Internet Printing Services in Consumer Imaging Applications

Chris Tuijn and Jan De Clippeleer
Agfa-Gevaert N.V.
Mortsel, Belgium

Abstract

Digital cameras are no longer exotic gadgets being used by a privileged group of early adopters. More and more people realize that there are obvious advantages to the digital solution over the conventional film-based workflow. Claiming that prints on paper are no longer necessary in the digital workflow, however, would be similar to reviving the myth of the paperless office. Often, people still like to share their memories on paper and this for a variety of reasons.

There are still some hurdles to be taken in order to make the digital dream come true. We will give a survey of the different workflows in digital photography. The local, semi-local and Internet solutions will be discussed as well as the preferred output systems for each of these solutions. In this paper we focus on the application and workflow issues and we will only briefly indicate some important underlying technical and architectural issues, such as color management, image enhancement, etc… These aspects are dealt with in greater detail in other papers by the same and other authors.[18]

Introduction

In conventional photography, the captured scenes are recorded on a strip of film with a photographic emulsion that is contained in a specific holder (such as the popular 35mm or the newer APS capsules). In order to obtain photographic prints, these capsules must be delivered to the photo shops for development; the resulting negative filmstrip can then be used for the generation of prints. The main difference between the conventional cameras and digital cameras from the end-user's perspective is the different medium: digital cameras record their digital image data on digital media (such as Smart Card, Compact Flash, Memory Stick, optical discs etc.). The digital workflow that resembles the conventional workflow the most (i.e. delivering the digital media to a print shop for reading and further processing) is, however, not being used widely yet. It is precisely this workflow that would enable the people with little or no computer affinity to start using the digital alternative. The most common solutions that are being used today for printing digital images on the conventional photographic paper are realized via the Internet. Different solutions are, however, readily available. It turns out, moreover, that the wealth of alternative workflows that have been made possible by the digital workflow, often frighten people and cause a lot of confusion. One of the major challenges of the next decade to make digital photography a real success will be to make the digital solutions accessible for all consumers.

In this paper, we briefly discuss the different workflows that are available today for generating prints from digital images; we also will elaborate on upcoming solutions and future trends. In the following section, we will present a uniform, Internet architecture that can be used to realize all these scenarios.

Different Workflows

Local Printing

The most obvious solution to generate prints on paper consists of printing out the digital images locally on your desktop printer. It should be said that the quality of the desktop printers today (which typically are based on inkjet technology) has been improving dramatically over the past few years. For some printers, however, there are still some quality concerns related to the fading of the colors and the fact that the printed surface is quite rough because of an uneven distribution of the ink drops. Often, this surface is quite sensitive and the frequent manipulation of a specific print might cause non-repairable defects. Sometimes, it also takes a while before the prints are completely dry. Another concern is the cost factor: although the price of good desktop printers is quite reasonable, the main factor that drives the price are the glossy ('photographic') paper and the ink cartridges. A quick calculation proves us that a high-quality inkjet print often costs more than a digital print on real photographic paper. A third factor relates to convenience and ease of use: printing a number of pages often takes quite a while and needs constant monitoring.

An obvious advantage, of course, relates to the instantaneous satisfaction.

Kiosk Printing

A print order kiosk is a system with a user-friendly interface that allows end-users to define print orders. For ease of use, most kiosks have only a limited number of

input keys; some even have no keyboard at all and work exclusively with touch screens. Print order kiosks are typically equipped with a variety of input slots, supporting the most popular digital media. After inserting the medium in the appropriate slot, the system will prompt the end-user for further actions. The system will typically display the content of the digital medium on the screen by generating thumbnail versions of the images. The end-user then specifies which images he wants to have printed, as well as the product (paper size in case of photographic paper, T-shirts, mugs etc.) and the number of copies wanted. Optionally, the end-user can ask for automatic color corrections (see further) and, if required, carry out manual corrections as well.

For the fulfillment of the order, there are different possibilities. If the kiosk is located at a photo print shop, the prints can be made locally and picked up either directly or at a later point in time. If the kiosk is located at a public location (in a shopping mall, airport, supermarket etc.), the kiosk should be connected to a system that records the orders and makes sure that the fulfillment is carried out. The orders are then typically sent by regular mail to the end-users; for the payment, either a credit card or invoice-based system can be used.

The advantages of such a system are quite obvious: even inexperienced digital photographers can easily define orders themselves; a disadvantage for the user can be that he has to go to a shop or public place where such a kiosk is placed to make his order. If such a system is put at a place with a lot of public attention, the danger exists that people have to queue to transmit their orders. For the owners of such a system, it is often quite hard to predict the successful locations; since the investment is quite high, the penetration of these systems will never be able to beat, for instance, Internet solutions.

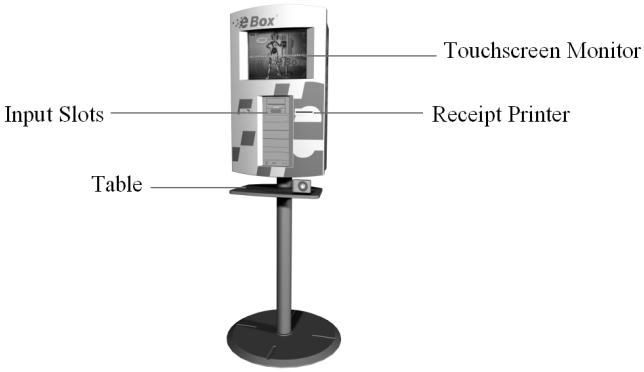

Figure 1. A sample print order kiosk

Internet Printing Using a PC

A very convenient solution consists of defining a print order locally on a PC and then transmit it over the Internet to a Print Server. The big advantage is that you can take your time to define your order and that you will not be disturbed by the environment. There are different possibilities to get your images and orders across the Internet.

A first solution is to use a stand-alone application that connects to the Internet independent from a browser. After entering your personal data (which you typically have to do only once), the system will prompt you to choose the lab of your choice for the fulfillment. The photofinishers will typically have a number of pickup points where the prints are delivered; most of them also support mail order. In the latter case, you will have to specify your payment method that, most of the time, comes down to entering a number and expiration of a credit card to be charged. In some countries, the use of credit cards for e-commerce transactions is not really common practice; some labs therefore also support invoicing. The main problem is, of course, that the risk for the photofinisher of not being paid is higher if he cannot charge a credit card. This is, of course, a general e-commerce concern and is by no means typical for digital printing services. Only when client authentication will become more popular, businesses will be able to trace and verify the identity of their customers.

The next step then, again, consists of adding images to the print order and specifying the product type. The end-user then can confirm the order and the price will be calculated; after a last verification, the end-user can commit to the order. Then, all images will be uploaded to the server (in batch) and the e-commerce transaction is completed.

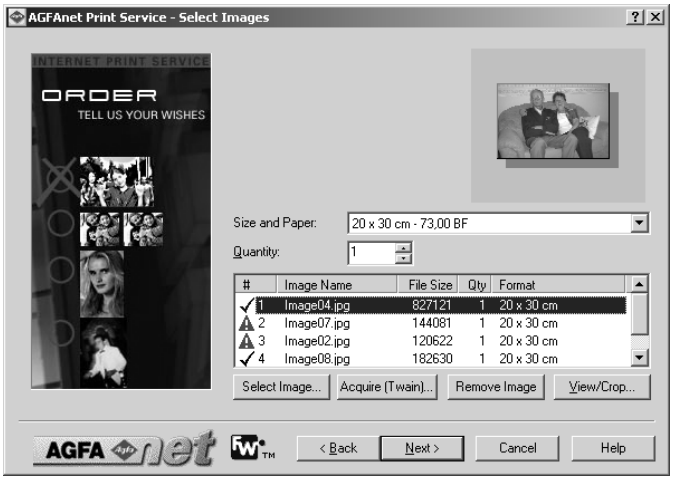

Figure 2. A typical image selection dialog of a stand-alone application

One of the advantages of a stand-alone application is, contrary to the browser-based solutions, the flexibility. Browser-based solutions will typically be combined with photo sharing capabilities. In this case, the user has to login to the photo sharing site and can upload his personal images to a web site. The uploaded images can be organized in web albums; often, these albums can be shared with friends who can get access to the images via passwords.

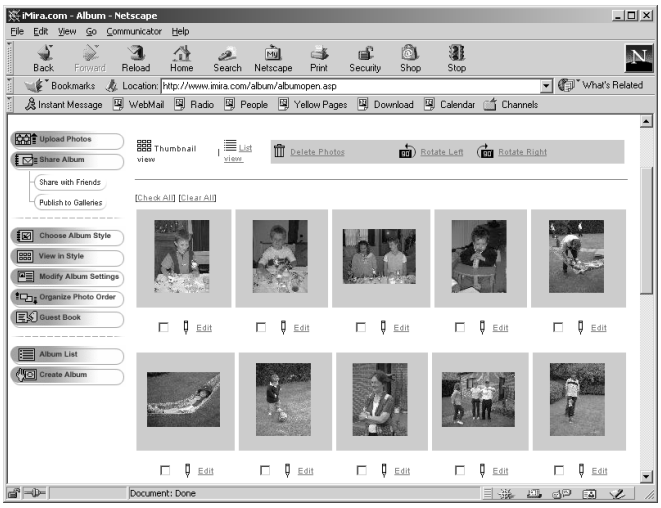

Figure 3. A sample album page of a photo-sharing web site

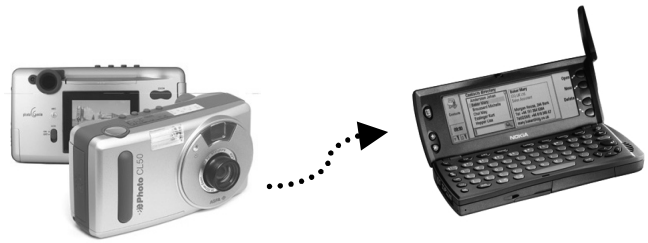

Figure 4. Wireless transmission of the images from a digital camera to a mobile

The advantages of using a sharing site are that you have your images on-line and that you can define print order or re-orders from everywhere. Defining a print order from a browser, however, is usually more complicated than with a stand-alone application and is typically implemented using the shopping cart paradigm. Many shopping cart implementations in browsers often force the end-user to move back and forth between pages, which is often experienced as a rather tedious task.

New Trends

A lot of changes can be expected in the wireless area. Although the typical bandwidth of today limits wireless digital transfers to 9600 Kb/s for single lines (or more if circuit switching is being used as, e.g., with HSCSD[0]), the rapid growth of wireless communication devices proves that the industry believes in its applications. In addition to the conventional mobiles (that often support rather limited digital services such as SMS), some powerful (more expensive) mobiles have been introduced on the market with the well-known browsing characteristics. An example of such a mobile is the Nokia Communicator 9110; this mobile internally has a larger rectangular screen and has an embedded HTML browser. For the support of the small mobile screens, a special mark-up language (called WML or Wireless Mark-up Language) has been defined by the WAP forum.[0]

In addition to the mobiles, we also see a lot of PDA's (Personal Digital Assistants) with embedded mobile and modem support. Some of these PDA's even support digital (still) cameras; and we will undoubtedly see the first PDA's with motion cameras appearing on the market very soon.

The applications of wireless communications in digital photography are quite astonishing: just think of a journalist who has taken 'the picture of the century' with his digital camera and instantaneously transmits it to his mobile (over a standard, local, wireless communication channel such as IRDA[0] or Bluetooth[0]); the mobile can then on its turn transmit the image to a central image server on the Internet or e-mail it to the news redaction. Although the communication costs are still quite high at the moment, feasibilities have proven that this is already possible with today's technologies.[0]

Digital cameras with a direct Internet connectivity (wireless or not) can make life even easier. In this case, there is no need anymore for an intermediate station (such as a PC or mobile). Most of the GUI involved in defining which images have to be uploaded and/or printed, will have to be realized on the digital camera. This GUI can be made available through the user via the LCD screen that most digital cameras have. Whereas the integration effort (in terms of R&D) involved to offer any kind of image upload/print support into a typical digital camera can be quite considerable (most cameras have their own proprietary run-time operating system), some standardization efforts in terms of digital camera operating systems can be expected. A first example of this trend has been the definition of Flashpoint's DigitaOS.[0]

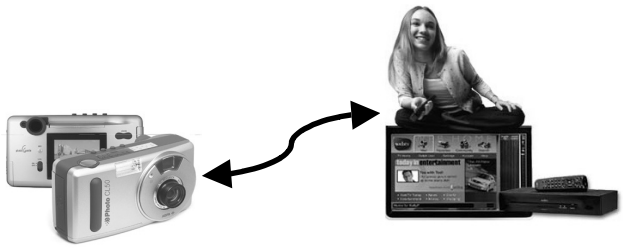

Figure 5. Images are uploaded from the digital camera to the set-top box over standard interfaces

In order to make digital photography a real success in the future, solutions will be needed that do not require the presence of a personal computer. Also in the future, there still will be a lot of people that will not be familiar with the fast moving information technology. The obvious answer to this people is to integrate the digital technology and Internet into appliances they are familiar with such as television (WebTV through, e.g., set-top boxes) and, as already referred to above, digital cameras, phones etc.

In the WebTV use case, one could imagine that through a standard interface (such as USB), the digital

images are uploaded from the digital camera on to the WebTV which, afterwards, uploads the images into an album on the Internet provided by a photo-sharing site.

Internet Printing Architecture

General

In order to implement the use cases explained above, we now propose an Internet-based architecture that embodies, similar to the approach of Ref. 0, a decentralized system consisting of the following different components:

- A client component that has access to the Internet and is basically the initiator of the print ordering; there are different incarnations of this client component (such as stand-alone client applications, browser-based solutions, mobiles, cameras, set-top boxes etc.);
- One or more e-commerce servers that register the orders;
- One or more image servers that import the images from the client components and deliver the images on demand to the different photofinishers;
- A variety of photofinishers that poll their e-commerce servers for pending orders and download the specification of the different orders from the e-commerce server and the digital images from the associated image servers.

The main difference with Ref. 0 is that the system we propose is also decentralized at the back-end. This can be visualized in the following diagram.

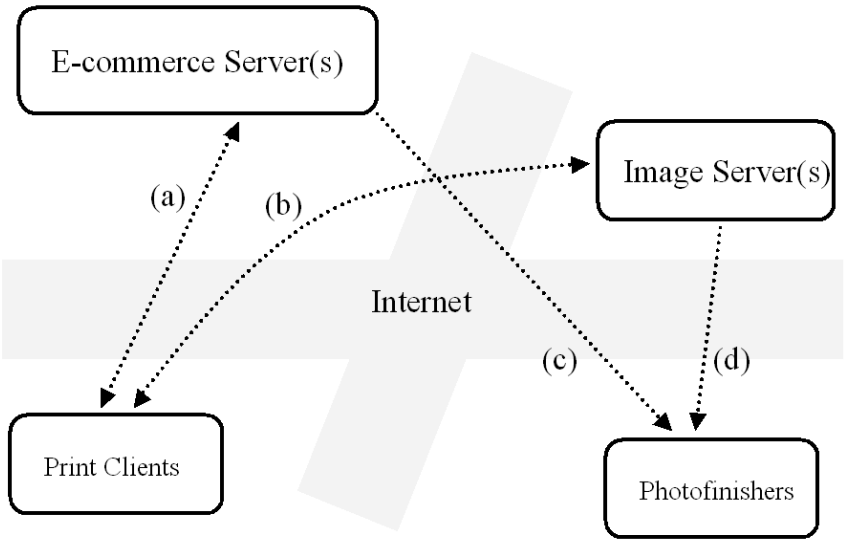

Figure 6. The different Internet Imaging components

In the diagram above, we can see different streams of information:

(a) The print clients obviously have a bi-directional communication channel with the e-commerce servers for retrieving the available storefronts, product items and prices and for uploading the orders.

(b) Stand-alone applications will upload their images to image servers; very often, the e-commerce servers will also act as image servers. For bigger photofinishers, it makes sense to deploy an image server that is located at the photofinisher. The image servers will also provide a thumbnail service to the print clients. This is a useful feature that can be used to facilitate the re-ordering of prints that belong to an album on an image server.

(c) The photofinisher downloads the orders from the e-commerce server.

(d) The images are downloaded from the appropriate image servers; if the image server is local to the photofinisher, this will be realized over a LAN.

Different Input Channels

The rich variety of potential print clients as presented in the previous section asks for a unifying approach. Although the different clients each talk in a different way to the Print Server, they all are defining print orders. This means that a big part of the services they require are identical. In order to share the code needed to implement these services, a 3-tier web server architecture is being proposed. The middle tier basically implements the business logic; for this layer, we use the Enterprise Java Beans standard, part of Java 2 Enterprise Edition

framework of Sun Microsystems.[0] In addition to the layering, there are many other features that are part of this Java-based framework such as transaction management (roll-back), messaging etc. Another advantage is that the J2EE standard has been adopted by many application server vendors supporting many hardware platforms and therefore promotes the freedom of choice of both hardware and software (application server).

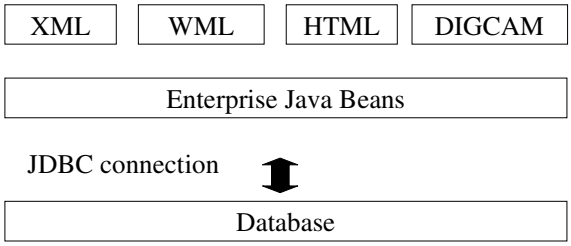

Figure 7. A typical Internet Imaging Server's Architecture

The Java Beans communicate over a JDBC socket with the lower layer; this lower layer consists of a powerful relational database that contains all relevant information related to the photofinishers, storefronts, customers, products etc.

The upper layer presents the API towards to rest of the world. Depending on the type of the clients, different protocols and/or languages will be spoken. Conceptually, there are three types of clients:

- Thin clients: these clients do not have a lot of intelligence and/or processing power. They typically only speak standardized languages and do not have real 'programming power'. Examples of such clients are:
    1. Limited HTML-browsers (such as available in some mobiles and PDA's). Sometimes, they use very special flavors of HTML with specific features.
    2. WAP-based mobiles: in order to make optimal use of the small screen, a special markup language has been defined (WML). Today, only bi-level black/white screens are supported and, therefore, the applications are quite limited. For consulting albums and re-ordering, WML might be powerful enough. It can be expected that, in the near future, the WAP-based mobiles will have large storage capabilities and will also support contone gray or color displays.
    3. Digital cameras: most of the digital cameras with Internet connectivity features only support the low-level HTTP protocol. They do not support the capabilities of a browser and are not capable of parsing more complicated languages such as XML. Therefore, only simple, tab-based information can be exchanged with these clients. Some of these systems also still lack the support of secure connections (such as SSL).
- Browser-based clients: these clients can be divided in two classes:
    1. Direct connection of the browser to the Print Server: for clients with powerful browsing capabilities (such as the classical workstation-based browsers), there are several possibilities. If the client directly accesses a Print Service, he should receive a general page that allows a user to login, upload images and define a print order. It should be pointed out that, in this case, the end-user has to wait until all (local) images are uploaded to the Print Server.
    2. Connection to the Print Server via a third-party web site: if an end-user has already uploaded his images to a third-party photo-sharing site, the images can be printed from there directly. This typically happens through functionality that has been provided by the photo-sharing site web developer. They typically connect to the print server through specific communication libraries. Depending on the server architecture they use, either C++-based or Java-based communication libraries should be used.
- Independent (stand-alone client applications): for these clients, the emphasis is on the user-friendliness of the GUI. Here, there are no limitations what so ever with respect to the environment in which they run. They are full-blown applications that connect to the Internet automatically. These clients speak with the XML-based client protocol that has been implemented in a communication library (that can also be used for integrating the print service in third-party web sites).

It is our belief that by using the standards that are currently being proposed by the W3C[0] organization (such as http(s), XML, SVG etc.) and other organizations (such as the International Color Consortium,[0] the Digital Imaging Group,[0] the Bluetooth Forum,[0] the WAP Forum[0] etc.), the architecture of the proposed system will be very open and easily adaptable to support upcoming future industry standards.

Organization of the Print Order Fulfillment

On the back-end side of the Print Server, an XML-based server protocol will allow the photofinishers to check whether orders have been uploaded for processing in their lab. The photofinishers will be able to download all the orders from their lab in a local database. They will be able to check from what type of client this order comes from, but the fulfillment will not differ from client to client.

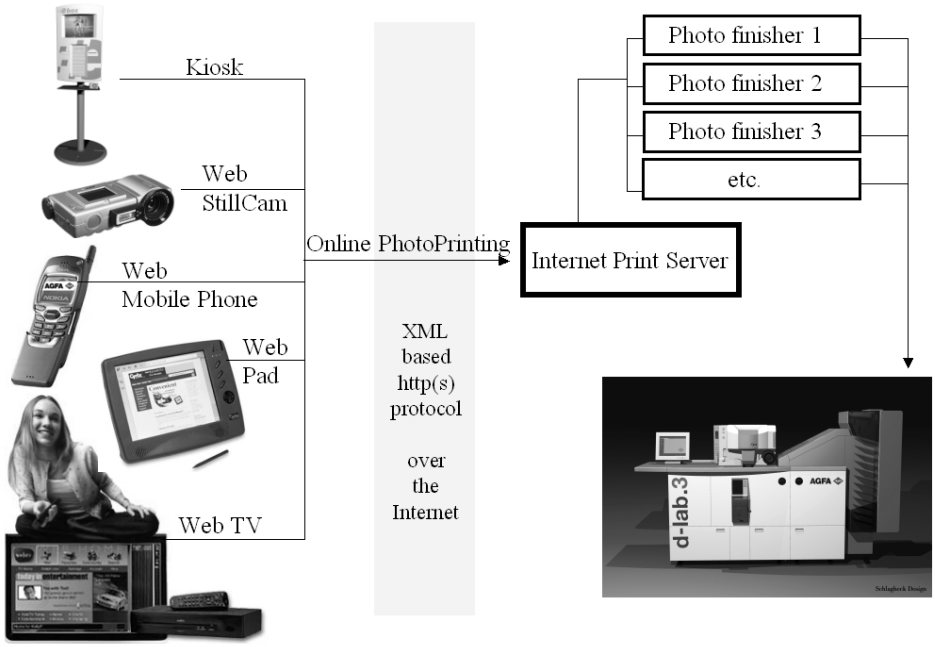

Figure 8. Overview of the different input channels

This functionality is implemented in an application that directly connects to the Internet. For photofinishers, a dial-up line will not be sufficient. We propose to consider at least a DSL[0] or ISDN[0] line; for big photofinishers, direct full-bandwidth connections to the Internet might be required. These photofinishers will typically deploy their own image servers. In the latter case, the client applications will upload the digital images directly to these images servers.

Color Management and Image Enhancement Issues

In the previous sections, a system's architecture is presented for on-line, digital printing. It is obvious that in order to guarantee optimal color quality for all types of digital sources, special color correction, image processing and color management support is required. There should be a clear separation between image enhancement on the one hand and color management on the other hand. This basically means that input images should be enhanced and delivered in a standard exchange space and, from there, standard color management techniques (cf. [0]) should be applied to guarantee reliable color. In other papers[18] by the same authors these issues are discussed in greater detail.

Conclusions

In this paper, we proposed an Internet-based system that realizes an Internet-based print ordering system. This system supports a large variety of clients ranging from stand-alone applications, browsers, kiosks, mobiles to digital cameras. At the back-end side, the system supports a chain of fulfillment partners that wish to join the network. Due to the openness of the system, the end-user can choose the photofinisher he likes the best. The architecture we proposed is based on open standards that will make connectivity to new input and output devices, sharing partners, image databases etc. much easier in the future. In order to reconcile the wide variety of input devices with the different output devices, appropriate image processing and color management techniques are required.

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