



cellular  
**SAVVY**

The essential guide for improving cellular performance  
in your venue, campus or arena

**ROD PERRY**

**Savvy Consulting, LLC**

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In the cellular world, if you give the same project to one hundred different engineers and ask them for a system design, four will stub their toe and provide a flawed response. Ninety-five will come back with essentially the same, competent and safe design. And lastly, one independent thinker will create a real work of art. A design that is elegant, simple and probably with a lower overall cost to deploy. This book is dedicated to those engineers that deliver art. The clever, deep-thinkers in the cellular industry that slay the biggest problems with nothing more than an original idea. You've taught me much and kept it interesting. It has been a pleasure working with you.



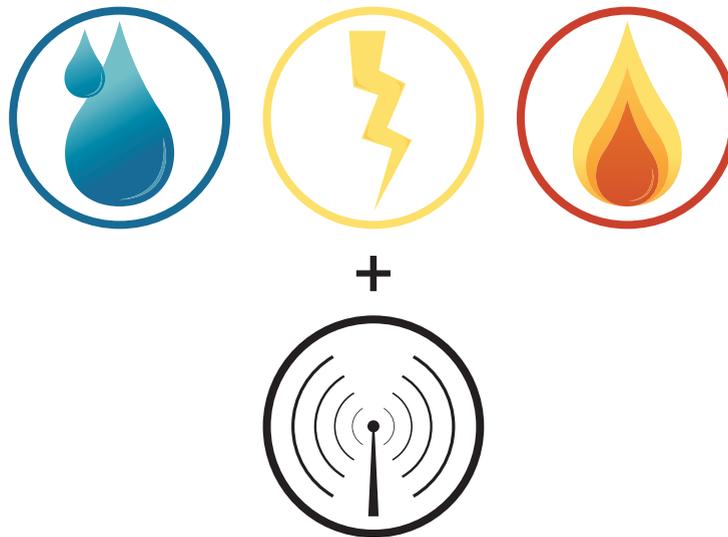
# Introduction

## *Education is the key to successful cellular projects in venues*

It can be easily argued that cellular communication has been one of the most disruptive technologies of the last twenty years, and it has been an amazing twenty years. Having a quality cellular connection has gone from a technical “nice to have” to a personal and professional must have. Today the idea of needing to be at your desk to speak on the phone or access the Internet is like wearing a whalebone corset - it’s something from another era that no one wants to revisit.

For the first decade or so of the cellular era, people who owned and managed real estate properties could relegate management of the cellular environment on their property exclusively to the cellular operators and then live with the results. Consumers were used to dropped calls and poor cellular coverage inside buildings. Today, however, cellular subscribers count on their devices for always-on connectivity and poor service indoors reflects badly on the property. Therefore, more and more public and private organizations are getting involved in the delivery of cellular service in their facilities in order to ensure quality cellular for their customers and visitors.

This embracing of cellular has made it popular in the cellular industry to draw a comparison with cellular and traditional utilities like water, electricity and natural gas. The concept is that like water, electricity and gas, cellular started out as a service that was totally managed by the provider, but over time, building owners and managers claimed the distribution of the utility within their four walls. Everyone plans and designs for water, power and gas in their buildings; now many are adding cellular infrastructure.



**figure 0.1** In-building wireless, including cellular services, is now considered by many to be the fourth utility

On the surface, this is a valid comparison. But unlike traditional utilities, cellular communications are a very different and unique beast. Cellular has attributes of being a utility, but it is also a competitive consumer product with multiple providers and it even has elements of being a public safety service. Unlike power or water, or even IT services, the venue cannot create or distribute a cellular signal without the permission and cooperation of the cellular operator or operators. And if a venue owner wanted to provide cellular signal for everyone, he or she would be faced with the task of creating three or four cellular networks to match the services that are “in the air” surrounding their facility.

The cellular industry has essentially agreed that about 70% of all calls and 80% of all cellular data sessions originate inside a building. Yet, a very small percentage of the cellular network construction monies have historically been spent on indoor cellular networks. This disparity is about to change as in-building and campus cellular are getting lots of attention and projects to “wire up” buildings are happening across the country. Most of these projects will be lead by the operators themselves, but a wide array of entities are now involved in the planning, financing, managing and deploying of cellular infrastructure in venues. It has become a big business.

I have been fortunate enough to be involved with the cellular venues business for most of the last 15 years and while the majority of the projects I have witnessed can be called a success, the venue cellular playing field is littered with unhappy customers, poorly performing projects and unfulfilled expectations. In examining how to make more projects more successful, I have arrived at the conclusion that better educated Venue Managers would be the best way to improve the process. In almost every setting, the Venue Managers have been the least “cellular savvy” of all the parties involved and this lack of education is one of the primary reasons that Venue Managers are not getting the results they want.

The purpose of this book is to provide a fundamental reference tool to anyone associated with cellular infrastructure in buildings and on campuses so that they will have higher levels of success for themselves and their organizations. The book is written for managers and specialists in IT, Property Management, Real Estate and Legal departments at universities, hotels, airports, convention centers, sports arenas, municipalities and other owners and operators of buildings and venues, but even if you don't hold any of the above positions, feel free to turn the pages and gain the understanding. At a minimum, this knowledge will help you become a fascinating cocktail party guest.

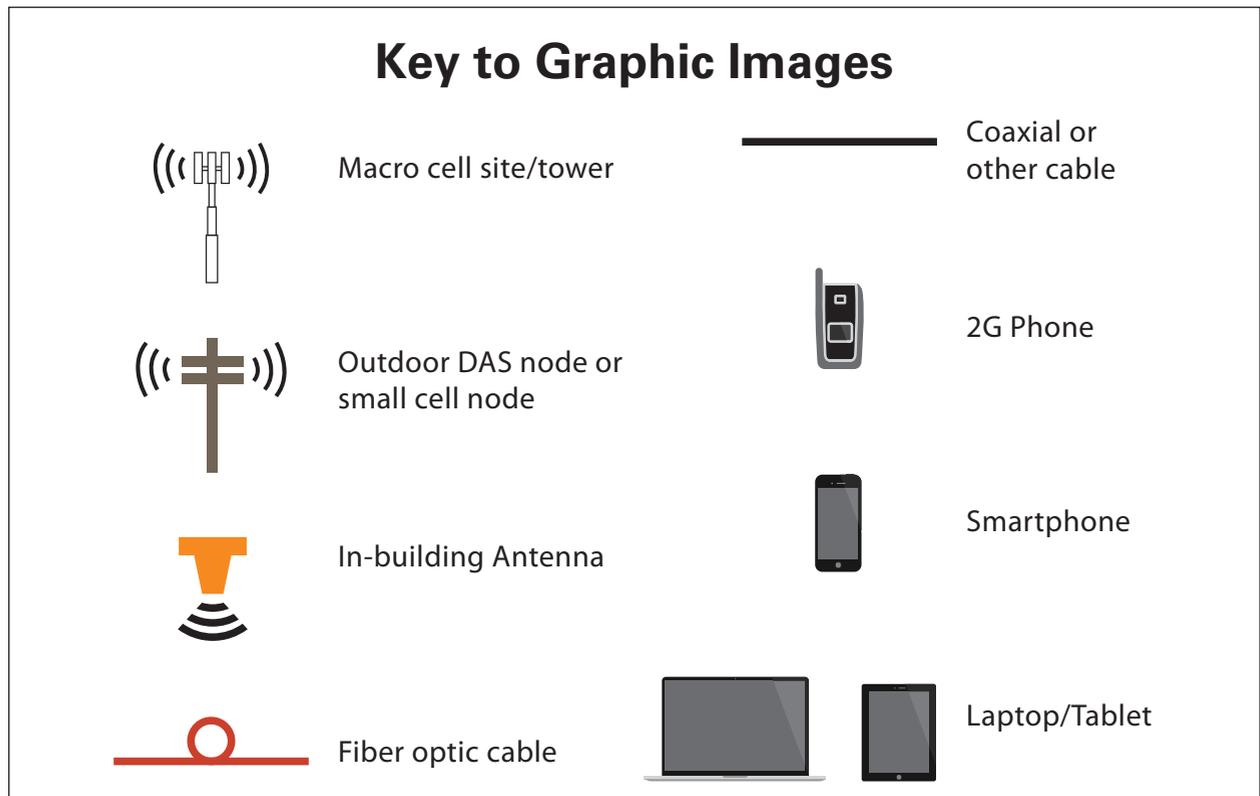
## **When reading this book, please be aware that:**

- This book deals specifically with cellular communications and not WiFi.
- All references to network frequencies are for the United States and Canada.
- I am going to discuss how to improve the cellular coverage and capacity in your venue (the plumbing) and will not delve into applications, security and the higher functions of the network.
- Cellular service and infrastructure in buildings and venues is a very dynamic space. There are a wide range of exceptions to every rule and for every example or maxim I put down, there will be a number of exceptions. This is not scripture. Your mileage may vary.
- I am consciously going to use the term “operator” to describe the cellular providers. The word carrier is more common, but confusing in the sense that carrier is a word used within the industry to describe the air-link interface. For example, “we are installing a new 2<sup>nd</sup> UMTS carrier at the site” is referring to a new cellular channel being broadcast for added capacity, not the cellular operator.
- When referencing the owners and managers of the venues and properties, I am going to use the term Venue Manager. This is a narrower definition than I would like, but it will allow for a consistent place holder for all those people who own, manage and work for the myriad places where cellular can be installed.
- The primary purpose of this book is to provide a broad-based treatise on all factors that go into improving cellular coverage in your venue or facility. Most technical concepts will be introduced and covered to a depth sufficient to allow Venue Managers to have a reasonable understanding and participate in the process of obtaining quality cellular services for their venues; but you're not going to get college credit for any of this and you won't be able to design and deploy sophisticated cellular infrastructure. If you want to learn more about the technical aspects of cellular communication, there are a number of good books on the topic already

written (I recommend Morten Tolstrup’s “Indoor Radio Planning”) or web resources such as Wikipedia can be used to learn more.

- The illustrations and figures used in this book are conceptual, and designed to illustrate basic concepts.
- And lastly, the contents of this book are primarily drawn from my own experience and observations. I have worked on cellular projects in venues as varied as airports, manufacturing plants, hotels, college campuses, government buildings, sports arenas, nuclear power plants and military bases. I have worked with operators in North and South America, Europe, Africa and the Middle East. I was lucky enough to live with my family in Europe for two years and manage the operations of a cellular infrastructure company in Europe, the Middle East and Africa. I don’t list these credentials to boast, but to communicate that my insights come with all the scar tissue of real world experience, not the calluses of combing through the Internet.

Lastly, a number of figures and graphics are used to help illustrate various technologies and concepts. The following graphics key will help acquaint you with some of the graphics used and what they represent:





## Section One

# Cellular Network Primer

Over the past three years, I worked as an intermediary between venues (universities and sports arenas, mostly) and the cellular operators on projects to improve cellular performance for these venues. I found it beneficial in these relationships to educate my venue business partners in the basics of the cellular network so that the decision makers could participate in, or at least understand, the design process and the technical challenges of the project. After several different attempts to develop a simple, easy to digest syllabus, I came up with the idea of teaching cellular basics as a kind of history lesson based on the development of today's cellular networks. In other words, I simply took the deployment of cellular services and used that timeline as the outline for my training presentation. So with that as my guide, the first section of this book will serve to educate you as to the basics of cellular communications - all the way from the analog "brick" phone to HetNets. So fill the dog's water bowl, silence your cellphone and let's get started.

### MAKING YOU SAVVY

#### Let's level the playing field

There's an old saying about the game of poker. If you have played for 30 minutes and you don't know who the patsy is, you're the patsy.

When discussing cellular, everyone at the table knows more than the venue manager. This book will teach you how to hang in there with the cellular big boys and stand a better chance of getting what is best for your venue.





## Chapter One

# A Few Technical Tidbits to Start With

Before we dive into a cellular history lesson, I would like to introduce you to some of the physics behind cellular networks and make sure you have a fundamental understanding of how radios work. If this gets too technical for you or you already know this, just skip ahead to Chapter Two.

### **Electromagnetic Radiation is everywhere**

Cellular network signals are part of a wide range of natural electromagnetic radiation (EMR). All the light from the sun, the radio stations we listen to in our cars, and even your cordless baby monitor are examples of EMR. For about the past hundred years, humans have been able to harness a portion of the EMR called the radio spectrum to transmit communications and information through the air. In talking about cellular communications, it is important to recognize that cellular communication is just one of hundreds of applications of wireless communications and the frequencies used by cellphones constitutes a small fraction of the total electromagnetic spectrum.

### **It's all divided up by frequency**

The Radio Spectrum is segregated by frequency, which is, essentially, the number of oscillations (wiggles) measured in the radio

### **SAVVY RULES**

#### **The FCC rules the airwaves**

Each wireless application from garage door openers to airport radar gets its own piece of the electromagnetic spectrum. The FCC allocates the spectrum and controls the radio equipment standard for each application. In order for wireless communication to work well, everyone needs to follow the rules.