power techniques, and participate in numerous standards committees to evolve and support their wireless technology flavor. On the one hand, we may assume these companies merely have an economic death wish; more realistically, on the other hand, there's something about wireless that offers a sense of freedom. We are not suggesting that cables literally bind you, but with Wi-Fi, for example, and the explosion of hotspots populating streets, restaurants, offices, metros, airports, and so on, we have quite literally become unconstrained by our location. Likewise, simple applications such as synchronizing your cellular phone with your desktop or notebook has become a small matter of bringing your cellular phone within the proximity of your desktop computer, for example. Both devices wirelessly detect each other and automatically synchronize – (normally) no user intervention is required.

Let's return our attention to the cable argument. Removing the cable from your environment is a valid contention for wireless, as it has been the founding belief for so many wireless technologies. In particular, the notion has been pivotal in the marketing of Bluetooth wireless, which has been touted as a cable replacement technology from its inception. Likewise, Wi-Fi technology was hyped as an alternative to a fixed cabled infrastructure, and, as such, Wi-Fi-enabled equipment is often installed where a cabled alternative is difficult to deploy, especially within a large building or perhaps across a large university campus, for example. Nowadays, connecting to a Wi-Fi *Access Point* (AP) has become akin to plugging in an Ethernet cable, something which has become very evident in today's technology fashion; for example, Apple's iPad, iPhone, and its MacBook Air, along with numerous Netbooks and smartphones that are so readily available, simply require a Wi-Fi connection. All these products rely on the idea of wirelessly connecting, which is tantamount to an increasing trend to sustain that all-important wireless connection. Let's not forget that Apple suggested that, with a ubiquitous wireless

presence, we no longer need to rely upon other physical mediums (CD-ROM drives, for example) to retrieve data, software, or any other applications. This is further compounded by the many “application” stores offered by so many software providers, such as Apple, Microsoft, and Google.

1.1.3 Cutting the Cable

So, let’s move beyond our *Personal Area Networking* (PAN) space for a moment, and shift our attention to the *Wider Area Network* (or WAN) to strengthen the “cutting the cable” argument. Naturally, deploying cables across continents and oceans is undoubtedly a challenging task. This is something that has already been done, but often these cables are subject to the elements surrounding them and can be prone to accidental severing. Nevertheless, the British firm, Global Marine Systems, is laying a new transatlantic fiber-optic link called the Hibernian Express.<sup>1</sup> The new link aims allegedly to “shave six milliseconds” off the existing leader’s (Global Crossing) AC-1 cable, which currently supports a transatlantic connection of 65 milliseconds. The saving of just one millisecond can be worth up to \$100m “a year to the bottom line of a large hedge fund.” Increasingly, worldwide communications rely on some kind of fixed infrastructure where, for example, cables have already been deployed; however, utilizing fixed satellite communications to support the wider network has become somewhat easier to manage and deploy (not wanting to over-simplify unnecessarily the infrastructure or the technology). Fixed satellites comfortably support voice and data communications across the world, enabling the remotest of areas to sustain that all-important digital communication channel.

What seemed to be a tenuous argument for wireless technology has now become a significant factor in its future success. Likewise, the promise of simplicity also seems to be seeping into numerous products and applications. But applying security to these products has become a cumbersome process since the initial cutting of the cord (see Figure 1.1). In the chapters that follow, we tackle issues of security and encryption and examine how industry bodies and manufacturers overcome these unfortunate shortcomings. In the meantime, the packet-hungry eavesdroppers will continue to challenge innovators, and numerous standards bodies will continue to strive to ensure that connecting and pairing products becomes as simple as connecting a cable.

In taking a forward step and reviewing the innovation landscape, it seems, to a greater extent, that many innovators and manufacturers haven’t forgotten the simplicity needed to ensure the future success of wireless technology. In fairness, it’s an arduous and challenging task to achieve seamlessness between many different products, and let’s not forget that plugging in one end of a cable to device **A** and the other end to device **B** has, over many decades, become second nature to a generation of consumers – it’s become an unconscious process. Fundamentally, this is something we need to mimic in the new generation of wireless-enabled products. In short, we need to strive for the

<sup>1</sup> Williams, C. “The £300m Cable that will Save Traders Milliseconds,” 2011.



**Figure 1.1.** Cutting the cable is not necessarily a straightforward task.

same simplicity in all wireless-enabled products and deliver an uncompromising sense of unconscious usability.

The fundamental premise of wireless communications is to simplify connectivity between personal area devices. What’s more, this premise should extend to simplifying communication within buildings or over distances where normally a fixed infrastructure would be difficult to deploy. Nonetheless, cutting the cable introduces an unmeasured sense of complexity.

Looking back thus far, we have discussed some of the factors that have, in part, been the motivation behind wireless technology. These have included simplicity, where deploying a fixed cabled infrastructure may be troublesome; an ability to use and operate a device easily; sustaining communication in both a personal and wide area perspective, in turn enabling communities around the world to remain connected no matter how far apart they are; and the need to drive toward an ecosystem supporting transparency and ease of use across all consumer electronic products. We now have a better understanding of some of the motivation behind “making” wireless, but let’s turn our attention to understanding the audience – the community of consumers who will ultimately invest and provide longevity for a wealth of products and their associated technologies. Ultimately, we need to convince the purchasing population that wireless technology is here to stay, that it will become more pervasive, and that its use will increasingly become commonplace.

## 1.2      **Understanding the Audience**

More and more, manufacturers are wirelessly enabling their products and, as a result, cables are gradually being thought of as a second choice for connecting devices. Yes, a new generation of consumers has begun to look at their products very differently – we all yearn for the day when we can simply bring our television *Set-top-box* (STB) into proximity with our DVD player and our 7.1 stereo speakers (and other entertainment related products) and witness all our devices behave by seamlessly interoperating with



each other. A day that shall be devoid of user manuals, configuration, and set-up – a truly holistic out-of-the-box experience, which is currently lacking in many consumer electronic products (again, it’s another reminder of the simplicity factor and addressing those primary questions!). In successfully marketing wireless-enabled products to the consumer, marketers and manufacturers alike need to establish an added-value perspective – both a qualitative and quantitative factor, if you will, that convinces the consumer to “buy-in.” We are already armed with numerous one-liners to hook the consumer, but the *Low Hanging Fruit* (LHF) needs to be devilishly tempting for the masses to bite into it. More often than not, adding new technology into a product inflates the purchase price, which, in turn, may deter rapid consumer adoption. With this in mind, we provide a cursory review of the marketing techniques used to increase product sales, which encourage the consumer to buy-in, at which point, of course, marketers offer that important added-value! In moving forward, the following sections impart a succinct perspective of the typical psychological makeup behind the ordinary consumer and offer an insight that will allow a better understanding of the intended audience. But first, we look at a technique that marketers have employed to convince ordinary consumers that this wireless stuff is all brand new and, perhaps, cleverly mislead them into a belief that wireless technology has only largely been conceived within the last 20 or so years.

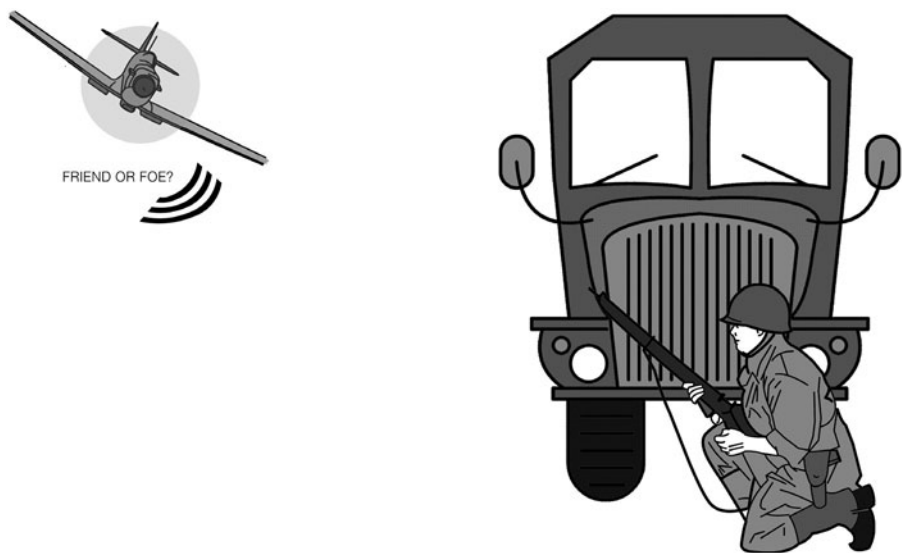
1.3 Making Wireless Technology New

In fact, wireless communications has been operating now for over 100 years, and whilst we delicately tiptoe around a history lesson, it is merely curiosity, along with the need to demonstrate the aforementioned marketing technique, that momentarily draws us into an historical anecdote. Nevertheless, the purpose of highlighting the technology’s longevity is to demonstrate that wireless communication and its associated techniques, algorithms, modulation schemes, conceptualizations, use case scenarios, and so on, were, to a greater extent, founded in the early twentieth century and witnessed extensive growth during World Wars I and II.

1.3.1 The Nineteenth-century Wireless Secret

Again, whilst eluding a lengthy historical narrative, let’s reinforce, through example, some fundamental technologies and products that have been in existence for several decades, if not at least a century. Let’s take the basic radio; that is, radiotelegraphy or wireless telegraphy, as coined in the mid nineteenth century. It’s amazing to witness a notion of *wireless*, or at least a definition used to characterize an application using a transport medium, which wasn’t physically connected or wired. Most notably, Albert Einstein, when asked to explain wireless technology, used an analogy of a long cat:

You see, wire telegraph is a kind of a very, very long cat. You pull his tail in New York and his head is meowing in Los Angeles. Do you understand this? And radio operates exactly the same way: you send signals here, they receive them there. The only difference is that there is no cat. (Albert Einstein)



**Figure 1.2.** Ground forces would await the aircraft’s response via RFID prior to taking action.

In later years, the term “radio” was generally adopted globally, where it characterized a device that provided basic communication from one point to another, that is, without the long cat. Some early use cases of wireless telegraphy were used to offer the first communication applications in the form of Morse code. In the early twentieth century (circa 1910), we eventually witnessed early broadcasting, the delivery of real-time audio content. In a modest number of scenarios, these early pioneers transmitted voice over relatively short distances but, fundamentally, the technology evolved to undertake an instrumental role in the First World War. Incidentally, the terms “radio” and “wireless” were used synonymously; however, in the early 1920s “radio” became widely adopted across the world. In Britain, for example, the word “wireless” was still used to characterize the broadcasting medium, and nowadays we can still witness the use of the word in publications such as *Practical Wireless* ([pwpublishing.ltd.uk](http://pwpublishing.ltd.uk)), and perhaps your grandparents may often refer to the modern day radio as a “wireless.”

*Infrared* (IR) is another example of our nineteenth-century wireless secret. Of course, hitherto use case scenarios of IR have extended to some generic wireless applications, and you will surely correlate IR to such products as your television and sound system remote controls. Infrared radiation was discovered in 1800, and its applications are not limited to telecommunications. Infrared light lends itself well to other application areas, such as defense/military, astronomy, meteorology, medicine, and so on. Nonetheless, IR in data communications is performed over a short distance and has been integrated into a number of personal computers and other mobile devices.

As our final example, we cite *Radio Frequency Identification* (RFID) – a technology currently employed in many industries including healthcare, packaging, manufacturing, aerospace, and defense – which has its origins firmly dated as far back as World War II, as we illustrate in Figure 1.2. We say more about NFC topologies in Chapter 12,