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## INTERNET CONNECTIVITY SOLUTIONS FOR DIGITAL PHOTOGRAPHY

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### Abstract

The exposure of consumers to the Internet is opening up broad new markets for data-centric services and products. One of these new markets is that of digital photography. A key to growing this emerging market segment lies in simplifying the mechanisms for connecting digital cameras and other sources of digital images to the Internet. In this paper we describe a number of mechanisms of achieving such connectivity using existing desktop PC and Web technology, and additionally using a new generation of consumer Internet appliances. In addition, details are given of the server-side infrastructure required to support a range of network-oriented services.

### 1. Introduction

Today's digital cameras are increasingly sophisticated and are rapidly superceding conventional photography. However a digital camera does not offer consumers the ease of use and service available from conventional photography today. In particular it is difficult and expensive for consumers to obtain prints of their digital images. Further, they must rely on their home PC for long-term storage of such images. In short the digital photography solutions available today are inadequate for the needs of most consumers.

In this paper we examine how today's consumer uses digital images and describe how connectivity solutions can be provided in today's marketplace using a conventional desktop PC and Web-based DCOM technology. This solution can provide connectivity to almost all of today's digital cameras without the need for the consumer to install any camera-specific software on his computer.

We also describe the next generation of Internet connectivity solution, which is achieved through replacing the desktop PC with an embedded Internet appliance. Such an appliance can be very lightweight and portable - much more so than even a conventional laptop.

In addition we give an overview of some of the new Internet connectivity options which can be offered through such an appliance including DSL, cable and wireless techniques. In particular we will consider wireless Internet connectivity using GSM networks and describe a practical implementation of such. A discussion

of techniques for accessing the Internet connectivity built into GSM phones is also included.

To support client-side consumer access to new digital photography services it is important that a flexible server-side infrastructure exists to provide the end user with a range of exciting and interesting new services, focussed around the network-enabled digital camera. We describe a preliminary implementation of such an infrastructure. Note that a key aspect of this client-server architecture for digital photography is that practically all of the client configuration information is maintained on the server-side. This, in turn, reduces maintenance issues and facilitates upgrading of services and the infrastructure as a whole.

Ultimately we predict that the functionality of the client-end will be directly integrated into the digital camera itself. This is eminently sensible as it will simplify the use of digital cameras from the consumer's perspective. However such integration will not occur until common standards for connecting digital cameras to the Internet begin to emerge.

### 2. The Basics of Internet Photography

In this section we give an overview of the key infrastructural elements of an Internet Photography (IPh) system. These are summarized in *fig 1* and comprise (i) a client-access mechanism; (ii) a server-infrastructure and (iii) fulfillment services. A more detailed account was originally given in [2].

The client-access mechanism provides a means to reliably download pictures to an on-line server which provides storage, access and management services for digital pictures. The pictures are maintained on-line for a certain period and then migrated to archival storage for long-term storage. Users can access pictures stored on-line and a range of services are available to manage and post-process images. Finally, volume fulfillment services can offer similar bulk pricing structures as for conventional photography.

One of the key advantages that digital photography has over conventional photography is the inherent flexibility of the digital medium. Thus there are already a broad

range of new added value services being developed by a number of Web start-ups to compliment the basic functionality of picture upload, storage and fulfillment.

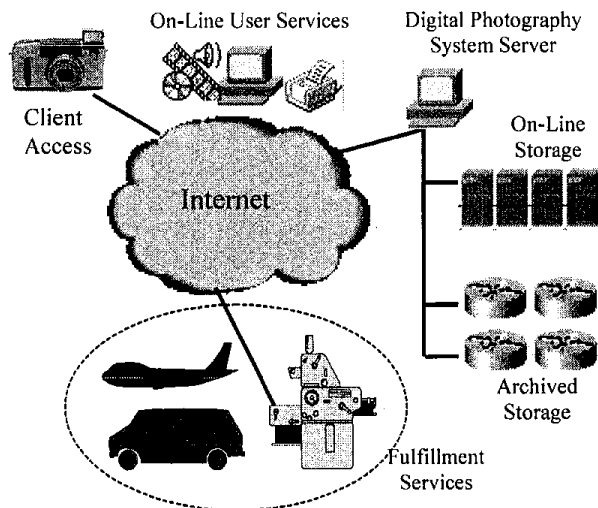


Fig: 1 The Key Elements of Internet Photography.

### 3. "Two-Step" Internet Photography

For most consumers their initial experiences of digital photography will have begun with the home-PC. These will have consisted of going through the often-painful process of installing software for their camera and learning how to use it to download pictures. Afterwards the tasks of organizing, cataloging, managing and archiving these pictures is left to the consumer.

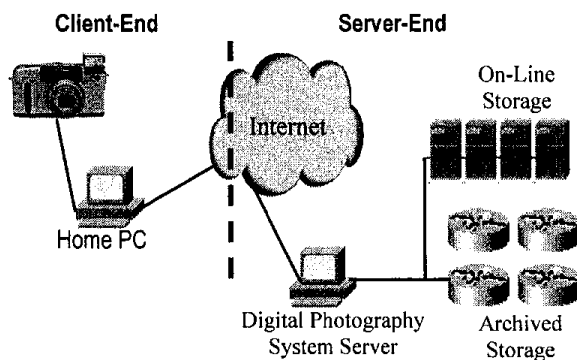


Fig 2: Two-Step Internet Photography Infrastructure based on a conventional home-PC.

The general user-unfriendliness of digital photography in today's consumer marketplace has led to the rise of a multitude – over 50 at our last count - of new web

services during the past 12-18 months. Each of these new services seeks to exploit the newly created market for added-value services for digital pictures. In essence they offer web-based storage of a user's digital pictures coupled with a range of services for printing, managing and post-processing these pictures. They have become known, generically, as *photo-communities*.

However a user's experience of most photo-communities is no less confusing than their first experience of conventional digital photography. Firstly they must load and store pictures on their home-PC. Following this they must then access a photo-community's website and initiate some web-based procedure to upload their pictures. This is generally slow and unwieldy, typically some form of *e-mail* or *FTP* based procedure, and is relatively complex from the user's perspective. Further it is also wasteful of both time and network bandwidth – particularly if the user is connecting to the Internet over a conventional phone line.

We like to think of this typical user's experience of a photo-community as the "two-step" digital photography experience – see Fig 2 above - because the process of loading the pictures from the camera is a separate process from the upload of the pictures to the Internet. Most end-users find this disjoint process both confusing and unnecessarily complicated and are discouraged by their experiences. Nevertheless this is how the majority of consumers experience Internet connectivity for digital photography in today's marketplace.

### 4. Direct-to-Web Internet Photography

In an earlier paper we described software techniques to allow practically all of the digital cameras available in today's market to be accessed from a common Java-based interface [1]. In this paper we also explored techniques to allow device driver modules for different cameras to be loaded remotely over a TCP/IP network. A logical extension of these concepts is to allow pictures to be uploaded, stored and managed on a remote Web site.

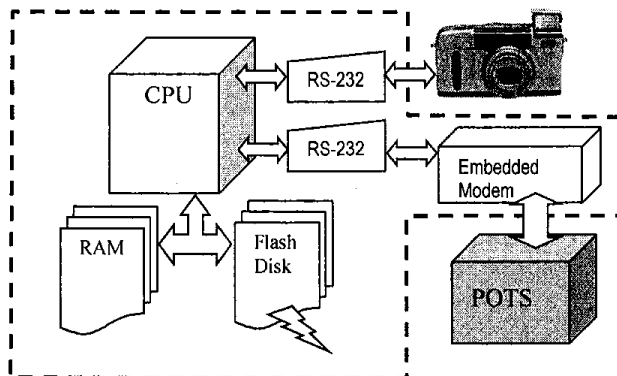
We now describe remote object technologies, based on DCOM, which can provide the end user with access to their digital camera and pictures from any desktop PC, which is connected to the internet. Connectivity is provided for the end-user directly from a Web site using a DCOM software infrastructure to detect and directly access images on a digital-imaging device. Most importantly, this connectivity is transparent to the consumer. The technology employs DCOM techniques to load and install driver software for a digital camera on a client PC.

As is illustrated in Fig 3 below the end user accesses this connectivity solution on a remote website using a



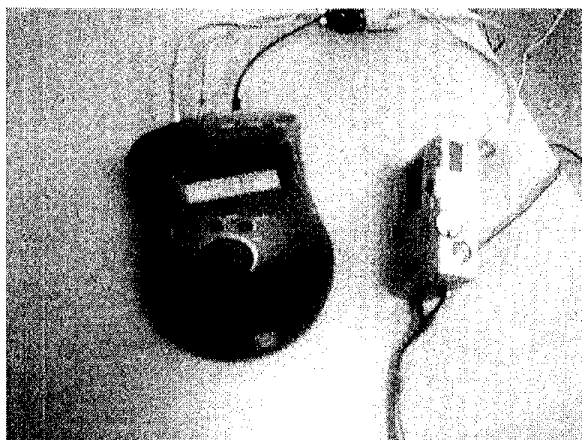
implementation of such an appliance was described in more detail in an earlier paper [2]. A diagram of the main hardware subsystems of this device is given in *Fig 5* below.

In many respects this is a simplified embedded form of the standard desktop PC. By using an embedded CPU, which is compatible with many desktop products, it is possible to leverage existing interface software developed for digital camera applications and to reduce the unit cost to consumer levels.



*Fig 5: Client Hardware for an Internet Appliance, which connects digital cameras directly to the Internet.*

A prototype implementation of such an appliance and the associated system software was described in some detail in an earlier paper [2]. A picture of the final product is shown in *Fig 6*.



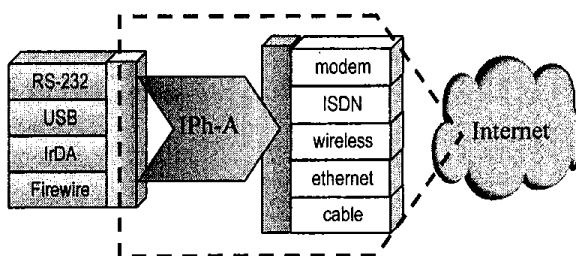
*Fig 5: Internet Photography Appliance which connects digital cameras directly to the Internet.*

## 6. Next Generation Connectivity for IPh

In the earlier sections of this paper we have explored some of the Internet connectivity technologies which are available and practical today. We saw that the home-PC is still the access channel for most users, but section 5 has indicated that a new generation of Internet-enabled consumer appliances will provide a wealth of new connectivity options.

We note that the latest digital cameras have evolved from using serial connections to adopting the faster USB, or Universal Serial Bus, for connecting to a home-PC. Similarly, many consumers can now avail of high-speed DSL, or Digital Subscriber Line, technology for home Internet access. The combination of these two emerging technologies makes the Direct-to-Web connectivity, described in section 4, very attractive for home users. Now their pictures can be loaded from a digital camera to a Web album in the blink of an eye. We expect to see similar advances in appliance-based connectivity very soon.

An overview of the functional requirements for a generic Internet connectivity appliance for Digital Photography (the IPh-A, or *Internet Photography Appliance*) is summarized in *fig 7*. For the prototype implementation described in an earlier paper [2] we confined ourselves to the commonest means of accessing pictures on a digital camera – via the RS-232 port – and the commonest means of establishing an Internet connection – via the telephone network using a conventional analog modem.



*Fig 7: Connectivity Requirements for a generic Internet Photography Appliance (IPh-A).*

One of the more interesting means to achieve Internet connectivity is using emerging wireless broadband technologies. This, we feel, will be the key technology jump which breaks down all the remaining barriers to wide-scale user acceptance of Internet Photography.

Although there are no clear winners in the wireless broadband arena, it is evident that next-generation GSM mobile phone networks will be a leading contender both in Europe and the US. As a first step towards investigating the practicality of building a connectivity

solution for GSM we have undertaken a project to demonstrate Direct-to-Web connectivity using the existing GSM infrastructure. For this technology demonstration we decided to use a standard GSM PDA, the *Nokia Communicator*. This device combines a mobile phone with a full alphanumeric keyboard and a reasonably sized grayscale LCD. It has an RS-232 port and can establish an Internet connection over the GSM network to allow the user to receive e-mail or to browse the Web.

The *Communicator* runs a windowing OS known as GEOS. This is an older OS, originating on simple x86 systems, but it provides adequate multi-tasking functionality to allow us to implement a Direct-to-Web solution for a standard digital camera.

This connectivity solution is, naturally enough, somewhat cruder than its big-brother equivalent which runs on a standard Pentium-based PC. For example, only filenames are displayed when the user has to select the pictures for uploading to the Web. It is just not practical to provide a thumbnail view to the end user. Further the data transfer rate is limited to 9600 baud over the GSM connection which limits the practicality utility of this demonstration. However the key point is that it is possible to port the multi-camera Web solution which runs on today's Pentium PC to run on a much less powerful PDA platform.

We expect that as next generation GSM services come on stream that initial Internet connectivity will be at 115k baud rates. This is expected to rise to 384k baud about 12 months after initial deployment. Ultimately, it is expected that some next generation GSM services will support wireless 2-Megabit connectivity to the Internet. These new wireless services will undoubtedly be one of the key driving forces of Internet Photography over the next 2 years.

## 7. Conclusions

The digital camera is one of the most successful new consumer electronic products of recent years. However, although most digital cameras are functionally similar, each camera is accessed via its own proprietary software and protocols on the user's personal computer. This is quite confusing for the average consumer who is most interested in simplicity and convenience. For example, in order to have access to his holiday snapshots while away from home he is faced with the prospect of taking his PC on vacation, or borrowing a portable PC from the office. Thus, for many consumers digital cameras and photography remains complicated and inaccessible.

In this paper we outline an evolution of digital photography from today's desktop-constrained

infrastructure to a much freer, consumer-oriented technology. We believe that there are three key steps to this evolution: firstly, the infrastructure for digital photography must become internet-enabled; secondly, the dependence of digital photography on the home-PC must be broken and thirdly, network access must become global and transparent through the adoption of wireless network connectivity.

We believe that the connectivity techniques described in this paper provide a practical, market-focussed, bridge between the digital cameras available in today's market and future models which will, without doubt, incorporate embedded Internet access directly in the camera unit itself.

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## BIOGRAPHIES

**Peter Corcoran** received the BA, BAI and Ph.D. degrees in Electronic Engineering from Trinity College Dublin in 1984 and 1987 respectively. He was appointed to a lectureship in Electronic Engineering at the National University of Ireland, Galway in 1986 and still teaches there on a part-time basis. His research interests include network appliances, home networking technologies and digital photography. He is currently the General Manager of FotoNation Ireland Ltd., a Zing Networks corporation based in Galway, Ireland.

**Eran Steinberg** is one of the founders of FotoNation Inc. Previously he was the chief scientist and vice president of software at Epix Imaging Systems and manager of the Core Technology group at Electronics for Imaging (EFI). Mr. Steinberg holds a Masters of Science from the Rochester Institute of Technology, a Bachelor of Science in Mathematics and Computer Science from Hebrew University, and a Bachelors in Fine Arts in Photography from the School of Visual Arts in New York City, where he also worked as a freelance photographer. Mr. Steinberg is the author of several patents in the field of digital photography. He is currently CTO of Zing Networks Inc.