A comprehensive book on digital signage technologies from content gathering and content management, to distribution, media players, and display systems!

ABOUT THE BOOK
• Contains numerous full-color illustrations and real-world examples
• Covers technology, operations, content, and more
• Global insights and perspectives for worldwide implementation

Digital Signage Broadcasting is a perfect introduction to this new world of opportunities for media professionals in all areas. Whether you are in engineering, IT, advertising, or management, you will gain knowledge on the operations of digital signage systems, content gathering, customer billing, and much more about this new and exciting medium.

This book includes coverage of basic elements, examples of advanced digital signage applications, as well as traffic capacity calculation formulas that can provide guidance when choosing a means of distribution such as physical media, broadband, or satellite. Digital Signage Broadcasting helps you discover the fascinating possibilities of this new convergence medium with hundreds of color illustrations, which the author created using the latest 3D graphics methods, and his own real-life photographs that show the capabilities and future of digital signage.

ABOUT THE AUTHOR
Lars-Ingemar Lundström has been pioneering satellite, cable, and digital TV distribution systems in the Scandinavian countries since the early 1980s. He has written hundreds of articles on TV distribution techniques along with a number of books, including Understanding Digital Television (Focal Press, 2006).

DIGITAL SIGNAGE
BROADCASTING
Digital Signage
Broadcasting
Content Management
and Distribution Techniques

Lars-Ingemar Lundström

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This book is dedicated to people all over the world who struggle at the bleeding edge of technology to make new products become reality instead of staying just as ideas.
After writing about television broadcasting systems for more than two decades in a world of conventional radio and television and then the Internet, I did not think it was very likely that a completely new medium would show up. It seemed that most things were already invented and that most innovation would be in the realm of improvements. However, one day it happened. I understood that something new was on the move.

When I started to work with satellite IP distribution a few years ago, I saw digital signage as a very specialized business media–related application. Retail chains and gaming companies used VHS recorders and DVD players in their stores to improve business. Some closed-circuit television networks also were used for gaming and betting. All seemed to be spin-off effects of the TV and video media that used conventional home electronics.

As time passed, however, flat-panel display devices and computers and Internet and satellite distribution were introduced. Suddenly I realized that digital signage really is a new medium that encompasses most other kinds of digital media. It also became clear to me that people in this business, including me, did not see the full picture. This is not unusual because digital signage involves both broadcasting and telecommunications technologies in a way that may seem to be a complete mess. Broadcasting people do not know telecom very well and vice versa. Still, everyone has been talking about the convergence of the two for a decade or more.
Exploring this new medium has meant new “A-ha!” experiences almost every day, so obviously there is much more to learn. I soon found that there was not much written about the whole digital signage phenomenon, and that probably a lot of people want to know what digital signage is all about. Clearly, there was a need to put the pieces together to try to find the structure of this new medium.

Digital signage is very different from most other kinds of media because it is really a combination of existing technologies. Internet technologies merge with digital broadcasting, and computers develop toward set-top boxes. On the media production side, television, radio, web site development, and conventional printed media join to form one new medium.

When you start to study digital signage, you soon realize that you have to find out most things by yourself piece by piece. My intention in writing this book is to give readers a comprehensive view of the key elements in digital signage systems and of ways to manage the content and distribution in different applications. Especially important is the need to put the spotlight on broadcasting IP data for digital signage applications.

ABOUT THIS BOOK

I have arranged the content of this book in a way that I believe most people would approach digital signage technologies.

When starting to think about establishing digital signage services in stores, most people probably begin by thinking about the screens, such as, where to install them (which is much easier with flat-panel displays than the old cathode-ray-tube TV sets)? Second, what content should be put on the screens? Third, what content should be exposed in different departments of the store at different times? Finally, what about customizing information depending on the stores’ geographic locations?

Most people still seem quite unaware of the unique possibilities for tailoring the displayed content for each application, geographic location of screens, and time of day. Even fewer people have a deeper insight into the problems involved in distributing content and controlling what kind of content appears on each screen.
For this reason, and to give you new ideas and stimulate your imagination, we begin in Chapter 1 with some of the numerous applications for digital signage. In Chapter 2, we take a more in-depth look at display devices and address how to choose the right technology for the application and location of the screens.

Digital signage has completely new ways of combining information from different sources. Getting to an understanding of how the visual message in digital signage systems is put together is described in Chapter 3.

To get all this to work, we need a different kind of device from conventional broadcast receivers. Media players are computers somewhere between broadcast receivers and personal computers. They exist in many shapes, and Chapter 4 describes these key devices in detail.

One consideration that is often neglected when planning digital signage applications is the means of distribution. This behind-the-scenes issue is critical to the types of applications that can be implemented. Chapters 5, 6, and 7 shed some light on questions that are rarely fully analyzed.

A store or public area with many screens may benefit from a local site server that stores all the information that is to be provided to the screens. The site server, described in Chapter 6, leads us to another important element in the retail environment—the customer terminal.

In the long run, the choice of distribution method affects the economy of the system in a significant way. Chapter 7 describes and explains the most powerful means of distribution—digital signage broadcasting.

Digital signage systems would never work without someone controlling which content is shown on which screens. The content management server, described in Chapter 8, is not only the heart of a digital signage system but also the spider in the web when it comes to collecting information from the Internet that is to be distributed to the screens.

Perhaps you have heard the expression, “There is no success without the right content.” Chapter 9 discusses in more detail the ways to
use web site information and TV commercials on the screens of the
digital signage system. The possibilities prove to be even greater than
most people think. Much of the content production needed for a dig-
tital signage application may already exist on your web site or in your
video archives.

Digital signage must be regarded as a new kind of medium. Completely
new approaches may have to be used. Such new systems also require
new ways of operation with completely new operational problems. Chapter 10 investigates the known facts about the new challenges.

Digital signage systems are a part of the environment in retail stores
and affect the atmosphere in them. Therefore, it may be a part of or
significantly affect the culture of a brand. Chapter 11 raises some ques-
tions related to this very complicated question concerning this new
medium. To stimulate your imagination, the chapter contains exam-
pl es of screens in various environments, outdoors as well as indoors.

Today’s digital signage systems are mostly seen in stores and public areas. But other kinds of applications may be a part of the media of tomorrow. Chapter 12 speculates on how digital signage may develop in the decades to come. Already, many people have media players in their homes to view digital photos and play their MP3 music using their TV set or home theater systems. Much of the digital signage you find in stores already exists in many homes, even though you may not realize it! And I am sure you already have one or more media players on your laptop or desktop computer. Whether you know it or not, your computer screen works more or less the same as a digital signage screen.

*Digital Signage Broadcasting* does not delve deeply into topics such as the Internet Protocol, digital television, satellite distribution technologies, and design of outstanding advertising signs. Other books describe such topics in detail. Instead, my aim has been to fill the gap between these topics and to link them closely. I hope you will find a new world of possibilities here (see also [www.digitalsignagebroadcasting.com](http://www.digitalsignagebroadcasting.com)).

Welcome to the world of a new medium—digital signage.
AN OVERVIEW OF DIGITAL SIGNAGE

IMAGINE THE WORLD IN 20 YEARS

The bulky cathode-ray tubes of the twentieth century have all long been replaced by ultrathin, inexpensive, high-resolution, and high-quality display panels. These panels can be located indoors or outdoors and can have any format or shape. The panels are fitted to suit the walls in any public area or your home.

The screens are filled with live television as well as near-real-time information that is mixed with non-real-time video spots or still images that are suited to the screen’s location or to the person who is watching it at that moment.

This scenario may seem like science fiction, but really, why should this be an impossible forecast of the media of tomorrow?

We can already see an obvious trend where flat-panel display systems become larger, cheaper, and thinner, with improved resolution. Therefore, it is not impossible to imagine that in the not-too-distant future we will find one or more of these thin flat-panel displays in each room of a home. Nevertheless, the world where wallpaper is replaced by electronic display systems is probably still far away.

But in stores and other public areas, things are already on the move. The introduction of flat-panel TV sets and computer screens has meant that dynamic digital media can be found everywhere. The need for content suited for the specific location and the specific moment has made this a reality in these kinds of environments.

However, to get the scenario of the future to work, we need the right content on the screens. In a society of hundreds of thousands or even...
Figure 1.1  Future digital signage applications will make use of thin, inexpensive, high-resolution electronic display devices that may be easily located everywhere. Imagine all the new opportunities!

Figure 1.2  Digital signage is becoming a more common sight, both indoors and outdoors. The same messages might appear on plasma or LCD screens in stores as well as on large LED screens outdoors. Actually, they are all the same medium.
millions of display panels, all this content must be managed and distributed. And that is what this book is all about.

This can be done using computers, some people might say. This is certainly true, but still, there is so much more to it.

THE DAWN OF A NEW MEDIUM?

Modern society is a world of satellite, cable, and terrestrial television, now accompanied by Internet Protocol Television (IPTV) and broadband Internet access in an increasing number of homes. Could there really be another medium to discover and to exploit?

It is quite obvious that conventional television is not suited to provide content that is specific to the individual screen, especially not if the content on the screen depends on where the screen is located or who is watching it. In an ideal digital signage system, the screen location, the time of day, or the actual viewer would decide that content. The TV set has one simple way of handling all this: The viewer simply switches the channel using a remote control device.

Digital signage means moving one step further in other respects as well. The content on the screen does not necessarily originate from one single source or channel, as in television broadcasting. Instead, the different picture components can originate from several separate data files in a manner similar to the content on your computer screen. Also, some content may be live broadcast in real time and other information may be stored on its way to the screen. The content may have been stored for a fraction of a second, a couple of minutes, hours, days, months, or perhaps even years.

DIGITAL SIGNAGE: A BRIEF DESCRIPTION

Digital signage is based on various methods of using computer and television screens (as well as other kinds of display devices) in ways that are as efficient as possible to provide advertising and information to people in public areas.

In modern digital signage systems, the screens are divided into regions and layers, and the content on the screens is made up of several files. Inside all this, there may be real-time streaming media as IPTV.
However, the content files and data streams are not enough. Information and instructions are needed to control how, where, and when the content files and streams are displayed on the screens. This control information is stored in scheduling and playlist files. Content files, data streams, scheduling, and playlist files are discussed further in Chapters 4 and 8.

Figure 1.3  The screen is divided into regions and all content does not necessarily originate from the same source.

Figure 1.4  Regions, layers, and tickers originating from separate files and IP streams are the basic digital signage screen content components.
How Is Digital Signage Different from Television?

When you watch television or listen to the radio, you are seeing a picture on the screen or hearing the sound from the speakers that originate from a single stream of analog or digital information. When you use your computer, the things you see on your screen do not originate from one single source of information but rather from a large number of files from a large number of providers. In most cases, this also applies to digital signage: modern electronic commercials and information in stores and public environments.

In radio and television, there are ready-made, live-transmitted signals that are processed by the receiving equipment and then presented to the listeners and viewers. The content on a digital signage screen may originate from several different data files. Each file represents the content in a specific region of the screen or in a specific layer or the text content of a ticker. However, this is not the only difference. Conventional broadcasting is based on real-time distribution. This is not necessarily the case in a digital signage system.

Of course, television today is often combined with non-real-time elements such as hard drive storage of programs. In conventional television, however, storing information in the distribution chain is not an automated process, even though a timing feature may be used for automatic recording when you are not able to make the recordings manually. Digital signage systems allow automatic content storage at several locations en route to the viewer. The stored content may also be updated at any time. (See Table 1.1.)

There is another significant difference between conventional radio and television broadcasting and digital signage. In both analog and digital broadcasting, the transmission formats and protocols are specifically designed to carry audio and video signals. In digital signage systems, the Internet Protocol (IP) is used to carry the files and the streams to their destinations. IP is not designed to carry any specific type of information, but it can be a carrier for any existing or future media. As a result, investments in the distribution infrastructure are more or less insensitive to changes in audio and video compressions standards and other transmission formats. And if someone should come up with something completely new, such as some kind of 3D display device, it is likely that an existing IP-based distribution system would be able to carry this content as well. The bitrate of an IP distribution channel can be easily increased to fit any future need.
Finally, there is another advantage to IP-based distribution: Local area networks exist almost everywhere. Even if there is no network available, it may be possible to quickly establish a wireless local area network (WLAN) for digital signage use. However, as we will explore later, WLANs are not suitable for all kinds of digital signage applications and must be used with some care.

In traditional broadcasting systems, IEC and F connectors are used for the coaxial cables carrying analog and digital TV signals. These TV broadcasting systems usually carry only audio and video, along with some metadata as teletext and program-related "event information." In an IP-based distribution system, twisted-pair cables
with RJ-45 connectors are used to carry IP Ethernet traffic (Figure 1.6). Using IP, which can carry any kind of information, the distribution part of the system becomes quite future-proof.

**How Is Digital Signage Different from a Web Site?**

So, digital signage is created from several kinds of files or IP media streams rather than just one ready-made, continuous live signal. Why, then, is digital signage not the same as the presentations of content that are bought to us when visiting a web site using a personal computer? Web site content is most certainly based on separate files and IP streams.

In digital signage systems, the content is presented to us in a more or less automatic way, just as it is with radio and television once we have selected the desired channel. We do not have to constantly request specific information. In digital signage systems, an automated process handles most things. The key elements of this handling are the schedules and the playlists.

The content is based on one or more files being combined into a complete message on a screen just as they are on the screen of a personal computer. However, just as with television, we do not have to work actively to get the message on the screen. That is done automatically. When surfing the Web, you actively fetch content from web sites by
selecting the pages you want to view. In digital signage systems, the content is automatically fetched from somewhere or, as we will see later in the book, it may be broadcast directly to a large number of users. In that respect, digital signage is much more like broadcast media than a web site.

But digital signage can also be configured to allow interaction between the user and the system. In some applications, the user can control the screen content by selecting or editing playlists. This could be compared to a TV viewer using a remote control device to change channels or select subtitling or alternative languages. Consequently, digital signage, like the museum information display in Figure 1.7, may be regarded as something between traditional TV broadcasting and Web browsing on the Internet.

Television and radio are old media that have been in stores for decades. Living in the shadow of home entertainment media, VCRs and CRT TV monitors have been used in the stores to provide commercials and product demonstrations closer to where the purchasing decisions really take place. Presenting products at the point of purchase (POP) is the core idea of digital signage.

Can digital signage be regarded as a new medium coexisting with radio, television, and the Internet? Or perhaps radio and television should be regarded as a part of the much larger medium of digital signage.

When television was first introduced, it was immediately regarded as a new medium, in addition to traditional radio broadcasting. But in reality, radio broadcasting is a part of the television medium because an audio signal (radio channel) is needed to carry the TV sound channel(s).

The same is true for digital signage systems that comprise audio, video, and all other kinds of information in real time, near-real time, and non-real time. These systems may make use of broadcast distribution and may then be regarded as a new kind of medium beyond television. Radio and television broadcasting may be regarded as a part of the new medium because one or more regions on a digital signage screen may be live IPTV broadcasts. Alternatively, the audio may be a real-time IP radio channel. This means we now have a new medium that encompasses live radio and television as well as real-time and non-real-time presentations of media files. An interesting point is that newspapers and other printed media are non-real-time
media and that digital signage methods may be used to integrate these with traditional broadcast media.

Digital signage is perhaps not the best name of this media because it encompasses much more than just digital signs. Digital signs are actually only one application of this kind of file- and IP-stream-based media. Today there is no appropriate name for this medium. A better name of this new medium would have been Digital Media
**Figure 1.8** If digital signage uses a broadcast transmission chain, it can be regarded as a new medium that encompasses traditional radio and television as well as the non-real-time possibilities available on the Web.

Broadcasting. However, DMB is already taken as an acronym for Digital Multimedia Broadcasting, used for terrestrial data broadcasting associated with digital radio.

In this book, we use digital signage as the name of the new medium. If a broadcast medium is used for distribution, it could be called digital signage broadcasting. In the future, this might be shortened to just signage broadcasting (since today’s technologies are all digital anyway). But digital signage and digital signage broadcasting will have to do for now.

## RETAIL APPLICATIONS FOR DIGITAL SIGNAGE

Digital signage could be used for any electronic signage or visualization application. However, it is evident that the most popular application today is for commercial and advertising purposes in stores and public areas such as railway stations and airports. There are both indoor and outdoor applications.

Today people are exposed to electronic advertising media primarily in their homes—watching commercials on TV or surfing the Internet. However, except for e-commerce and some TV shopping
accomplished by ordering the merchandise using the phone, both done at home, customers have not been exposed to much electronic advertising at the point of purchase, that is, in the stores.

With digital signage systems, it becomes possible to get electronic advertising—just like on the Internet—into the stores where the customers are making their purchasing decisions. This is important because it may be more efficient to reach consumers at the point of purchase. In the shops people are more focused on looking for products than when watching TV at home. And it is well known that a large portion of the purchase decisions are made right in the shops.

Accessibility of Internet Content

The Internet is very much a marketplace for commercial purposes and is filled with advertising. However, Internet information reaches the consumers only in their homes, at their workplaces, and possibly on their cell phones.

Figure 1.9 Digital signage in stores is a way to get the marketing and advertising information from the Internet out into the real world.
It seems quite strange that electronic media have been present in the homes for such a long time while printed media have completely dominated retail environments. Radio has been present in homes since the 1920s, and television has been the largest commercial medium in many countries since the late 1940s or early 1950s. Still, printed material is essential to reach people in their homes but the gap between the retail environment and the home environment when it comes to the use of electronic media is astounding.

Digital signage systems can move commercial content from the Internet into the stores. This is quite important because customers now often get more and better updated information from sources on the Internet than in the stores. But increased e-commerce comes at the expense of the retail industry. Therefore, getting Internet information to the brick-and-mortar stores as well is essential.

**Greater Control and Flexibility of Content**

Digital signage provides the possibility of changing the message all the time. The dynamics allow the content to be adapted to different hours of the day and other circumstances. Using suitable means of

![Figure 1.10](Hair_Spray.jpg)

*Figure 1.10* The image file Hair_Spray.jpg is simultaneously sent to all locations and shown on the screens according to playlists that are also downloaded to the screens.
distribution (see Chapters 5, 6, and 7) also allows near-real-time or live update of the content.

Finally, digital signage provides very accurate control of what appears on the screens. Printed signage has to be changed manually in the stores, making the advertiser dependent on the manual work of the staff to display the most current message. An even greater benefit to digital signage is that content on point-of-purchase screens can be changed simultaneously and automatically across a whole continent. This has never been possible before.

CURRENT HOME APPLICATIONS OF DIGITAL SIGNAGE–LIKE DEVICES

A technology similar to that used for digital signage is already in use in many homes without people really noticing its connection to digital signage systems in public environments. Many people collect their digital photos and video recordings in their computers rather than use more traditional ways of doing so (such as photo albums, videocassettes, and CDs). Separate media players are used to watch the photos and video stored in the computer.

The media players are used to bring video clips, digital photographs, and music to the TV set and the home cinema system. Of course, media players also exist in computers to play video files and music. These media players are based on the ability to play files and streams of many formats. They also include playlist features so the user can create slide shows and other presentations. The media players fetch files from a PC somewhere in the home via the local area network IP switch. Many of these media players are rather thin; they do not have a hard drive and depend on specific server software installed in the PC. Some media players also enable Internet access from the TV set.

The in-store applications for digital signage discussed in this book resemble these home media networks that consist of computers or other centralized storage, a home Ethernet IP network, and a variety of media players suited for different kinds of applications. As shown in Figure 1.11, the user can retrieve files from a PC in another room using the media player’s remote control. Then the files are combined
by the player to generate the final screen content. (In Chapter 12, we will dig deeper into how these present-day hardware and software media players might evolve into the home digital signage systems of tomorrow.)

The closest thing you can get to a home digital signage system today is a Home Theater PC (HTPC), which is a PC designed and equipped to provide easy access to television as well as digital files and the Internet. The only thing missing from such a system is the availability of content streams and files that are controlled by schedules and playlists that do not have to be created by the consumer. Today you simply have to be your own digital signage content provider. But that is about to change as completely new kinds of media providers begin to show up and capitalize on this new medium.

In the following chapters, I discuss the elements of digital signage as well as content management and distribution methods that are available today and how they seem to be evolving.
Every technology occupies a certain window in time. Most people have learned that it is essential to use the right technology in the right era.

The reason digital signage systems have become popular is very much due to the increasing availability of very thin, inexpensive, high-resolution screens that can display large pictures. These new display devices can be installed on any wall, anywhere. The future development of these display devices will also undoubtedly decide the success or failure of the digital signage medium.

How do you choose the right kind of digital signage display device? Today there are many kinds of display devices to choose from (see Figure 2.1). Before the plasmas and liquid crystal displays (LCDs), the only option was equipment that used a cathode-ray tube. There were some LCD projectors, but these only reached the required performance levels for digital signage applications quite recently.

One of the basic ideas of the digital signage medium is to divide the display area into regions, layers, and tickers, and this requires a large screen in order to offer content that is reasonably easy to read or view. And to fit a large screen into a store or home, it has to be quite thin.

This chapter focuses on the display options and applications that are most suitable for each alternative.
CATHODE-RAY TUBES

In stores, conventional TV sets have been used for a long time to make product presentations, but cathode-ray tube (CRT) TV sets (Figure 2.2) are heavy and bulky. Therefore, they have only been used when absolutely necessary and with suitable stands or shelves to get these ugly devices into the retail environment. These ordinary TV sets that are used to display demonstration videos on a VCR are regarded as the first electronic (though not digital) signage display appliance. To use VHS-based systems for in-store signage purposes, it was necessary to rewind the tape again and again. The idea of using multiple recordings on a tape combined with an autoreverse capability to repeat the commercial message was the predecessor of the playlists that can be considered as the fundamental core of any digital signage application.

CRTs and TV sets have also been used for live coverage of horse racing and other sports in gaming parlors around the world (Figure 2.3).
Cathode-ray tubes are based on electron guns (A) that generate beams of electrons (B) propagating in a vacuum toward a surface of zinc sulfide where light is radiated as a result of the collision between the electrons and the sulfide.

The conventional CRT-based TV set and VCR were combined to present the first electronic display appliances for product demonstrations in stores and presentations of live events such as horse races in gaming parlors.

CRTs do not have an easy life these days. The competition with LCDs, plasma screens, and projection systems will probably be impossible to beat in the long run. However, new slim CRTs have been developed that might make it possible for this technology to survive. Until now (2008), however, these new display devices are not yet competitive in the market.
One thing is clear: The market wants thin display systems that are easy to put on any wall and that do not occupy much space. The display device has to be able to provide a large picture with a sufficient contrast ratio during daylight conditions.

**FLAT-PANEL DISPLAYS**

Flat-panel display systems have opened up many new ways to use digital media in stores. In contrast to the bulky CRT-based displays, flat-panel displays give an awesome impression and improve the atmosphere in the store.

**Liquid Crystal Display Panels**

For screen diagonals smaller than 40 inches (102 cm), the liquid crystal displays are the most cost-efficient flat-panel displays. As shown in Figure 2.4, LCDs are based on a large fluorescent white light source in front of which there is a filter that provides polarized light. In front of this filter is a grid of tiny pixel-sized liquid crystals that can be electrically prodded to twist the polarized light to the same polarization angle as the second polarization filter. In this way, the light is either allowed to pass through or not. Additional filters give the pixels their red, green, and blue colors.

The LCD screens are popular because they are very insensitive to burn-in effects, which can be caused by the sometimes static content used for digital signage. (In the long run, still pictures and graphics may cause burn-in effects in virtually any type of display; smart digital signage managers will design their content to change occasionally to avoid this.)

In comparison to the competing technology of plasma flat-panel displays, it is easier to make tiny pixels and achieve high resolution on an LCD. On the other hand, the contrast ratios are usually better for plasma display systems.

**Thin Film Transistor LCDs**

Unlike television, digital signage does not rely completely on display devices that are specifically made for television. Computer monitors can also be used. As discussed in Chapter 4, media players have
Figure 2.4 The basic LCD flat-panel display design.
video interfaces other than television set-top boxes; they are actually computers. Therefore, conventional flat-panel computer screens are used for applications where smaller screens are needed.

The most common type of computer screen is the thin film transistor (TFT), which works in a similar way to TV LCD displays. Today’s TV LCD displays, however, are of the same class as computer monitor LCDs.

One thing to remember is that computer TFT screens do not always have the 16:9 aspect ratios that are normal in TV-type displays. The screen may be narrower than a standard aspect ratio television display. This will affect the kind of applications that the screens can support. In digital signage applications, the computer TFT LCDs are often installed in portrait rather than landscape position (Figure 2.5).

Interactivity can be added with touch-sensitive screens (Figure 2.6). They can be added quite easily to the smaller TFT screens. There are four basic kinds of touch-sensitive screen: resistive, capacitive, acoustic surface wave–based, and infrared light–based touch screens. All these touch-screen-sensing technologies determine the coordinates on the screen where the user places a finger. These X and Y coordinates are connected to various actions within the

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**Figure 2.5** For applications that require screen sizes smaller than 26 inches (66 cm), general computer TFT screens are often used.
software of the interactive application, such as zooming in on a product image or selecting different content to view.

**Plasma Screens**

For 42-inch (107 cm) and larger screens, plasma display systems are the most popular for digital signage just as they are for television.

Plasma flat-panel displays consist of small pixel-sized cells containing ionized gas that glows when an electrical field is built up around it by a grid of electrodes. Each pixel actually consists of three fluorescent lamps: one red, one green, and one blue (Figure 2.7).

Plasma screens have a high contrast ratio and are therefore suitable for store environments. The improved contrast ratio is possible because each pixel can be completely shut off and appear completely

**Figure 2.6** Touch-screen displays make it possible for customers to interact with media players without a keyboard or mouse.