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Digital Signage Application

Developing a Public Venue Multimedia Touch-Screen

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Abstract

Digital signage is a relatively young technology in which the engineering and advertising come together to achieve a common goal in the market. As any business is always looking for gain benefits and that is why WeeGee museum introduce a digital signage system based on touch-screen.

Metropolia university has a group of developers to carry out the task of creating software and application design. For this purpose, a thorough knowledge of digital signage and the technology is needed. In addition, knowledges acquired during the years of study are put into practice.

A group of engineers aim at developing a software capable of operating a touch-screen application for a temporary exhibition of the WeeGee museum, taking into account customer needs and providing maximum utility and ease of use.

The project can be considered as an introduction to the technology used in digital signage. It also has a practical application that demonstrates the advantages provided by multimedia technology in public places to attract user attention, which ultimately is the most important aspiration of digital signage.
Resumen

La señalización digital o digital signage es una tecnología de comunicaciones digital que se está usando en los últimos años para reemplazar a la antigua publicidad impresa.
Esta tecnología mejora la presentación y promoción de los productos anunciados, así como facilita el intercambio de información gracias a su colocación en lugares públicos o al aire libre. Las aplicaciones con las que cuenta este nuevo método de publicidad son muy variadas, ya que pueden variar desde ambientes privados en empresas, hasta lugares públicos como centros comerciales. Aunque la primera y principal utilidad de la señalización digital es la publicidad para que el usuario sienta una necesidad de adquirir productos, también la posibilidad de ofrecer más información sobre determinados artículos a través de las nuevas tecnologías es muy importante en este campo.

La aplicación realizada en este proyecto es el desarrollo de un programa en Adobe Flash a través de lenguaje de programación XML. A través de una pantalla táctil, el usuario de un museo puede interactivamente acceder a un menú en el que aparecen los diferentes estilos de arte en un determinado tiempo de la historia. A través de una línea de tiempo se puede acceder a información sobre cada objeto que esté expuesto en la exhibición. Además se pueden observar imágenes de los detalles más importantes del objeto que no pueden ser vistos a simple vista, ya que no está permitido manipularlos. El empleo de la pantalla interactiva sirve para el usuario de la exhibición como una herramienta extra para recabar información sobre lo que está viendo, a través de una tecnología nueva y fácil de usar para todo el mundo, ya que solo se necesita usar las propias manos. La facilidad de manejo en aplicaciones como estas es muy importante, ya que el usuario final puede no tener conocimientos tecnológicos por lo que la información debe darse claramente.

Como conclusión, se puede decir que digital signage es un mercado que está en expansión y que las empresas deben invertir en el desarrollo de contenidos, ya que las tecnologías avanzan aunque el digital signage no lo haga, y este sector podría ser muy útil en un futuro no muy lejano, ya que la información que es capaz de transmitir al espectador en todos los lugares es mucho más válida y útil que la proporcionada por un simple póster impreso en una valla publicitaria.
Abstract

The Digital signage is a digital communications technology being used in recent years to replace the old advertising printed.

This technology improves the presentation and promotion of the advertised products, and makes easy the exchange of information with its placement in public places or outdoors. The applications that account this new method of advertising are several; they can range from private rooms in companies, to public places like malls. Although the first major utility of Digital signage is the advertising that makes the user feel and need of purchasing products. In addition, the chance of providing more information about certain items through new technologies is very important in this field.

The application made in this project is the development of a program in Adobe Flash via XML programming language. Through a touch-screen, a museum user can interactively access a menu in which different styles of art in a particular time in history appears. Through a timeline you can access to information about each object that is exposed on display. Also you can see pictures of the most important details of the object that can not be seen with the naked eye, since it is not allowed to manipulate it. The use of the interactive screen serves to the user exhibition as an extra tool to gather information about what is seeing through a new technology and easy to use for everyone, since only need to use one’s own hands. The ease of handling in applications such as this is very important as the end user may not have expertise technology so the information should be clearly.

As conclusion, one can say digital signage is an expansion market and companies must invest in content development, as although digital technologies advance digital signage does not, and this sector could be very useful in a near future, because information that is able of transmitting the everywhere viewer is much more valid and useful than that provided by a simple printed poster on a billboard.
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1 Introduction

Digital signage is a multimedia digital communications technology that is increasingly replacing the old printed advertising. Based on the use of technologies that have been emerging in recent years, digital signage is spreading to all branches of business, both public or private, to provide additional information to the user and even create a certain interest for some products.

The technology used in this wide market starts on the display, which is the element that the user will see and ultimately the most important part of the chain. But for the images to reach the screen, they must first pass series of processes. Firstly, through a CPU or media player, and then the signal must reach these devices, which can be done in several ways. It should be kept in mind that in the digital world there are several standards for the same use and compatibility problems may exist, therefore it will deepen in the more theoretical study of this technology.

Digital signage is a technology that is constantly evolving, and each day new applications and new technologies appear to grow its distribution in the market for advertising and marketing.

In this thesis, an application of digital signage will be introduced and studied from a theoretical point of view. This is the application of touch-screens in a temporary exhibition for a museum. This application includes business, as it is an agreement between a client (WeeGee museum) and a provider of digital technology (Metropolitan University) as the technology industry as a group of engineers are developing the application using the resources at their disposal.

For this application a preliminary study with the client to reach an agreement on how the project is focused on the design, usability and interaction should be done. The technical team is responsible for providing the theoretical and the software necessary to the application to run correctly according to customer needs. This way is concluded the study of digital signage development and implementation of a public multimedia touch-screen venue.
2 What is Digital Signage

Digital signage is a digital communication media that is consumed by people who are away from home and that is installed as a mass medium. “Narrowcasting”, “screen media”, “place-based media”, “digital merchandising”, “digital media networks”, “digital out-of-home” or “captive audience networks”, which are other ways to talk about digital signage, offer the possibility to spread advertising or information by using television screens, computers and other kinds of devices. [1]

Outdoor advertising can be considered the predecessor to digital signage, because it uses public places to develop itself and is driven to an indefinite public. In addition, it is a means aimed at people in motion, usually on land-transport routes, and public places. Are formed by so-called billboards, verbal advertisements, by advertising affixed to mass transportation, for ads placed where passengers waiting to board and those that are placed inside malls. But there are some disadvantages compared to the digital signage, such as [1]:

- Outdoor advertising is a means limited. It is summarized in a visual impact, does not support long sales pitch not even an adequate presentation of the product.
- Low level of attention. People do not look at the posters and other visual impacts, they just glance at them.
- You can not focus on a particular audience segment. You could say that outdoor advertising is addressed to all people in general and none in particular.
- Problems of location. It is complex to choose the best locations that are often taken over by the big advertisers.
- The impact on the purchase or product or brand recognition is difficult to measure.

Digital technology is increasingly replacing traditional outdoor advertising to improve the presentation and promotion of products, to display information or to facilitate interaction with the content. In addition, presenting content dynamically instead of static, allows creating a network of audiovisual systems with content updated daily. For the use of these systems a combination of hardware, special software for the player and content management is used, Internet connectivity or other technology that enables remote updating, such as both 3G, Satellite, or ADSL are also applied.
2.1 Applications

Digital signage is a booming area and is used for different purposes. The list is growing every day.

- It is possible to find digital signage providing public information, such as news, local, weather or traveler information [2].
- In companies, digital signage can be used to show internal information, such as corporate messages, health & safety, news, etc.
- In public places, digital signage is useful in advertising, either related to the location the signage is in or just using the screens for general advertising.
- Digital signage is a means to get a brand building, either in-store digital signage to promote the brand or to build a brand identity.
- Advertising has always been used for influencing customer behaviour. It is possible to direct customers to different areas and increasing the dwell time on the store premises. [3]

But the most important application of digital signage is enhancing the customer experience. These applications are included in the reduction of perceived wait time in restaurant waiting areas, bank queues, etc., as well as recipe demonstrations in food stores. Enhancing the environment with interactive screens or with dynamic wayfinding may also help. [4]

There is no limit to where it is possible to apply this new technology. Digital signage can be used almost everywhere where it is necessary to inform and promote better communication and reduce costs.

2.2 Technology

For the installation of a digital signage system several components, both in computer and conceptual level are necessary.

2.2.1 Hardware

When designing a digital signage application the first step is choosing a screen, in which information and data appear. But one screen requires a PC or a media player to handle the actions to take, determine what information must appear at each moment and where on the screen. It should appear in systems that use internet to keep updated
information also other systems such as servers to store data and use the maximum bandwidth of the network are needed. Other devices to extend an internal network and to get the signal to reach all the devices of the same company are also needed. Modems can also be necessary in any digital signage application for a satellite communication, since it requires special equipment so that the data is decoded and processed.

2.2.2 Software

The production and specially the content management works with the help of special software such as media players, responsible for making playlists and manage schedules programs that handle different content to be played at different times. The distribution of content (text, animations, videos, pictures...) is done via internet to reach its destination. The point of sale, point of information, advertising screen and many other issues must be analyzed.

3 Display Devices

It must be clear that the most important part of digital signage is the screen, since the information will be exposed on it to attract the attention of the population. But technology has advanced not only on the screens. The rest of devices used in digital signage have reached a complexity and variety that deserve further study. This can provide an overview of the capacity offered nowadays by a digital signage application such as being able to display information in near-real-time and even real-time.

Today, thanks to the development and emergence of increasingly fine screens and high resolution, digital signage has emerged and is becoming one of the most widely used means of signage. Digital signage can be used in a wide range of displays, as introduced below.

3.1 Cathode Ray Tubes

The cathode ray tube (CRT) was the first image display device, and it has been used on TV for a long time. It consist of an electronic valve in which an electron beam is focused onto a small area of a light emitting surface that is the screen and the intensity and position on it can vary. The main objective in the design of a CRT television is producing an image with good brightness and high contrast, something very necessary
in outdoors applications, as screens with a low brightness do not allow good visualization in the daylight.

When the electron beam hits the inside of the tube coated with luminescent material, emitted light is distributed approximately 50% reflected back into the tube. 20% is lost by internal reflection in the glass tube itself and last 30% is emitted to the front where the observer stands. [5]

As seen from the above approximate figures, the process is very little efficient as only one third of the emitted light reaches the observer and also the contrast is degraded by light that is reflected back to the screen after reaching other points inside the tube itself. The solution to this problem is the use of flat-panel screens in whose development has progressed considerably in the last years so as cathode ray tube displays are no longer used neither on TV nor digital signage.

3.2 Flat-Panel Screens

Flat-panel screens have become popular in recent years, occupying less space and are less heavy than traditional CRT devices. In addition, the technology used by flat-panel screen typically use less energy and emits less electromagnetic radiation, which has wide acceptance by the market, resulting in nearly complete disappearance of CRT technology. There are several types of flat screen that coexist in the market, since each has different properties, advantages and disadvantages.

3.2.1 Liquid Crystal Displays

The Liquid Crystal Display (LCD) is a trans-missive display system because the light produced by a fixed font back, crosses the screen where it is processed. At each pixel are helical liquid crystal molecules that react in a predictable electric shock. When these molecules are activated, they rotate, allowing it to pass more or less light to create the entire grayscale. Then, the color is achieved by using colored filters.
3.2.2 Plasma Displays

Plasma Display Panel or plasma screen is a flat display in which the light is created by phosphors, red, green and blue excited by an electric shock. The combustion results in a combination of noble gases that are injected in small sealed cells, passing to plasma state when they are activated by electrodes.

This is, like the traditional CRT, a technology that emits its own light. They permit to visualize a very wide range of colors and can be manufactured in large enough sizes. They are able to reproduce the black color with very little light, thereby creating a black color which is more desirable for watching movies. Although invented in 1964, this technology is quite behind in terms of level of implementation because of its price, but its quality is better.

3.2.3 Thin Film Transistor LCDs

Thin Film Transistor-Liquid Crystal Display (TFT-LCD) is a variant of LCD technology that uses TFT to improve picture quality. TFT-LCDs are one type of active matrix LCD, though this is usually synonymous with LCD. They are used in television and are commonly available in sizes from 12 to 30 inches. [6]

3.2.4 Organic Light-Emitting Diode Displays

An organic diode of light emission, also known as OLED, is a diode that is based on an electroluminescent layer formed by a film of organic compounds that react with a particular electrical stimulation, generating and emitting light by themselves.

OLED technology can be used in all types of applications: television displays, computer screen, displays of portable devices (mobile phones, PDAs, MP3 players...), indicators or warning information, etc., with formats that under any design will range from quite small to huge sizes. OLED displays can also create large or small advertising signs, as well as light sources for general illumination, which is a breakthrough for the emergence of digital signage in public places. In addition, some OLED technologies have the ability to have a flexible structure, which has already led to develop folding screens or shutters and in the future, perhaps on garments and textiles. [7]
3.2.5 Differences between devices

It is necessary to study the differences between display products on the market, because for each digital signage application may be required a different screen, which promotes competition among manufacturers and the development of the newest technology.

- **Contrast.** The contrast is the ratio of brightness between the white and black that can offer an image simultaneously. This information is provided as two numbers, separated by the symbol of the colon, where the second digit is always one, as in this example: 10000:1. The higher the contrast ratio, the more pronounced is the difference between the "whitest white" and the "blackest black" that a display can play and is therefore, better. [8]

  The Plasma has clearly the best contrast due to its ability to produce a deep black. The LCDs is only capable of generating very dark grey, and the OLEDs directly emit light. Therefore, OLEDs compared to LCDs allow a greater range of colors and contrast. [8]

- **Brightness.** The brightness is the luminous flow measured in a certain direction. As with the contrast, the numbers provided by the producers must be taken into account with many reservations as it is difficult to extrapolate to the home environment.

  Normally, it is considered that the LCD offers a brighter image and intense at high brightness in the environment, as in a store or a station. The plasma, in turn, performs better with warm and precise colors, in darker environments. The fact is that in retail outlet with high fluorescent lighting seems to detract from the plasma compared to LCD, but the sensation varies in duller environments. [8]

- **Viewing Angle.** It is not uncommon that in the characteristics of an LCD the viewing angle that promise to be of 170 degrees. It is true that the image can come to appreciate if we list up these levels, but results are very poor, neither brightness, nor color nor contrast. More important than the theoretical
maximum viewing angle is the maximum angle of view from which the screen may be seen in good condition. [9]

The plasma is, to date, clearly better than LCD in relation to the viewing angle. However, LCD technology is improving constantly to ensure that this superiority will be gradually diluted. [9]

Then in Table 1, can be seen the advantages and disadvantages between display technologies currently [10]:

<table>
<thead>
<tr>
<th></th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TFT-LCD</strong></td>
<td>Long life</td>
<td>Contrast</td>
</tr>
<tr>
<td></td>
<td>Sharp Images</td>
<td>Color definition</td>
</tr>
<tr>
<td></td>
<td>Vivid colors</td>
<td>Few colors</td>
</tr>
<tr>
<td></td>
<td>High resolution</td>
<td>Viewing angle</td>
</tr>
<tr>
<td></td>
<td>Reduced production cost</td>
<td>Refresh time</td>
</tr>
<tr>
<td></td>
<td>Save of energy</td>
<td></td>
</tr>
<tr>
<td><strong>Plasma</strong></td>
<td>Contrast</td>
<td>Short life</td>
</tr>
<tr>
<td></td>
<td>Viewing angle</td>
<td>High production costs</td>
</tr>
<tr>
<td></td>
<td>Refresh time</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No mercury</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Soft colors</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Color accuracy</td>
<td></td>
</tr>
<tr>
<td><strong>OLED</strong></td>
<td>Flexible and thin</td>
<td>Short life</td>
</tr>
<tr>
<td></td>
<td>Reduced production cost</td>
<td>Manufacturing process</td>
</tr>
<tr>
<td></td>
<td>Save of energy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Large size of screens</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Range of colors</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Contrast and brightness</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Viewing angle</td>
<td></td>
</tr>
</tbody>
</table>

As you can see, each type of screen has characteristics that make it different from the others. Therefore, a digital signage provider should consider either where the screens will be placed or the luminosity necessary for that place or even the ability to withstand adverse weather conditions, among others.
3.3 Projectors

The projectors are another way to implement digital signage technology. Using a projector is the cheapest way to generate a large image. The only two requirements are the projector and a wall on which to project the image. Nowadays, there are two competing technologies in terms of projectors, LCD and digital light processing.

3.3.1 LCD Projectors

In this technology, the light is divided into three and passed through three LCD panels, one for each primary color (red, green and blue), and finally the images are recomposed into a single image, made up of pixels, and are projected on the wall or place chosen using a lens.

3.3.2 Digital Light-Processing Projectors

The technology Digital Light-Processing (DLP) uses a chip Digital Micro-mirror Device (DMD), thousands of tiny mirrors, electrically controlled. These mirrors form a matrix of pixels and each one can pass or no light on the screen, the style of a switch. The light that reaches each micro-mirror has previously undergone a color wheel, which has to be synchronized electromechanically with each pixel color is going to represent. In Table 2 are shown the characteristics of the previous kind of projectors [11]:

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCD Projector</td>
<td>More efficient than DLP</td>
</tr>
<tr>
<td></td>
<td>Brighter images</td>
</tr>
<tr>
<td></td>
<td>High saturated colors</td>
</tr>
<tr>
<td>DLP Projector</td>
<td>Color reproduction</td>
</tr>
<tr>
<td></td>
<td>High contrast level</td>
</tr>
<tr>
<td></td>
<td>Low weight</td>
</tr>
<tr>
<td></td>
<td>Lamp life long</td>
</tr>
<tr>
<td></td>
<td>Competitive prices</td>
</tr>
</tbody>
</table>
As in the case of normal screens, projectors have different characteristics that limit their use to a particular environment. Moreover, the possibility of transporting the equipment can make that a particular digital signage provider choose the product or not. As well as the dead pixels rate, are parameters that the customer must know before opting for one system or another.

3.4 LED Outdoors

A relatively new form of digital signage in outdoor applications is the use of LED technology, with which can be created large screens with backlight that makes it very ideal for viewing during both the day and night.

A LED display is a video device that uses LEDs placing them in the form of an array using diodes of different RGB colors to form the pixel. For each of the LED displays shine more or less dynamically was developed a technology known as dynamic pixel technology, which offers a higher resolution image. Thus, there are pixels and sub-pixels formed entirely by LEDs green, red and blue, getting through the mixture or combinations of these the more than 16,000 million colors. [12]

These displays satisfy all the features and advantages of this technology, because of are made from LED. Outdoor displays are the brightest and easiest to read under sunlight. They consist of modules that allow their expansion. In itself, these screens are incredibly resistant to shock, which determined that are used on billboards in stadiums, where both shock and environmental exposure are outweighed disadvantages by such screens. But they can be used also in outdoor video screens, advertising displays, big screens for all types of events, and every day more in television studios.

3.5 Electronic paper

Electronic paper is a technology that allows to create flat panel displays, as thin as paper, and with a flexibility that allows them to be rolled. These screens represent information in black and white and can not display moving images. The electronic ink technology tries to solve some problems for TFT-LCD such as the small size, poor handling and reduced range of vision. The screens are made of three layers, one with electric Micro-transmitter, another with polymer and the third with a protective film. In the polymer matrix are a million capsules that are floating in a gel that allows them to be stimulated electromagnetically. Through this stimulation each capsule goes on to show his face white or black, so the display shows a text or graphic. [13]
The concept of electronic paper itself does not have great applications for digital signage, but the big high-technology electronics companies have used the idea of flexible electronic paper to develop new opportunities in broadcast industry and therefore, digital signage.

For example, Samsung Incorporation has recently introduced transparent flexible displays in 4.5-inch and 19-inch developed based on the electronic paper technique. The 4.5-inch display has a resolution sufficient for television, 800x480, is made of a plastic substrate which facilitates the flexibility of the material and may be rolled getting one-centimeter radius. The 19-inch display has a transparency of 30% when the market average is around 10%. This screen has a resolution of 3840x2160 pixels with an aspect ratio of 16:9. Table 3 shows the state of the electronic paper technology today, with its advantages and disadvantages. [14]

Table 3. Characteristics of electronic paper devices.

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronic paper</td>
<td>Expensive color displays</td>
</tr>
<tr>
<td>Not require backlighting</td>
<td>Refresh rate is not high</td>
</tr>
<tr>
<td>Brighter than TFT-LCD</td>
<td></td>
</tr>
<tr>
<td>Save of energy</td>
<td></td>
</tr>
<tr>
<td>Not necessary voltage to get image on screen once represented (just text)</td>
<td></td>
</tr>
</tbody>
</table>

Innovations that audiovisual companies are causing suggest a future of digital signage adapted to everyone. Maybe thinking about cards that can be updated automatically will not be a dream, and even be used to find information via Internet.

3.6 Touch-Screen Displays

The development of digital digital displays has created a new alternative in digital signage, this is, the capability of the user to interact with the screen and get relevant information depending on the required application.

A touch-screen is a display that tapping directly on the surface allows the entry of data and commands to the device. In addition, it acts as output device, showing the results previously entered. This contact can also be done with pencil or similar tools. Currently
there are touch-screens that can be installed on a normal screen. Thus, the touch screen can act as a peripheral data input / output device.

Touch-screens have become common in both PDAs and ATMs. The popularity of smart phones or car GPSs is generating demand and acceptance of touch-screens. This technology is popular in private and public situations, such as museum exhibitions as in the application in the WeeGee museum, where normal input interfaces do not allow a successful interaction, intuitive, fast, and accurate of the user with the content of the exhibition.

There are different implementations of touch-screen devices depending on the technology used.

3.6.1 Resistive

A resistive touch-screen consists of different layers. Two of the most important are thin layers of conductive material between which there is a small gap. When an object touches the surface of the outer layer, the two conductive layers come into contact at a particular point. This will produce a change in electrical current that allows a driver to calculate the position of the point at which the screen has been touched by measuring the resistance. Some screens can measure, apart from the coordinates of contact, the pressure that has been exerted on it. [15]

These kinds of touch-screens are as a rule more accessible but have a loss of approximately 25% of brightness due to the multiple layers required. Another disadvantage is that they can be damaged by sharp objects. By contrast they are not affected by external factors such as dust or water and that is why this type of touch-screens is the most commonly used today. [15]

3.6.2 Surface Acoustic Wave

The surface acoustic wave technology (SAW) uses ultrasonic waves that pass within the touch-screen. When the screen is touched, a portion of the wave is absorbed. This change in the ultrasonic wave allows detecting the position which has touched the screen and sending it to the controller to process it. [16]
The operation of these screens can be affected by external factors. The presence of contaminants on the surface can also interfere with the operation of the touch-screen. But the quick development of this technology offers new features to enhance their resistance to the environment. Thus, pure glass touch-screen devices have appeared which offer better image clarity, high resolution and no change in color. The glass covering the image is durable and may keep running even with scratches. New features are added every day, either special non-glare treatment, or the development of techniques that avoid interferences caused by the weather or electromagnetic fields.

3.6.3 Capacitive

A capacitive touch-screen is another kind of display that works in the next way: The screen is coated with a material, typically indium oxide and tin that conducts a continuous electrical current across a sensor. The sensor therefore shows a field of electrons precisely controlled in both vertical and horizontal, that is, acquires capacitance. The human body can also be considered an electrical device inside which there are electrons and therefore also has capacitance. When the normal field capacitance sensor is altered by another capacitance field, such as a finger of a person, electronic circuits on the screen start to determine which point has been touched through sinusoidal waves and send the information to process it mathematically. [17]

Capacitive sensors must be touched with a conductive device in direct contact with the hand or a finger, unlike resistive screens or surface wave in which you can use any object. Capacitive touch-screens cannot be affected by elements of the environment, but its complex signal processing makes their cost is high. The major advantage of on resistive displays is its high sensitivity and quality.

These three kinds of touch-screens are the most widely used, but besides these there are others such as infrared, optical imaging, dispersive signal technology and acoustic press recognition.

3.6.4
Differences

From the user point of view is useful to study the differences between the most used touch-screen devices. Table 4 shows a complete comparison between resistive and capacitive touch-screens.

Table 4. Characteristics of touch-screen devices [18].

<table>
<thead>
<tr>
<th></th>
<th>Resistive</th>
<th>Capacitive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor visibility</td>
<td>Usually very good</td>
<td>Usually very good</td>
</tr>
<tr>
<td>Outdoor visibility</td>
<td>Usually bad, by the extra layers on the screen</td>
<td>Usually very good</td>
</tr>
<tr>
<td>Pressure</td>
<td>Required, either finger, stylus, gloves or nails</td>
<td>Rubbing of the skin is enough to activate the sensor</td>
</tr>
<tr>
<td>Precision</td>
<td>Very precise</td>
<td>Accurate within a pixel group, by size of the fingers</td>
</tr>
<tr>
<td>Cost</td>
<td>Good price</td>
<td>More expensive</td>
</tr>
<tr>
<td>Multi-touch</td>
<td>Impossible unless redesign the operation of sensors</td>
<td>Depends on the software, the screen allows it</td>
</tr>
<tr>
<td>Duration</td>
<td>Normal damages and may require recalibration</td>
<td>More resistant to scratches, but glass may shatter in a strong blow</td>
</tr>
</tbody>
</table>

As in flat panel displays, in touch-screens may be chosen the appropriate technology for each application needed, considering the positioning of the display, outdoor or indoor, windows in stores, shopping malls…

4 Contents on the display

The main and most important improvement of the displays used in digital signage over traditional advertising poster and billboards lies in the versatility of the screens to provide content in motion, that is, images that change depending on the user, the place where you are or even time of day which you are. Therefore, it should make the
best of the capacity of the screens to introduce layers, which can be inserted images in
different formats, either static, or video or text.

After studying the kinds of available displays on the market, next natural step is to
determine what should appear on these screens, what kind of images and for what
purpose. Besides being able to use different formats, different content may be inserted
to make the experience more complete. We can distinguish two kinds of regions on the
screen: dynamics and fixed regions, and is possible to find them at the same time on
the display.

4.1 Dynamic regions

The dynamic region provides content, such as the word indicates, in motion. Digital
signage includes animation, video, either in real time or non-real time, or audio signals
to improve the user experience. To create exciting applications for digital signage is
possible add real-time signal as in television through IPTV technology combined with
still or dynamic regions, and create a playlist that can be modified depending on the
users.

4.2 Fixed regions

The regions of the screen should be used to get the most of them. In addition, still
images can be used to improve advertising in certain establishments. Thus, there may
be a still image from time to time, creating a dynamic environment without having to
use animation or video, but providing maximum information to the user. Other method
in the fixed region is the use of tickers that might be used to provide additional
information about the product in a store or on TV to provide the latest information.
[19, 51-54]

4.3 Interactivity

Using large touch-screens is possible to generate active communication with
consumers. These may access intuitively through menus to multimedia content such as
text, images, audio or video.

This digital communication mode is complemented by the possibility that the client may
download the content they are seeing on the screen to their cell phone via Bluetooth
technology. This content can be the map of the site you're visiting, shopping mall, museum or similar, or discount coupons or loyalty content.

5 The CPU or media player

Media Player is a digital content transmission device that sends such information to be displayed on screens like LCD monitors, plasma screens and LED panels. In addition to presenting content dynamically instead of static, it allows to create a network of audiovisual systems with content updated daily. For the use of these systems is used a combination of hardware, special software for the player and content management, Internet connectivity or other technology that enables remote updating, such as UMTS.

There is no limit where is possible to apply this new technology. Almost everywhere where people need to inform and promote better communication and reduce costs using a digital signage system.

The media players must have a sufficient number of filters and decoders for the signal may be decompressed and thus display a large number of different file formats, either video or animation, or images or audio files.

5.1 Media Player Interfaces

One of the most important questions that a customer must be done when choosing a digital signage system, and specifically to decide which media player to use, is to check that the system will be compatible with respect to future applications, and this is achieved through interfaces. In recent times we are experiencing a transition from analog to digital, which means that device manufacturers of high quality media player include both interfaces in their products, while the more outdated devices have fewer features that allow its diversity use.

5.1.1 Output Interfaces

The output interfaces of a media player can vary between analog and digital, analog being the most widespread since that have seen years of use, and digital newer and better performance but less widespread since its implementation and standardization is not always easy due to the strong competition in the industry [19]. Now different types
of output interfaces with their characteristics and possible improvements that may be introduced to digital signage will be developed.

VGA

The VGA, which means Video Graphics Array has been one of the most popular color platforms of all the time that would be relatively recently replaced by new, more modern compositions. The VGA is implemented as a single chip separated from the rest rather than requiring a variety of smaller chips. Thus, the VGA could be installed directly on the computer mother space and simplify its assembly. [20]

In addition, VGA interface, in its resolution of 640 x 480 pixels allow to obtain a color palette more both diverse and complete that other mediums. It contains 16 basic colors and 256 color modes which in turn generate a number of 262144 values of the color palette. Later appeared the Super VGA, that in its first version supported a resolution of 800 x 600 pixels and a palette of 16.7 million colors (True Color), but the number of colors that can simultaneously display was limited by the amount of video memory installed in the system. Then it was followed by a version of 1024 x 768 pixels. As consideration VGA works internally with digital signal but outside offers and receives analog video signal. [20]

DVI

DVI comes from Digital Visual Interface and it is a semi-rectangular connector with 24 or 29 terminals, which then sends signals relating to the graphics from one computer to a screen to be displayed for the user. By the fact of allowing the sending of data between an external device (peripheral) and the computer, is called port. This port is designed to maximize the visual quality of video devices with flat screen, such as LCD screens, plasma screens and video projectors. In addition, DVI has the potential of Plug&Play, this is, just connecting the device to the computer it automatically runs without installing drivers. [21]
HDMI

In the last years, HDMI or High Definition Multimedia Interface is the most widely used connector for audio and video applications. This interface is trying to unify all the media components with just a single cable. HDMI has a limit of 5 Gbps bandwidth, quite enough if we consider the bandwidth of the HDTV that is just 2.2 Gbps. The most advantages of this system are the compatibility with the new future technologies and the replacement of the entire analog signals as well as HDTV digital signals.

To HDMI 1.0 maximum pixel clock rate is 165 MHz, which could have a 1080p image at 60 Hz. Later, appears HDMI 1.3 increased the rate to 340 MHz, allowing resolutions up to 2560x1600. [22]

Other Output Interfaces

There are many more output interfaces in a media player, but the most important today and in the future have been discussed earlier. Digital technology will of course be present and future of digital signage, is therefore misplaced the explanation of ancient analog interfaces including S-Video, RGB Components, Composite CVBS, RS-232 ports or Y-Pb-Pr connection, although there may be most of the systems that still use these connections because of the compatibility.

Analog Audio

The same problem exists in terms of the analog audio. This technology is becoming outdated and is increasingly used the digital technology, as the bandwidth and the usefulness of this makes the analog audio as RCA connectors, SCART connectors is in the background.

S/PDIF

The standard S/PDIF or Sony/Philips Digital Interface is the most common digital transfer format of audio data. S/PDIF is used to store digital audio media such as DAT (Digital Audio Tape) or to manipulate it with audio playback devices. The main advantage of S/PDIF is its capability to transfer sound between two digital audio
devices without using an analog connection that would reduce the quality. An audio signal S/PDIF encoded suffers no attenuation or distortion and can be transferred without loss.

The standard S/PDIF supports the following sampling rates: 44.1 kHz for a CD, a 48 kHz and 32 kHz DAT tape to DSR (Digital Satellite Receiver). In practice, most devices (like sound cards, CD and DVD players, amplifiers, 5.1, etc.) come with an RCA plug, as it is both the most famous and traditional way to transmit audio signals.

5.1.2 Input Interfaces

The most used input interface in digital signage is the RJ-45 cable because it is the most extended technology so far to transmit data over local area networks and Internet, due to its bandwidth and that allows a high transmission speed. RJ-45 is commonly used 8-pin (4 pairs) and the transmission speed goes up to 1000Mbps, transporting IP packets in Ethernet network cables. Somehow everything that exists on the Internet is a matter of IP packets. Each packet carries the information that will help to reach the destination of the data - basically the IP address that sent the packet. The IP has to get something that tells to the network how many packets it has left the message, and the number of each particular package. [23, 395]

The data packet carries the information in the protocols that Internet used, which is TCP/IP (Transmission Control Protocol/Internet Protocol). Each packet contains part of the message body. Typically, a packet usually takes about 1500 bytes. Each packet is then sent to its destination by the best available route - a route that can be taken by other packets of the message or any message packets. Firstly, the network can balance the load for various equipments in a matter of milliseconds. Second, if there is a problem with one or more systems as the message is being transferred packets can be routed through alternate sites, ensuring full delivery of the message. [23, 395]

There could be another input interface in the media player but this solution is not very both common and useful. This is the RF Aerial input, because the RF signals can be distributed a very long distances. So, this input can be used as well to show either analog or digital TV. The main use of this interface might be when the same signal, usually TV signal, has to be distributed to a large number of displays.
5.2 Storage in the media player

Nowadays, there are currently no media players that do not use some kind of storage capabilities. It is very useful that the signal reaching the multimedia player can be stored somehow, since messages will be reproduced may need to be shown again, and instead of that require by the media player to request information through the server, the internal memory can give an easier solution. There are two possibilities to store contents, the flash memory and the hard drive.

5.2.1 Hard Drive

The hard disk can store hundreds of gigabytes in the internal storage of the media player, but the disadvantage is that in some application such amount of memory in the media player is not necessary, and could not be useful to implement for the digital signage provider as it will make the equipment costs higher.

5.2.2 Flash Memory

Basically, the difference between hard drives and flash memories lies in the amount of information that can be stored in the media player, since the flash memory only can store a few gigabytes. This does not mean that flash memory can not be used, as there will be applications where the media player's internal memory is not necessary, and to reduce equipment costs can be a good solution.

5.3 Interactivity in the media player

A very important application in digital signage is the possibility of the information that the user want to see through touching the screen is sent to the media player to detect and render the necessary changes. Immediately a different signal returns to the screen and produce so the interaction between touch-screen and media player. Could also be used mice or keyboards, but the touch-screen devices are more practical in public places. For this purpose, the USB (Universal Serial Bus) is the most widely used interface because when is connected a new device, the server lists it and adds the necessary software for it to work, so there is no more components necessity.
5.3.1 USB

The most USB interface used today is the high-speed USB (2.0) which has a transfer rate of up to 480 Mbps but usually up to 125 Mbps. Is present almost 99% of today's PCs. The USB 2.0 cable has four lines, one pair for data, a power and ground. In addition, USB has almost completely replaced the keyboard and mouse PS/2, as well as RS-232. There are many applications where USB is fundamental. Thanks to USB is possible to enable the interaction, reduce the complexity or even increase the security in the installation. [24]

USB is extended from the touch-screen device to the CPU or media player to enable the interaction even in long distances. As the media player is located remotely, there is no need to support having more equipment on the retail floor, and also the security of the application will be improved, as the CPU is not anymore installed where the screen is located.

6 File Formats

The media players must have a sufficient number of filters and decoders for the signal may be decompressed and thus display a large number of different file formats because standardization is not very common in computer file formats, due to every format may be useful for different applications, as either video or animation, or images or audio files. Below will be introduced the file formats that make digital signage applications.

6.1 Image Formats

The most widely used image format is JPEG (Joint Photographic Experts Group). This format usually uses a loss compression algorithm to reduce the size of image files and it allows regulating the level of compression for each of the images so is possible to decide between a low quality image, which involves smaller the file or an image with high quality, which represents a greater weight.

The JPEG compression algorithm is based on two visual defects of the human eye, one is the fact that it is much more sensitive to changes in luminance than in chrominence, that is, captures more clearly the changes in brightness than color. The
other is that more easily notices small changes in brightness, in homogeneous areas or in areas where the variation is large, for example at the edges of the bodies of objects. JPEG is one of the formats used so far to store pictures, but there are other formats such as GIF, PNG, TIFF and others.

6.2 Video Formats

Video format is cornerstone in the development of digital signage. The main reason of the boom of these applications lies in the capability of display interesting content for the customer. Video files have the capacity of attract the attention more than the rest of file format. The most used video formats in digital signage are MPEG, in its variants MPEG-2 and MPEG-4, and WMV (Window Media Video). The following defines each of them.

6.2.1 MPEG

MPEG (Moving Picture Experts Group) is a group of the ISO (International Organization for Standardization) and the family of compression standards and file formats of digital video developed by the group.

The algorithms of this technology compress the information into small packets that can be transmitted easily and then are decompressed. MPEG achieves its high compression rate by storing only the changes from one frame to the next, instead of storing the entire frame. The video information is encoded using a technique called DCT (Discrete Cosine Transform). By using the MPEG compression lose some information, but this loss is generally imperceptible to the human eye. [25]

6.2.2 MPEG-2

MPEG-2 compression is usually used to encode audio and video for broadcast signals, digital TV including terrestrial, satellite or cable. This introduces and defines TS (Transport Streams), which are designed to carry digital video and audio through means unpredictable and unstable, and are used in television broadcasts. With some enhancements, MPEG-2 is also the current standard for HDTV broadcasts. [25]

This video technology supports video streams as both progressive and interlaced scan. In progressive scanning flows, the basic unit of coding is a field. In the other hand, in interlaced scanning flows, the basic unit of coding is a frame, which is half of a field.
MPEG-2 is also used for coding of moving pictures and associated audio that creates a video stream through three types of frame data arranged in a specific order structure called GOP (Group of Pictures). A GOP is a group of successive images within a video encoded stream. Each video stream is encoded in successive GOPs, and from images containing these GOPs from which visible images are generated. [25]

A GOP may contain different types of images: [25]

- Image type I (intra coding) is a reference image that represents a still image that is independent of the other images. Each GOP begins with an image of this type.
- Image type P (coding by prediction). Contains information on motion compensation of the previous image, either type P or I.
- Image type B (bidirectional predictive coding by). It contains different information from the image above and the following, either type I or P, within the same GOP.

A GOP always begins with an image I-type. Then, the GOP has several P-type images, in each case, with multiple images of distance. Finally, the remaining gaps are filled with images of B-type, as seen in Figure 1 below:

![Figure 1. Layout of image types I, P and B within a group of pictures.](image)

I type images contain the whole image, and require no additional information to be rebuilt. Therefore, any errors that may be within a GOP structure will be corrected by the next image I-type. The more I-images have such a video stream, the easier editing is, but in contrast this stream will be on more size. To save bandwidth and disk space, video ready for broadcast on the Internet, only have one I-type picture for GOP.
6.2.3 MPEG-4

MPEG-4 represents the next step in compression technology. It was consequence of the need to maintain acceptable image quality with higher compression ratios, allowing transmission of video over narrow channels such as Internet or wireless networks.

A few years ago, the MPEG group and the Video Coding Experts Group (VCEG) joined forces in developing the H.264 standard forming the JVT (Joint Video Team). The development obtained received, therefore, different names: AVC (Advanced Video Coding), H.264, or MPEG-4 part-10.

MPEG-4 has an important advantage over MPEG-2 to allow further compress images maintaining the same quality, being a more advanced standard, offering better performance and greater efficiency. Thus, where a channel with 720p in MPEG-2 may need between 10 and 14Mbps video in MPEG-4 with 6-8Mbps get the same result. In the case of 1080i would be 14-19Mbps using MPEG2 and 8-12Mbps using MPEG-4. This earns a margin of bandwidth that may be used to improve the quality of the image (keeping the bit rate, but changing the codec) or is possible to use this bit rate obtained in other channels of standard definition, HD channels, or additional services (radios, interactive services, data...). [26]

6.2.4 WMV

The last method used for video transmission of digital signage is Windows Media Video. Windows Media Video (WMV) is a generic name given to the compression algorithm suite located on the set owner of video technologies developed by Microsoft, which is part of the Windows Media framework. WMV is not built only on Microsoft's internal technology. [26]

The video is often combined with sound in Windows Media Audio format. This video technology is packed in a container normally multimedia, such as AVI or ASF. The resulting files are .avi extension if the container is of this type. In addition, .wmv extension is used if it is only a video file or .asf extension if it is an ASF container, with video and audio content. [26]
6.3 Audio formats

The audio is not one of the main parts in digital signage, as in public venues and outdoor locations is not always possible to introduce this format in those applications. Instead, they may be some utility in digital indoor signage installations where the sound can have an important role.

The most used audio formats in digital signage are MP3, WMA and WAV. The media player can handle these files even though the screen at the point of sale is always accompanied by video, but they do not have to correspond, which image can be used for certain clients and audio for radio spots for other customers.

6.4 Animation Formats

The animations are an alternative to play content in motion, since the file size is less respect the video, although there is a considerable difference between the two formats. The most commonly used file formats for animations are PowerPoint (.ppt and .pps), Macromedia Flash file (.swf) and Executable Macromedia Flash (.exe). Nowadays one of the most popular file formats is the Flash format and some media players just use it for almost everything.

6.5 Other formats

Increasingly, in media players are appearing features adapted to the ease of the Internet to provide content for digital signage improvement. Thus, new formats can be processed in the media player such as most of Web pages (.HTM, .HTML or .XML) or Web archives (.HMT).

7 Signal distribution

After explaining the performance of a media player and what signals can act in it, it will be explored how the signals reach the media player and through what means. Before beginning any content distribution in the digital signage application, a planning should be created including the following steps [27]:

Firstly the customer has to think carefully about the locations where the digital signage technology will be placed. Later, the network connectivity has to be checked. If is not available, it should be planned wireless or standalone devices in the locations where
the screens are. The different distribution options have to be studied, to choose what would be the best integrated within the hardware and software equipment.

7.1 Manual distribution

In the first moment of the appearance of digital signage, the portable players incorporated VHS, then CDs and finally DVDs. This method of signal distribution is called manual, and there must be some person responsible for placing these devices in the player to reproduce it so.

Manual distribution means loss of quality. This is because of the playback devices as CDs, as the more the file is played, the more the quality is lost. But there is a positive side in the use of DVDs, as the milestone of developing playlist. Playlist became very useful because it relieved the person responsible of rewind the disk or tape and is possible to design a list with the files ready to show. But with the appearance of Internet, the need of duplicate CDs and mail them was suppressed.

7.2 Internet distribution

The appearance of the broadband connections like ADSL has opened a new world in the digital signage distribution. ADSL (Asymmetric Digital Subscriber Line), is a technology that converts twisted-pair copper telephone in a mode of transmission of multimedia information and communications, voice and data.

Using existing telephone infrastructure has emerged this technology that increases the bandwidth of copper wire pairs between the network and the customer. Asymmetric means that the bandwidth in each of the directions of transmission is not the same as the ADSL technology is designed so that the download capacity is greater than the upload, which corresponds to the use of internet by most end users who receive more information than they send.

In ADSL communications are defined three channels, which are sending data, receiving data and normal telephone service. ADSL can theoretically provide up to 8 Mbps and 24 Mbps by ADSL+2 to where and when the line length does not exceed 5.5 km measured from the Telephone Central, or other services that are not on the same wire may interfere.
As for digital signage, ADSL has meant a revolution for its development, since the variety of content and the ability to send anywhere in the world make use has spread significantly.

7.2.1 Manual Use

The least advanced way to distribute files in Internet using ADSL is downloading and updating manually. This method basically based on the idea that a person is responsible to upload the files in the FTP server and then, in every point of sales, wherever the displays are located, another person is responsible to download these same files. Another way to retrieve the files is using HTTP, as a web site.

A FTP (File Transfer Protocol) server is a special program that runs on a server computer usually connected to the Internet. Its function is to allow the exchange of data between servers and computers. Typically, FTP servers are not usually found in personal computers, so that a user typically will use FTP to connect remotely to one and thus exchange information with it. [28]

The most common applications of FTP servers are usually hosting, where customers use the service to upload your web pages and related files, or as a backup server of files that may have a company. To do this, there are FTP communication protocols to transmit encrypted data, such as SFTP (Secure File Transfer Protocol). [28]

7.2.2 Automatic Use

The best way to use Internet-based connection to distribute content is automatically. This way the media player is responsible to retrieve the files from the FTP server and update them automatically by a preset schedule, getting the control of what is shown in the screens.

7.3 Internet connection equipment

In digital signage, the most common way to receive data from a Internet-based connection is in a local area network, which allows to different media players and screens manage all the suitable content. But this connection is made possible by certain equipment.
7.3.1 ADSL Router

The ADSL router is a device that can receive Internet data and connect one or more computers or even local area network. It really is made of several components. Performs the following functions [28]:

- **Gateway.** Providing exit to the outside of a local network.
- **Router.** When a package arrives from the Internet, it goes to the destination interface for the corresponding path, this is, is capable of routing IP packets.
- **ADSL Modem.** It modulates the signals sent from the local network that can be transmitted by the ADSL line and demodulates the signals received by it to the LAN computers can interpret.
- **Wireless access point.** Some ADSL router allows wireless communication with computers via local network, but in public or outdoor applications is not widely used because they may appear interference from other electronic devices.

The ADSL router provides Internet access through an ADSL line, so the interface that communicates with the outside world must adapt to this environment. Therefore, this unit has an RJ11 interface to connect the phone cord. There are routers that have two RJ11 connections to transmit on two lines and thus doubling the transmission capacity.

In addition, must be provided a modulator to adjust the data signals at frequencies in which the ADSL technology works and a demodulator to interpret the signals that come from outside.

7.3.2 Switches

A switch, like a bridge, is a device which connects different locations. In fact, the switch is called multiport bridge. The switches are capable of taking decisions based on MAC addresses (Media Acess Control), and so the whole LAN is much more efficient. The switches have multiple connection ports from 8 to 48, since one of its functions is the concentration of connectivity, this is, allow multiple devices connect to a network point. This device switches packets from input ports to output ports, each port providing a total bandwidth.
7.3.3 Hubs

A hub is a device that enables to centralize network cabling and is able to enlarge it. This means that the device receives a signal and repeats it issued by their different ports. A hub operates repeating every data packet in each of the ports which account, except that it has received the package, so that all points have access to data. These are the basis for star-type local area networks.

7.4 Internet and local network communications

It is undeniable that Internet technologies have established communication channels previously unthinkable or out of reach because of its high cost. Today we enjoy Web technologies and instant messaging as having been present for many years, but often we abuse of this technology, and worse, the resulting communication effectiveness is very low.

Effective communication demands the interaction between the communicating parts when, as and where required, by the most appropriate to each situation. Similarly, the communication should encourage action in the part receiving the communication. If no action counterpart, consistent with the objective, is not effective communication.

Internet communications also allow easy both access and use. It can handle the whole concept of combining multimedia voice, video, data, images, messages and to invent on, in one experience.

The family of TCP/IP (Transport Control Protocol / Internet Protocol) is the current basis of the Internet and networks. This includes more protocols it says and what they do is to allow computers to communicate with each other but there are two standards in this regard, the OSI model and the TCP/IP.

7.4.1 The OSI model

The OSI model begins with the premise that communication between two computers is so complex that it could be considered as a single entity. Therefore, the communication process should be divided into different layers, where each is located below the
previous one, using functions assigned by layer. There are seven layers defined by the OSI model, in ascending order [29, 28-49]:

- Physical: It is responsible for leaving the bit sequences in the media or picking them up. It is implemented by hardware.
- Data link: Define the packets (frames), allowing sending them between computers physically interconnected. Is implemented by combining hardware and software.
- Network: Responsible that the devices send frames through the lower layers. It is implemented by software and is not reliable, this is, packets may be lost, damaged or improperly routed.
- Transportation: Responsible for the reliable transmission of data over the network.
- Session: Handles communication between applications side by side. Opens and closes the session.
- Presentation: Translates data formats for different applications.
- Application: Applications and Users, for example the mail program.

7.4.2 The TCP/IP

This is the model used in internet and only consists of four layers but is compatible with the OSI model. For an understanding of TCP/IP is necessary to know one of its most important protocols: IP.

IP is the network building block of other protocols and layers. It is perfectly defined in RFC 791, Internet Protocol, although it has been updated later in RFC 1349. IP provides several services to the upper layer [30]:

- Network Protocol: Network protocol and routable. The header contains information needed for routing a packet, with source IP address and destination IP address. An IP address has two components, the network address and the host. Packet delivery and routing is possible to have a destination network address. Likewise also contains a hop count to limit the number of links the package will take before it is discarded.
- Multi-client protocols: IP is a conveyor between networks to higher layer protocols and can carry different protocols, but each IP packet can contain only
data of a protocol. Both the client and the server use the same protocol, so the package does not need to indicate the source and destination protocol. Some protocols are TCP, ICMP, IGMP and UDP.

- **Datagram Delivery**: Provides an offline delivery service and unreliable to the higher layer protocols.

- **Independence of the network interface layer**: IP is independent of the technology present in the network interface. Uses a 32-bit address (IPv4) that is independent of the addressing scheme of the layer network interface.

- **Fragmentation and reassembly**: In order to be compatible with the maximum frame size of different technologies network interface layer, IP fragmentation allows a load to forward it via a link with an MTU smaller than the size of IP datagram. Routers or host fragment the load and may occur several times. The destination host reassembles the fragments.

- **Extensible through IP options**: If is needed IP options can be used for features not available in the standard header. The options are attached to the header, adding custom functionality. For example, specify a path that can follow an IP datagram in an IP network.

- **Technology datagram packet switching**: Each packet is a datagram whose destination address is significant and will be examined by every router, which will take its routing decision whether to forward the packet. This means that routes of each packet may be different, and come in a different order than sent.

A datagram comprises an IP header and IP payload. The header has a size between 20 and 60 bytes, in increments of 4 bytes. Provides support for routing, load identification, size of the datagram and header, support for fragmentation and IP options. While the load varies in size from 8 bytes (68-byte datagram header 60 bytes) and 65515 bytes (a datagram of 65535 bytes to 20 bytes header). [30]

Perhaps most interest at this level are IP addresses, is very important that the allocation of these are unique and correct to all nodes in the network. That assignment does not seems to have too much difficulty, but actually does it using techniques subnet complicates it.

An IP address is a logical address of 32 bits (IPv4) which can be [31]:
• A unicast IP address that is assigned to a single network interface. This is used in communications one to one.
• A broadcast IP address, which is designed to be received by all IP nodes in the same network segment. Are used in communications between one and all.
• A Multicast IP address is an address to listen on a network segment or individual. Communications are used in one to many.

From this theory can be configured local area networks to implement digital signage technology used today. Media players check the content management server quite often, even several times an hour. Therefore, a lot of bandwidth is needed in a shop that may have multiple media players. One way to get reduce this excessive use of bandwidth is to install a server in the store, which stores the content to be used in the screens, this is, the edge server.

7.4.3 Servers

A server is a device that stores HTML documents, images, text files, scripts, and other Web material consists of data, and distributing content to customers who request it online.

Content management Server (CMS)

The content management server is made of a software that processes any server-side application by bidirectional connections and/or unidirectional and synchronous or asynchronous with the client generating or giving an answer in any language or application on the client side. The code received from the client is often compiled and run a web browser. To transmit all this data is normally used a protocol. Usually is used the HTTP protocol for these communications, pertaining to the application layer of the OSI model. The term is also used to refer to the computer running the program. [32]

It runs on a computer while waiting for requests from a client (web browser) and responds to these requests appropriately, through a web page to be displayed in the browser or by displaying the respective message if an error was detected. The customer is responsible for interpreting the HTML code, this is, to show the fonts, colors and layout of text and objects on the page, the server is limited only to transfer the code from the page without performing any interpretation of it. [32]
The content management server must meet a certain specification. First, new content must be inserted into the system's library. This can be taken from a remote website or simply adding files to a new folder. Later, it has to manage the multimedia player to provide a list detailing all media players that can be controlled by a CMS. They can also create groups of media players to more easily manage and update content and create playlists, such as using metadata tags to allow self-organize content. These playlists can vary daily, weekly, season or holiday periods. The CMS is responsible for controlling access to information, either by creating multiple user accounts and authorizing them to have different access rights, or restricting access through a username and password.

Before inserting the edge server, files and data passed directly to the ADSL router and after passing through the switches, the media player. Thus, there was a saturation of the bandwidth limiting speed file transfer, as can be seen in Figure 2 below:

![Figure 2. Block diagram of an Internet LAN application.](image)

This Figure 2 shows how the media players require of a switch to split the necessary content to each screen. But if the content is the same for all the displays, this same
content has to be downloaded to each media player, causing unnecessary overload on the network, using resources that could be needed for other applications.

**Edge server**

The edge server is used in medium to large networks of digital signage to improve cost efficiency of the network, reducing the amount of data exchange with CMS over the internet. Typically, the edge server is used on private networks such as retail outlet, containing a large number of media players that play a lot of identical content. When the edge server is installed, the media player requests the information from it to avoid the connection to the CMS and Internet. It is possible that the edge server does not have the requested content, so will retrieve it from the CMS and cache it locally. Once the edge server has stored the content, media player may request as many times as needed through the local network, reducing the bandwidth required for this action. [19, 133-138]

As can be seen in Figure 3 below, by introducing an edge server in the local area network ensures that only is necessary to request Internet for new content once, thanks to the possibility of cache the data by the system.

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![Figure 3. Block diagram of an Internet LAN application with edge server.](image-url)
After knowing how the edge server acts, is possible to decide whether to implement the
digital signage network in question, or simply through ADSL broadband Internet,
receive information from the Content Management Server. In the case of discarding the
dge server, the content retrieved from the Internet can reach the network in two ways,
either in the form of streaming or file transfer form.

7.4.4 Streaming

When the content to reproduce comes in the form of streaming, the media player
reads directly from the CMS, decodes it and displays it immediately. In this case, the
media player would not need an internal memory, type either flash or hard disk to
store the file.

The use of video streaming in networks of wireless local area is not recommended
because the signal could interfere with other devices such as Bluetooth. IP Local
networks should be used in wired systems if the IPTV set-top boxes depend on the
streaming signals.

7.4.5 Files Reception

The other option, in which the media player receives the file, stores and decodes, it
means an improvement of the technical characteristics of the media player, because is
need some kind of storage software, which will do more expensive the product.
As seen above, in both retail and public environments is more appropriate to have an
edge server to handle all applications. Thus, the edge server will store all the content
in the form of files directly from the Content Management server, for later delivery to
the respective media players in the form of streaming for the economic cost is lower,
and decrease the required software, being media players can be replaced by IPTV set-
box.

IPTV set-boxes

When an edge server is used that delivers streaming content to the media players, it
can be replaced by set-top boxes that allow software and cost savings for the client,
since the set-top box is a device that is not capable of storage or the ability to
reproduce still images, because is needed a continuous stream. Therefore, it is the ideal solution when you need to broadcast video and audio signals on network-based IPTV.

It is possible to display live TV programs or live events, since encoders receive video and audio signals and make them available as real-time streams on the network or record them on the server. The Set Top Boxes decode these streams and display them on the screens.

7.5 Unicast broadcasting

Digital signage has become a popular and effective way to promote and sell products and services. The use of digital signage in business starts using the existing Internet connection through the IP protocol, through local area networks to distribute content. This technology is based on unicasting mode or communication one-to-one, which is ideal for small networks and simple digital signage solutions.

7.5.1 Wi-Fi

Wi-Fi is a software that removes most of the physical connections between a computer and peripheral equipment that may own in a local area network. Nowadays, local networks are nearly everywhere, from small shops, to restaurants, to hospitals, this means that anywhere can be introduced a Wi-Fi digital signage application.

Wi-Fi is a trademark of the Wi-Fi Alliance, commercial organization which take, test and certify that the equipment meets the standards IEEE 802.11 related to WLAN (Wireless Local Area Networks). The first target of Wi-Fi was to promote wireless technology easier and ensure compatibility of equipment, and in the evolution of technology, wireless devices are becoming very popular, as it can be found almost everywhere. In addition, this technology is getting to remove a big amount of cable and even improve productivity in the work zone due to their disappearance.

There are various types of Wi-Fi, each based on a standard IEEE 802.11. IEEE 802.11b, IEEE 802.11g and IEEE 802.11n enjoy international acceptance because the 2.4 GHz band is available almost universally, with a speed of up to 11 Mbps, 54 Mbps and 300 Mbps, respectively. Nowadays is also handled the IEEE 802.11a standard known as Wi-Fi 5, which operates in the 5 GHz band and enjoys a
relatively clean operation channels. The 5 GHz band has recently been enabled and there are no other technologies that are being used, so there is very little interference. Its scope is somewhat smaller than the working standards at 2.4 GHz (about 10%), because the frequency is higher. [33]

Wi-Fi networks have a number of advantages for digital signal transmission, among which may include [33]:

- Being wireless, the convenience they offer is much higher than wired networks because anyone who has access to the network can connect from various points within a wide enough range of space.
- Once configured, the Wi-Fi networks allow access from multiple computers without any problem or infrastructure spending, not in cable technology.
- The Wi-Fi Alliance ensures the compatibility between devices with Wi-Fi brand is total, so anywhere in the world can use Wi-Fi technology with full compatibility.

But as wireless network, Wi-Fi technology has the intrinsic problems of any wireless technology. Some of them are [33]:

- Slow transfer rate compared to a wired connection due to interference and signal loss that the environment can bring.
- Security. Currently there are some programs that are capable of stealing the Wi-Fi connexion since this security is not very strong, and may even have connections without any kind of security.
- This technology is not compatible with other types of wireless connections such as Bluetooth, GPRS, UMTS, etc.

7.5.2 3G

3G stands for third-generation voice and data transmission via mobile phones. The technically correct definition is UMTS (Universal Mobile Telecommunications System). The services associated with the third generation provides the ability to transfer both voice and non-voice data (such as downloading programs, exchanging email, and instant messaging). Although this technology was aimed at mobile telephony, in recent years mobile operators offer exclusive access to the Internet using USB modem, without having to buy a mobile phone, so any computer can have Internet access.
There are some portable devices such as incorporating the modem built into the computer, but require a SIM card for use, so in this case must be activated with a phone number.

This is where the potential applications for digital signage, and is possible to use an Internet connection with a moderately high speed, without having to make a terrestrial connection type ADSL and even without a local area network. It is ideal for applications that do not have such infrastructure and the satellite can make a payment too high for small and medium applications.

The 3G technology offers several advantages such as [34]:

- Is based on IP packets download. You only pay according to the download.
- High transmission speed. Today is possible can reach speeds of 3 Mbit/s per mobile user.
- Faster access.
- UMTS, in addition to support Internet protocol (IP), are combined to provide new multimedia services and broadband applications.

Although there are also some disadvantages in the use of 3G [34]:

- Limited coverage. Depending on the location, the transfer rate can decrease dramatically.
- Decrease speed if the device from which is connected is in motion.
- Connectionless. Each of the packets can follow different routes between the origin and destination, so it can get messy or duplicates.
- High latency compared to that normally obtained with ADSL services.

7.5.3 Peer-to-peer

Peer-to-peer (P2P) is a computer network in which some or all aspects of it work without clients or servers fixed, but a series of nodes that behave as equal. In this type of network, computers act simultaneously as clients and servers to other nodes on the network. P2P networks allow the direct exchange of information in any format in the networked computers as can be seen in Figure 4 below:
Peer-to-peer exploit, manage and optimize the use of the bandwidth of other network users through connectivity between them, and get more performance and connections and transfers than with some conventional centralized methods, where a relatively small number of servers provide the total bandwidth and shared resources for a service or application.

Among the features of P2P networks as defined by Mueller (2003), it is possible to find [20]:

- **Scalability.** P2P networks are far reaching hundreds of millions of potential users. The more nodes are connected to a P2P network, the better their performance. Thus, when nodes come and share their own resources, increase the system's total resources.
- **Robustness.** The nature of peer-to-peer networks also increases robustness in case of failures in excessive replication of data to multiple destinations, and enabling peers to find the information without any centralized server requests indexing.
- **Decentralization.** These networks are by definition decentralized, and all nodes are equal. There are no nodes with special functions, and therefore no node is essential for the operation of the network.
• Costs distribution among users. Sharing resources in exchange for resources. Depending on the application of network resources can be files, bandwidth, processing cycles or disk storage.

• Anonymity. It is desirable that these networks remain anonymous the author of a content, the editor, the reader, the server that hosts and the request to find it.

Security. The objectives of a secure P2P would identify and avoid malicious nodes, avoiding infected content, avoiding espionage communications between nodes, creation of secure groups of nodes within the network or protection of network resources.

But unicasting transmission solution is not practical when the digital signage network extending to thousands of places, it is not easily manageable or is economically successful experience.

At this point is when the transmission appears through Satellite Multicasting, but can also be used multicasting on private networks.

7.6 Multicast broadcasting

Multicast broadcasting represents a means of communications in which a single stream of data is sent to several receivers at the same time. It is a network infrastructure to transport this data stream, replicating where necessary, for all recipients to register interest in receiving this data.

The multicast broadcasting is oriented to applications such as "one to many" and "many to many." In these cases presents clear advantages when compared with the mechanisms of unicast and broadcast transmission. In unicast, the source needs to replicate several identical data flows in order to transmit to each of the receptors, resulting in wasted bandwidth. On the other hand, the broadcast system sends the data to the entire network indiscriminately. This also results in waste of resources because it involves data transport for all network stations, although the number of recipients willing to have that content is reduced. With multicast, the traffic source sends a single copy of the packets to a multicast group address. The network infrastructure replicates these packages intelligently routing data according to the topology of receivers interested in that information. [35]
7.6.1 Private Networks

IP Multicasting is part of the TCP/IP. Multicasting is the most efficient way to transmit the same data to multiple receivers, because the information is sent to an address group. This allows the group of receivers to receive data from a single direction. As Williamson (2000), “IP Multicast packets are replicated by routers within the network when there is more than one sub-network requiring a copy of the data. IP Unicast makes the source responsible for creating an individual IP stream for each receiver. Multicast is a robust and scalable solution for group communication because of this distributed replication of data and because only one copy of the packet needs to traverse a link”. [36]

On TCP/IP, these receptors are represented by a group address or multicast address. This group corresponds to an IP address belonging to the old class D, i.e., in the range between 224.0.0.0 and 239.255.255.255. Each source sends packets to a group address, which are associated with different receptors. These receptors in turn can link and unlink in a dynamic way. It is up to the network devices and routers in particular, to determine which of its interfaces have interested receivers in a multicast group and which should receive a copy of the packets sent to that group. [36]

Small private networks using multicasting are very common but it can be expensive and useless to build private networks on a national level, because the efficiency and the costs of this implementation will not solve the problem.

7.6.2 Satellite Multicasting

Where the wired connection loses its utility and digital signage applications become so large that it required the appearance of a new method of data transmission, is when it appears the satellite broadcasting. Satellite transmission is based on the fact that no matter how many receivers the data go, is possible to send the information as easily to a place than a million different places.

Most of the satellites that are used today are designed for broadcasting digital television signals using the DVB standard. Digital Video Broadcasting (DVB) is an organization consisting of more than 270 companies worldwide, responsible for promoting international digital television standards such as HDTV, satellite TV or data communications via satellite.
One of the most important decisions to those encountered by the engineers responsible for the creation of the DVB standards was the selection of the source coding of audio and video that would be used. MPEG-2 was chosen for this purpose, base of HDTV (High Definition Television) and digital audio services such as AC3. Nowadays, several standards of the Digital Video Broadcasting organization are used to provide multicasting communications, among which DVB-S, DVB-RCS and DVB-IP, each with their respective characteristics, advantages and disadvantages. [37]

DVB-S

Transmission via satellite DVB-S uses the coding QPSK (Quadrature Phase Shift Keying), a kind of angular modulation based on that carrier phase varies between 4 values being discrete, being displaced each 90 degrees, typically being used values 45, 135, 225 and 315 degrees, giving each symbol 2 bits and using a digital signal as a modulating signal. The encoding bit-rate can vary from 18.4 up to 48.4 Mbit/s.

The transmission of satellite television has achieved great popularity and its success has caused the other DVB standards were implemented. DVB-S system is based on the transport stream used by MPEG-2 but adding different layers of protection to bring the signal through the channel that is transmitted. The new features of the transport stream are [38]:

- The procedure is to invert the sync bits in one of every eight packets of the transport stream, this being of 188 bytes. So that investment occurs every 1504 bytes.
- Random code is inserted into the plot to ensure the statistical randomness of the resulting data. This code is reset every eight packets of the transport stream.
- Is added a code error detection and correction of RS (Reed-Solomon) to protect information against errors in data transmitted over a communication channel. This code works with symbols instead of individual bits, and correct corrupted data at the receiver using some extra bits that allow a solution of the problem a posteriori.
- 16 additional bytes are introduced for each packet of 188 bytes. After this, a convolutional interleaving method is applied for dispersing channel errors. Thus,
if chain errors occur, the errors affect different data packets and can be removed using the corrective properties of error detection codes.

- A new code error guard is introduced, called inner code. This code is convolutional and the degree of redundancy which will introduce is not fixed, as each provider can configure it to suit the characteristics of the system.
- Carrier signal is modulated through QPSK.

In next Figure 5 is represented the block diagram of the signal path from MPEG-2 encoding to its diffusion through the antenna and the MPEG-2 transport packets located in every step of the signal path:

![Figure 5. Block diagram of MPEG-2 and transport stream.](image-url)
The receiver must perform the inverse operations to re-gain access to the transport stream that supports the information of the MPEG-2 format. Depending on the characteristics of the link can be selected the internal error protection code. In transmissions with a bandwidth of 36 MHz internal codes of ¾ can be used, this is, 3 bytes of data and 1 for redundancy, to achieve data rates of 39 Mbps. [38]

DVB-S2

DVB-S standard has come to be in the background since the emergence of a new more advanced version, the DVB-S2, which includes error correction algorithms based on employment in cascade of two encoders, the LDPC (Low Density Parity Check) and BCH. In addition, various modulation methods have been incorporated (QPSK, 8PSK, 16APSK & 32APSK) to increase system flexibility and allow different services with different bit rates, as well as an adaptation to input stream.

Although the DVB-S2 has the disadvantage that there are millions of DVB-S receivers around the world, it is estimated that the improvement it offers over its predecessor is 30%, including the latest developments in channel coding and modulation.

Thereby, it appears that most of the geostationary satellites are used to broadcast digital television signals. But satellite can be used in different ways. Another use of satellite technology may be the distribution of IP multicasting, through the DVB standard at its RCS.

DVB-RCS

DVB-RCS (Digital Video Broadcasting - Return Channel Satellite) is a standard that allows bidirectional satellite communication of a VSAT station (Very Small Aperture Terminal), so that the user can access both basic and additional services with a high availability, and completely autonomously.

This alternative gives to users the equivalent of an Internet connection via ADSL or cable, without a local terrestrial infrastructure. DVB-RCS is able to provide transmission rates of around 20Mbps for uplink and about 5 Mbps downlink, for each of the connected terminals. Transported data can be encapsulated into ATM cells (Asynchronous
Transfer Mode) or MPEG-2 packets. DVB-RCS technology allows the transport of IP protocol and also supports multiple routing protocols (RIP, IGMP) and transport (RTP, UDP, TCPS). In addition, all user terminals are connected to a central hub (Hub) which is responsible for traffic management, control and synchronization for data to reach its destination. This standard consists of the following parts [39]:

- **Feeder**: The ground station is responsible for sending the data to the satellite.
- **Gateway**: Responsible for receiving the return channel for all users of the network, and pass the traffic to its destination, either the Internet or any other network.
- **Satellite**: Reflects the data it receives from the ground station back to Earth, amplified.
- **RCST (Return Channel Satellite Terminal)**: This is the set-top box user, whereby the user is able to receive and send data to the network.
- **NCC (Network Control Center)**: This is the brain of the network and takes care of control and synchronization functions.

This is a very reasonable alternative because it reduces the amount of materials and elements necessary for the reception of data though can overwhelm the telephone line. In digital signage is not a widely used alternative, as the option of IP via cable has superior performance, but in remote areas where terrestrial wiring fails, this option is ideal.

In addition of DVB-RCS technology to send and receive IP information to any destination it can be seen more useful in certain cases the DVB-IP technology, whose main characteristic is that the modems are unidirectional, this is, they can only receive data.

**DVB-IP**

The DVB-IP standard is used for transmission of multimedia services using satellite technology, like the previous ones. This transmission method is based on that data, once encoded in MPEG-2, are inserted into MPEG-2 Transport Streams (MTS). After this, they are encapsulated in RTP (Real-time Transport Protocol), which are later converted into IP datagrams.
To receive information and decode it are used one-way modems, which can only receive data, and have only one input channel, called forward. So in order to send and receive data from the Internet is also needed a terrestrial connection either by telephone line or by cable.

This method is not very popular because it is necessary to hire satellite and terrestrial services, with the following costs increased to achieve effective communication. But has the advantage of using IP packets, which are the most used nowadays due to its implementation.

8 Trends and future

To continue the growth of digital signage is needed to create a culture in which such applications are considered important and essential. Just as all companies and marketing departments of companies are aware that media is needed to present their ideas, products, communications, etc. abroad, they need to know what makes digital signage for their business.

It is necessary to expand the concept of digital signage. Not only have to associate digital signage as an alternative to printed advertising. Digital signage can and must be used as support for transmitting information of any kind. Therefore, it should explore new horizons for this sector, since the imagination, the innovation and spectacularity are factors that will determine the future of digital signage.

Digital signage must be oriented toward the increasing sector quality, particularly in the contents generation segment. Nowadays, it can still be seen content directly imported from the television or low quality content. All this makes it less effective. Content development companies should devise ways to draw the attention of the users so that they are satisfied. Today many marketing companies are working hard to provide content that surprise decisively. For example, the AXE Company made spectacular campaign advertising in London Victoria Station, using 3D technology and flat screens. [40]

The degree of implementation of digital signage varies by country and even in each city. There are companies specialized in this sector completely, and places where digital signage is a reality today. But the digital signage industry in other countries is far
from reaching its peak as companies usually are reluctant to the introduction of new technologies, often by not being sure of getting the expected ROI (Return of Inversion). Now is also seen a lot of misinformation on the part of potential customers.

One possible solution to the shortage of new company entrants may be the segmentation of activities within the sector. It can promote the entry of companies specializing in a particular part of the cycle. With companies specializing in a particular point in the value chain, is improved the quality of particular process and finally achieved an overall improvement.

9 Application

A practical application of digital signage is appropriate to consider after the theoretical study of it. The Finnish museum located in Espoo, called KAMU Espoo City Museum WeeGee, responsible of exposing the permanent exhibition “A Trip through Time in Espoo”, as well as temporary exhibitions; through its specialized staff ask Metropolia University of Applied Sciences and more specifically the Media Engineering department and their head, Mr. Erkki Aalto about a new project for the museum.

This new temporary exhibition is titled “Passion for Collecting” and consists of 3 different topics. Each topic will consist of illustrative elements such as objects of their own, and a touch-screen that is the object of study.

For the realization of this project the following researchers have worked on different tasks: Ms. Minna Bollström as display designer. Mr. Matias Tukiainen as image technologist. Mr. Matti Lahtinen as a software engineer. Mr. Matti Paasenen as a development engineer. Mr. Erkki Aalto, the principal lecturer, is in charge of directing the project and makes the offer to the customer, as follows:

- The project consists of three interactive multimedia presentations, called "Porcelain", "Silver" and "Weapons".
- The multimedia material used in the application includes photos, which the customer has produced and developed and the text that will be connected to such photos, with information on each object or art style.
- The customer owns the copyright of all the photos, but gives the rights to the Metropolia University to work with them. In addition, the Metropolia University
also has the right of manipulate the photos if necessary to get a better result in the application and include it in the material.

- The customer often will get reports from Metropolia University, Department of Media Engineering, and progress with the design of the model, according to what was discussed between the parts to ensure that data are in the right places.

- In addition, the customer will be provided with the source code used in the presentation of touch-screens, which is running for Flash and XML.

- The customer will have written documentation to clarify the content creation process, and the phases that form. It also includes documentation on how the university handled Metropolia photos to produce an overall more pleasant sensation, such as resolution changes, touches of color, contrast or size.

- Later, when the application is ready will be made a usability test for 3 or 4 days to ensure that the application works properly and the customer is satisfied. On the other hand, the first person to test the application will be an old woman, as potential users of the touch screen will be people without deep technical knowledge in the field.

- Finally, the customer may a posteriori in example develop the program by themselves, and make changes and improvements, change photos and modify texts.

This proposal made by Mr. Erkki Aalto, as head of the department of Media Engineering of Metropolia University is accepted by the customer, the museum WeeGee, and proceeds to the realization of the project, which deadline should be April 19, 2011 since that day there will be an opening ceremony of the new temporary exhibition.

9.1 Customer’s needs for digital communication

The WeeGee museum and its management have a policy oriented to the acceptance and development of new technologies that the multimedia field can offer. In the WeeGee museum always has been claimed that the audience gets further knowledge about both the exposed objects and background, as before the appearance of digital signage they used printed posters. But nowadays printed posters can not attract as much public as make new technologies and more thanks to the interactivity it offers a touch-screen. WeeGee museum intends to be a leader in Finland with regard to the implementation of multimedia content in their exhibits. Therefore, when purchasing a
new exhibition, through digital signage attempt to bring all information to the visitors of the most innovative and interesting way as possible.

It should be noted that the WeeGee museum is not owner of all objects shown in temporary exhibitions, they only borrow from other institutions. With the advent of digital signage, even after the exhibition period has finished, is possible to retain all the digital elements that form, whether photos, videos or information related to them. Therefore, thanks to digital technology, the exposed object is not needed in order to direct exposure for guests to enjoy and deepen their knowledge.

WeeGee museum also has interest in becoming a good customer of multimedia content providers, and are interested in promoting digital content in their exhibits. Also looking to learn in this field and be able to know what seems more appropriate or useful for future exhibitions.

9.2 Additional values of multimedia in exhibition “Passion for Collecting”

For the WeeGee museum, one of the most important values regarding customer satisfaction is that they can interact with the exhibition hall and deepen knowledge. Since the objects cannot be touched for security reasons, in the exhibition "Passion for Collecting" these objects can be viewed and enlarged by the addition of touch-screens that provide additional information to visitors.

Moreover, the fact that the information and images of the objects are stored in the museum database means that when there is a temporary exhibition, the objects are not only in the facilities but also in virtual mode.

One of the most important achievements from digital signage in the WeeGee museum is the ability to upgrade the content automatically in the future. If new objects arrive to the facilities only have to insert into the database program that displays information on screen and modify the design if necessary, providing the visitor additional information to low operating cost.
9.3 Implementation and operation of the project

The study case of this project is a quite simple implementation of digital signage, in which the touch-screen has a brand Tyco Electronics, ELO-Touchsystems model and is also used a CPU Acer, Veriton model without internet content distribution. Application uses the manual content distribution, in which they are carried by some device via USB to the CPU and it's played on the screen through some software.

The realization of the project is a process that has been carried out following a certain framework. The customer provides the images and texts that later appear in the exhibition but the design team has the duty to retouch images and adapt the content to the screen, which shall have a resolution of 1680x1050 pixels. Therefore, the first step in implementing the project consists of the compilation of all images and files as necessary. From these, it is possible to start to work on a first layout that will be improved through meetings with the customer.

It starts from a basic design which already is displayed the text and images, and new features will be added, as the usability is very important in this application. Multiple design drafts that will later be discarded, either by developers or by the customer are listed. In addition, the images are retouched with Photoshop to create a similar style and fit them on the display together with the necessary texts. Developers then pose certain questions to create a defined and clear work environment, for example:

- Designing the buttons of previous and home screen.
- How text disposal within the display should be.
- Maximum length allowed for the text to share space with the images.
- What to do with vertical photos, as the resolution changes.
- How the photos gallery should be.

Thus, a pattern is defined for the application design. The customer and developers reach an agreement through Photoshop images on how would each screen within the application, and begin to work on the software which will support the application.
9.3.1 Interface

The WeeGee museum has a temporary exhibition with the theme "Passion for Collecting", for which must modify the environment of the exhibition hall to the harmony of the objects with the surrounding is not disrupted. Therefore, this affects the design of all the images that will appear on the touch-screen. As can be seen in figure 6, the main screens of the three applications are similar, changing only the background.

![Figure 6. Main page of the collections.](image)

As seen, the bluish color is predominant in the exhibition, and in each of the three different collections an object identifier can be seen in the background of the image.
Sidebar language and options is the same in every display as this facilitates handling by the users of the screen.

After touching the screen is passed from the home page to the index of each collection, where the general information and pictures appears and the user can find relevant data. In figure 7 the final disposal to be used for the three themes represented in the temporary exhibition can be seen.

![Index page of the collections.](image)

Figure 7. Index page of the collections.

The silver collection has objects of different styles depending on the period. This introduces a timeline for the convenience of the user where each style is represented by one of their most important object. This guideline has also been used for the rest of collections as it produces harmony among them and is practical for the user. You can
also see the final disposition of the option to change language section to the left, which does not interfere with the display of content as well as previous-screen buttons, home and information, with a design very clear to the user. Always creating the facility in handling the application and clarity about the display of content is searched, as the average user does not have deep technical knowledge and seeks for the information displayed in an easy way.

9.3.2 Interaction and navigation

Once digital signage becomes interactive, several things should be taken into account: The content is different, the reaction of the user is different, and the collected data are different. It should be understood that the content for touch-screens should be designed to engage the visitor. This is not simply make easier the handling to the user, but the point is to obtain inputs and options that will lead to information requested. There are three fundamental considerations involved in the creation of interactions:

- **Create the attraction.** It is essential to stimulate the visitor to participate. Therefore, the first task is to let the users to know that they get the leadership. The creation of an element of attraction in any part of the initial content that encourages visitors to participate is the first step.

- **Present one thing at a time.** Once the display has gotten the user interest, they must keep busy moving through in a logical progression. Provide information that is easy to understand about what is presented, and direct information to the layer below. Because the time in which the user is staring at the screen is limited in digital signage, it is necessary to provide it in a clear and logical way. Offering too much information that does not interest the visitor does not motivate him or her to continue the interaction, because it requires too much time and is unlikely to provide them with something valuable enough for their time.

- **The interaction must be more than just a “next page”.** There should be something special to engage the users and take them directly to a goal, in this case more detailed information on the theme. The value of interactivity occurs when the user is presented with options for customizing the information presented, and perceives that he or she is seeing something special.
Touch-screen technology today provides an excellent and proven method for users to choose the "path" that will take them through their content and customize the experience.

9.3.3 Media assets

Digital signage is a media and a way of advertising that has grown significantly in recent years due to the efficiency over traditional printed signage. One of the most important advantages is the versatility that the contents can be modified to suit the creative, so that the user experience will see increased.

In the implementation of this temporary exhibition, digital signage replaces the ancient poster that contain the same content, but the user would not be so encouraged to approach the site and start reading. The display provides a call effect for visitors, which promotes interaction and user interest in knowledge through the handling of the device.

Image processing of exhibition objects

The Museum provides the images to the Metropolia University to amend them as they see fit. When processing the images displayed on the application, one should have in mind that images appear both horizontally and vertically, so it is necessary to think of a suitable solution for image galleries. As seen in Figure 8, the images are the same height, without relying on them to be vertical or horizontal.
This provides a harmony on the screen that is very user friendly. It is also possible to see in the picture line that the vertical image is not complete, since it must be in line to meet all pictures that are equal to not disturb the linearity.

Background Image

The background of the display provides an image that will be exposed at any time, without relying on successive screens or new images as they appear. This is a point of reference for the user so that he or she does not lose interest in the application because in the short time the program opens a new window, the bottom of the screen remains unchanged.

Text files

Texts used in the application of "Passion for Collecting" have been provided by the WeeGee museum, leaving the Metropolia University with the responsibility to implement their design to provide visitors with a rewarding experience. The development team decided to use white font color as the background of the display is dark. This will produce a contrast that helps read text without being uncomfortable, as seen in Figure 9.
Figure 9. Example of text files displayed in the “Silver” Collection.

All texts used in the application have the same color but various sizes and fonts to create a nicer feel to the reader. In addition, the font size is adequate for proper display on the screen to use, at an average distance of it.

9.3.4 Running Software

XML is the programming language used to implement the project in the temporary exhibition of WeeGee museum. This language has several files that will be called when the program needed. In addition, Flash Player is used as an executable file where the XML will be transformed into an application which the audience will experience.

It is noted that in the performance of the XML application the screen space has been divided in different layers. Each element located on the screen, whether images, text or navigation buttons works as a layer in which each one is above the previous and the latter is that the user can see and use. There are three different layers in the application used to "Passion for Collecting":

- Background. This first layer as its name suggests is responsible for providing a background for the application and it never left with a blank screen and no content. It is used for transitions from one screen to other and the content
continues existing and does not reduce the interest of the visitor, as can be seen in figure 10 below.

Figure 10. Example of background display in the “Silver” Collection.

- Content. This layer is the one that shows the information which the user is interested in. It's placed above the background layer. The content displayed is the text, images and even navigation buttons. But this layer by itself does not carry out any action because it only shows the new content, as shown in Figure 11.
Figure 11. Example of the content index in the “Silver” Collection.

- Screensaver and GUI (Graphical User Interface). This is the last and third layer. Although it looks like two different layers they are the same. The GUI is responsible for producing reactions when putting the finger on the screen. It is a transparent layer placed above the content layer that gives it the ability to access new content and interactive actions. The screensaver appears on the display as shown in Figure 12.

Figure 12. Display of the screensaver in one of the collections.

The screensaver function is to attract the attention of the viewer when the screen is not being used, and this appears when after a certain time has not been used the GUI.

Features of XML and Flash

XML (eXtensible Markup Language) provides a format for describing structured data. That is, it is a meta-language, because with it you can define your own presentation language and XML focuses on the information itself. The most important feature of XML is that tags have no preset in advance, since it is the designer who creates them, depending on the content of the document.
XML imposes a more rigid syntax for marks, which allows it to process more efficiently. The marks finish with a "/>" to indicate that there are finished. Also XML is case sensitive. Also, any value of an attribute in a mark must be in quotes, this means that can not be ignored. Interpreting XML without knowing the valid set of marks is much easier. In particular, to define the type of document is not mandatory. In this case, the marks are obtained as the document is interpreted. XML enables to define markup languages for any purpose and has data validation capabilities. When XML appeared, a few key points were defined. [41]

- XML shall be directly usable over the Internet.
- XML shall support a wide variety of applications.
- XML shall be compatible with SGML.
- It should be easy to write programs which process XML documents.
- The number of optional features in XML is to be absolute minimum, ideally zero.
- XML documents should be readable by users of this language and reasonably clear.
- The design of XML shall be formal, concise and prepared quickly.
- XML should be simple but perfectly formalized.
- XML documents should be easy to create.
- The brevity in XML markup is of minimal importance.

A Flash Player is a software to display animations and movies using computer programs such as web browsers. Flash Player runs .swf files that can be created by the Flash authoring tool, Macromedia and other third party tools such as XML. Flash Player uses vector graphics. It uses them to reduce the file size and create files that save bandwidth and loading time. [41]

File Structure

The digital signage project for the WeeGee museum has a program in XML with the format of Listing 1 below, and it will be very similar in each of the possible screens. Thus, with the explanation of one of them could suppose the rest.

```
<element type="text">
  <contains lang="fi">Barokki 1660-1720</contains>
  <contains lang="en">Baroque 1660-1720</contains>
```
Listing 1. Element creation of XML code.

In this part of code it is seen how an element of some type is defined, choosing the position and size that will be put on the screen. It is also defined from where the element should be caught if it is an image, or where text is introduced if necessary.

Also, an element can contain various elements that trigger further actions by the program, as in this case choosing a different language would change the title of the current page, translating it to the different languages. Everything you can see on the screen, as in Figure 13 is an element that is defined and may open new windows with new contents.

Figure 13. Display of the previous piece of code in the “Silver” Collection.
In addition to this part of code, there are more XML files, more than one per page. These are the setting XML files that define the main structure of the program. This XML code is responsible for defining the resolution of the screen, opening the main window of the program and even starting the screensaver. It also may define the colors and fonts that will be used in the whole program.

9.3.5 Testing and acceptance

The application which has the museum for temporary exhibition must pass after its completion of a series of tests to ensure reliability and functionality throughout the duration of use. First, the application must go through a high use test to check the refresh rate and characteristics of the software used.

After that, when developers have concluded that there are no errors in the program that may affect the usability of the application, perform a trial run. In this test, an older person without deep knowledge in technology is chosen to use the display and share his/her feelings with developers. Usability is an important requirement for this application, so the results of this test may cause changes in the focus of the project. On the other hand, the acceptance that cause today touch-screens make their use in commercial and public areas has been extended.

In conclusion, when the application has passed the test it can be delivered to the customer to put it into operation and to terminate the project.

10 Conclusions

The digital signage is a growing business and the number of public and private projects using this technology is rapidly increasing. The appearance of the new digital technologies is changing the traditional printed billboards because of the lower price and the reduction of the manual work needed.

However, there is a lack of knowledge of this technology by the customer and above all the end user, the person consuming the content. An effort by the industry to explain what Digital Signage is and the benefits it can bring to everyday life is necessary,
whether this means choosing a prospective client to consume a given product or reporting some interesting activity for the customer.

Despite the many companies that are working in the sector, it is commonly considered that the market is not yet saturated. A company focusing on developing a specific part of the value chain of digital signage does not have to develop another part. In example, one company that develops and provides touch-screens should not develop media players, because other companies may enter in the market and create competition. This pushes some companies to fill gaps in some others firms, to the point of working with a competing model in many cases, which benefits both sides.

Digital signage sector is focused mainly on offering advertising at point of sale. The industry is hoping to expand the range of products in order to maximize the number of projects. The advantages are clear for advertising new products. Digital signage has some qualities as rotating content, interactivity, wider dissemination, positioning at the point of sale, more effective and visual communication or even remote access for varying content. Also the provider does not have the need to be on the site where the images are displayed. The client company can update content directly which means presenting the information in an attractive manner.

As a conclusion, Digital Signage will most likely not replace traditional signage, at least in the coming years, but will, however, continue to gain increasing prominence.
References


