The Cellphone
The HISTORY and TECHNOLOGY of the GADGET That CHANGED the WORLD

GUY KLEMENS
The Cellphone
The Cellphone

The History and Technology of the Gadget That Changed the World

GUY KLEMENS
LIBRARY OF CONGRESS CATALOGUING-IN-PUBLICATION DATA

Klemens, Guy, 1973–
   The cellphone : the history and technology of the gadget that changed the world / by Guy Klemens.
   p. cm.
   Includes bibliographical references and index.
   softcover : 50# alkaline paper

 1. Cell phone systems.  I. Title.
   TK5103.485.K58  2010
   621.3845'6 — dc22 2010029782

British Library cataloguing data are available

©2010 Guy Klemens. All rights reserved

No part of this book may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying or recording, or by any information storage and retrieval system, without permission in writing from the publisher.

Cover images ©2010 Shutterstock

Manufactured in the United States of America

McFarland & Company, Inc., Publishers
Box 611, Jefferson, North Carolina 28640
www.mcfarlandpub.com
# Table of Contents

*Introduction*  
1. Bandwidth  
2. Radio  
3. Mobile Phones  
4. Analog Technology  
5. The Analog Cellular Phone  
6. Digital Technology  
7. Digital Standards  
8. The Digital Cellphone  
9. The Business Reaches Maturity  
10. Implications of Cellphones  
11. Inside the Cellphone  
12. Cellphones Beyond Phones  

*Chapter Notes*  
Glossary of Terms  
Selected Bibliography  
Index
Introduction

Many areas along the Congo River probably meet the definition of an undeveloped region. There is little electricity or plumbing, and certainly few telephone lines. In 2005 an American reporter found a woman selling fish who kept them in the river since there was no refrigeration, taking them to customers when requested.¹ She cannot read or write, so sending a note will not help. Someone who wants to buy fish will just have to call her cellphone.

The cellphone, or cellular phone in its full appellation, a device that as recently as 1990 was an oddity, has long since reached ubiquity. Market saturation in the usual developed countries of North America and Europe approached or surpassed 100 percent at the turn of the century, meaning that some countries have more cellphones than people. But this new medium is more than the latest plaything of the prosperous.

Unlike many technological advances, the cellphone has not bypassed the developing world. By 2004 the number of subscribers in Africa had surpassed 75 million and continues to grow. The cellphone is too vital for developing countries not to adopt. For many in the world, the cellphone brings a flowering of opportunity, with the century of technology finally making drastic improvements to their daily lives. For others, the cellphone is not always so welcome.

Far from the hardships of the Congo River, and well into the most affluent of societies, a cellphone rang in a Niagara Falls courtroom on March 11, 2005.² When no one would admit to owning the offending device, the presiding judge ordered 46 people in the courtroom be taken into custody and transported to jail. Two years later a state commission ruled to remove the judge from office for this action, but the message is clear. These devices can be an annoyance. The cellphone has a significant role in society, although no one is quite sure what that role is or what it should be. Almost everyone uses a cellphone, but it is still an object of mystery.

What is inside these devices, how do they work and how did they origi-
nate? On a related thread, why did cellphones come into being? The story consumes a large part of the technological developments of the past several decades. A comprehensive history must therefore tread beyond names, dates and events, and explore numerous technical concepts.

An examination could begin with the many components that make up the device. First, of course, a cellphone is a telephone, but it is also a radio receiver and transmitter, calling for an understanding of radio waves, antennas, and the history of radio. Microscopic circuits perform the various functions, a liquid-crystal display provides an interface for the user, and none of it would work without a battery. All of these parts need explanation in order to understand the cellphone, and their sum presents more facets to examine.

The handset is only a small part of a larger cellular system, created to meet the demands of mobility under the constraints of limited bandwidth. All of the history of cellphones from the beginning and into the foreseeable future springs from the limitations of bandwidth. And the bandwidth under discussion here is not the vague entity of common usage. The bandwidth of a message is an exact number, as is the available bandwidth of a communication channel such as a radio link. A careful understanding of this fundamental topic is therefore essential to a history of the cellphone. The technological aspects are many, but the phenomenon of the cellphone certainly extends beyond the inanimate.

Engineers create cellphones and then release them into the world for people to use, so the technology and the design process is only part of the story. The industry itself is a large business, using enormous amounts of resources and personnel. And cellphones add efficiency that help other businesses, and the economy in general, prosper and expand.

On an individual level, the cellphone has reached universal acceptance. People throughout the world carry them, use them, and sometimes wonder if they are harmful. As it has for technology such as the automobile and the television, society has reshaped around the cellphone. The history of the cellphone is therefore also about people and their use of this device.

This book uses the terms cellular phone and cellphone rather than mobile phone because it focuses on a specific type of wireless connection. Cordless phones, for which the handset is in radio contact with a wired unit in the same room, are not under discussion here. Also outside the topics covered are wireless local-loop systems, in which fixed radio connections replace some of the street-level telephone wires. Instead, this history deals with wireless systems built around the cellular concept, in which wireless users operate in small local areas (the cells). This is the principle that allows personal communication systems to overcome the limitations of bandwidth and to give the users the mobility needed for continuous contact.

The term cellular phone also has the ability to describe several families of devices. For its first decade the cellular phone existed only as a car phone. It then became a bulky portable unit, and then shrank into the modern hand-
set. In this recent phase of the cellular phone’s existence it is the familiar **cellphone**. In the following story, there is a gradual transition in terminology, using “cellular phone” to refer to the general device and system-level and technology-level concepts, and then using “cellphone” to indicate the device that the current consumer experiences as a cellular phone.

This book makes no attempt to shield the reader from technical concepts, not only because to abridge the scientific explanations would be to remove much of the story, but also because such protection is unnecessary. The philosophy followed here is that an adequately careful explanation can clarify any topic. And so this book offers more than narrative history, it is also a lesson in the concepts and subjects important to understanding the cellphone as a device and as a phenomenon.

The fundamental theme in the history of the cellphone is how many trends had to reach an apex and converge at the right time. If someone were to take the complete plan for a cellphone back in time to only 1970, there is little that anyone could have done with it. Circuit miniaturization, batteries, displays and other essential components were still following their own independent development paths. Besides technology, society had to change in order to demand the cellular phone. Then there are the legal and business aspects. There were no frequencies available, and the telephone monopoly of the time had little motivation to build an expensive system to compete with itself.

This convergence would repeat often in the history, and is still taking place in many ways. The digital cellphone, for example, would have been impossible in 1980. As described in later chapters, the necessary techniques of digital audio compression were just developing, and integrated circuits did not have the necessary computational power. By 1990, not only was the technology in place, but the market demanded the digital cellphone. Large, experienced companies were ready to make the switch, and government agencies recognized the demand and knew how to modify regulations and allocate new frequencies. The history of the cellular phone therefore brings together a wide variety of historical threads.

The organization of this book mixes chapters that have more technical explanations than history with chapters having the reverse ratio. The first two chapters deal with bandwidth and radio, the foundational concepts that motivated and created the cellular phone. The chapter that follows is the pre-history of the cellular phone, with the creation and surprising popularity of the car phone. The demand for a better system takes the story to the 1970’s and the development of the first cellular systems. A chapter explaining the analog systems that emerged is followed by a chapter detailing the story of their introduction and growth. But that is only the first phase of the history.

What follows is the switch to digital technology, with a description of digital communications concepts in general and then specifically as they apply to cellphones. Having built the foundation of understanding, the history can pro-