Cloud Printing: An Inventory

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Extended Abstract

There is an unprecedented level of innovation today in the area of mobile devices, notably Smart Phones (that are, in reality, highly sophisticated "pocket computers"), and tablet devices, the adoption of which by consumers and corporate users continues to accelerate. Driven by such devices and other major forces of change in the IT industry, the computing model continues to shift from local data and processing on the desktop to such devices, combined with shared processing and data in the Cloud.

With the OS and data in the Cloud, it becomes necessary to print in, and to, the Cloud. Recent developments from Apple, Google, Hewlett-Packard (HP) and in this area, which include alliances between these companies, have moved the infrastructure for printing in the Cloud forward, and created opportunities for software developers and equipment manufacturers, as well as for service providers. In addition, these capabilities provide significant "openness" and developer support, which means that smaller companies than those mentioned above will also be free and even incentivized, to innovate in this area as well. Finally, content creators, including large publishers and media companies, game creators and many other types of companies, are rushing to participate in this new ecosystem. As a result, what only about one year ago was strictly a theoretical discussion has today become quite practical. And sophistication of capabilities will grow dramatically in a short period of time.

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This paper will begin with a brief explanation of Cloud Computing, and then inventory and compare the printing capabilities of the various systems, describe the capabilities available and touch on the level of effort required to develop solutions, discuss alliances and interoperability, provide some examples of their use, and look forward a bit into what we can expect in the future.

Overview

A new infrastructure for printing is being created to support the new "Cloud-based" computing paradigm. Today, software resident in new output devices (like consumer and small business-oriented HP Inkjet and laser printers), as well as software installed on desktop computers, allows pages viewed and/or stored on Internet-based devices, like Smartphones and Tablet computers, to be output in hardcopy (i.e., printed).

The capabilities are somewhat primitive today, but already support basic printing technologies like PPD (Postscript Printer Description) to represent the capabilities of an output device to a user via a Cloud-based user interface. More sophisticated capabilities will be layered on to today's infrastructure in the not-too-distant future.

Background

In our paper, entitled "Printing From Rich Internet Applications: A Standardized Approach," presented at TAGA ATC 2009, David Uyttendaele and I suggested ways that Cloud-based applications could generate pages suitable for hardcopy output, and compared desktop computing print infrastructure to printing from Rich Internet Applications. In the two years since, significant development has occurred to enable this idea.

Applications

There are many applications for which these new capability will be used.

1. Generating richly formatted pages from mobile devices; resident on websites and in Cloud-based applications to hardcopy output devices. This could involve printing a datasheet or a training outline on a local network attached printer, such as when staying in a hotel or visiting a customer. It could also include "collecting" documents while working mobile, and sending them to your home/office printer for collection later.

2. Direct printing from Cloud-based applications. This includes applications like Google Docs, and other SaaS (Software as a Service) or Cloud application services, and would allow those Internet-based

applications to print on connected devices in an office setting, or in a home. This is in contrast to downloading the content and using the capabilities of a personal computer operating system to direct the output to a printer.

3. Publishing Opportunities. The idea of print-on-demand availability of news, children's books, and other content is one that has been brewing for several years. This is now technically feasible, and business models may develop that make sense with the new infrastructure in place.

4. Commercial Printing applications in which a Print Service Provider is connected to the Cloud Printing infrastructure, enabling document building, production and distribution capabilities directly from mobile devices and Cloud-based applications.

Introduction

It's pretty clear that without the invention of the printing press, the information society we live in today would not exist. Quite literally, the Internet would not exist without this invention. As participants in the printing supply chain, we need to embrace the Internet, and exploit it to succeed in the future state.

Certainly over the last few years many applications for print have moved to digital delivery. In many application areas, print has been completely obsoleted. It's a natural trend with the evolution of technology, and will probably accelerate over the next few years. This doesn't mean that print is dead, though. Many applications for print continue to be useful, and some robust; new applications for print are emerging now, driven by mobile, social and content-based Internet applications.

While revenue in the printing industry is flat, and the number of establishments and employees continue to decrease, there is great opportunity within the downsized market. The printing process is in many ways being right-sized for our evolving global society. In an almost Darwinian march, the most appropriate applications for print are the ones that continue to flourish. New ways of creating and accessing content, and generating hard copy output, are emerging to meet that new demand.

Today, the latest perceived threat to printing (which is actually an opportunity, as we will see) is described as the "post-PC era." This encompasses smartphones, tablet computers and other non-PC machines that natively live in a "Cloud Connected" world, where applications, content and communication depend on around-the-clock connectivity. This new paradigm has thrown the publishing industry, notably books, magazines, and newspapers, into varying

degrees of chaos, with such participants scrambling to retain relevance and lay claim to the high ground.

While there is almost too much coverage of the turmoil that is happening in the publishing industry, there is less analysis of the technical aspects of how to capitalize on the opportunities. Here we will explore how printing happens under this new paradigm, and how commercial printers can take advantage of it to remain viable and competitive.

Background

In Cloud Computing, which is named for the way the Internet is depicted in network diagrams, companies no longer need to own the physical computing infrastructure upon which their software executes. Instead, they "rent" computing resources from a service provider, and only consume such resources (and also storage and other ancillary services, if desired), when needed. It's a shared, on demand, capability.

Cloud Computing Use Case

In early 2008, Dr Pepper pledged to give a free soda to everyone in America if the long-delayed Guns N' Roses album *Chinese Democracy* came out during the year. When the album finally appeared, the company announced it would fulfill its promise and that consumers could claim their coupon on DrPepper.com. On Sunday, November 23rd, very shortly after the announcement, the company's website crashed. How do you plan for capacity when you make a free offer to 300 million people? As a result of the outage, they extended the offer deadline, and added a phone number to massage unhappy fans. At the end of the day, the outage resulted in a lot of publicity for Dr Pepper, albeit somewhat negative (along with a lot of hand-wringing and additional expense to support the onslaught of Web traffic and the call center operation) Had the company deployed Drpepper.com on a Cloud Computing platform, they likely would have avoided the negative aspects and been able to focus on the positive publicity from the campaign.

A company called Major League Gaming (www.majorleaguegaming.com), hosts live gaming competitions for console and PC game players. The competition involves maintaining connectivity for players and streaming content for spectators. During an event, the site's traffic can spike up to 15 times normal levels. The company analyzed several options for solving this scalability problem, and decided that building out dedicated hardware and Internet infrastructure to handle peak loads did not make economic sense. Instead, they chose Cloud services from Rackspace, Inc. to support the variable nature of the traffic and assume the task of maintaining the infrastructure required to provide uninterrupted service to their millions of users. Perhaps ironically, Dr Pepper is today the "official soft drink partner" of Major League Gaming.

Enter Cloud Printing

"Cloud Printing", a term coined by the world's leading IT research and advisory firm, Gartner, Inc., represents a similar way of approaching print and distribution. Gartner has envisioned the ability for customers to order printed materials to be produced anywhere (i.e., it doesn't matter if the print facility is down the hall or across the world), and delivered anywhere.

As in Cloud Computing, this is an on-demand, shared resource model in which the consumer need not own the infrastructure of printing or distribution, but "rent" from a service provider when they need it, and use it as though it is their own captive resource.

Cloud Printing also represents a new way for the aforementioned "post-PC" or "Cloud-based" computing devices and applications, to access printers that formerly needed to be in direct proximity to the user—in fact, directly connected by a wire to a personal computer.

In this paper, we will discuss both the infrastructure of Cloud Printing, which enables the printing itself (including to home and office printing devices), as well as the drivers for the broader application of Cloud Printing to commercial print operations.

Cloud Printing Use Case

An international training company providing project and contract management training and consulting services to large corporations and government agencies was looking for a cost-saving alternative to continuing to operate their own in-plant printing operation. The in-plant was primarily focused on fulfilling customer printed products to use when conducting training over a wide geography, with many ordering users. A typical order included printing, binding, kitting and fulfillment of training manuals and related documents.

Similar to the above example for Cloud Computing, the company had peaks and valleys of traffic through their print shop. Often, equipment was either sitting idle for long periods of time (yet still incurring cost), or there was more demand than the equipment and personnel was capable of satisfying. Alternatives evaluated included "traditional" facilities management contracts or simply using local print service providers (PSPs) under contract. The trigger that caused the company evaluate such alternatives was equipment end of lease decisions.

Choosing the Cloud Printing model resulted in cost savings of 35%. The primary benefit beyond the ability to meet peak demand was that the cost became variable. The company only paid for what it used. It was able to eliminate the investment in equipment, real estate and staff for the printing operation. An analysis of the results after one year showed a decrease in cost

from $2 million to $1.3 million. The logistics capabilities of the Cloud Printing service provider chosen made it a better alternative to local print shops, because the print users (training providers) were geographically dispersed. In addition, the company saved even more by eliminating a coordinator position because ordering online was easier for users than the former in-plant's manual (phone/fax/email handled by a human) process.

Eliminating a coordinator position and replacing that person's function with a Web interface had the added benefit of making it much easier for the users to discover additional products and services the Cloud Printing company could produce—leading to more sales.

Infrastructure

There are several building blocks making Cloud Printing possible today and in the future. These include computing and storage, messaging, and domain specific Cloud Print capabilities. These building blocks enable the applications that need to print, as well as the printing capabilities themselves.

First, we will review the computing and storage offerings. Several companies provide Cloud Computing and Storage resources. Among the most popular are Amazon, Google, Microsoft, and Rackspace, Inc.

Cloud Computing Service Providers

Amazon Web Services is one of the first commercially available cloud computing platforms. Amazon spent over a decade and hundreds of millions of dollars building and managing a large scale, reliable, and efficient IT infrastructure for their own use. AWS lets others capitalize on Amazon's investment for their own applications, and includes Amazon Elastic Compute Cloud (Amazon EC2), the core offering, providing computing resources; Amazon Simple Storage Service (Amazon S3), is used to store and retrieve data from the Web. Amazon Relational Database Service (Amazon RDS) provides an easy way to setup, operate and scale SQL databases. Amazon Simple DB, as the name implies, is a simpler database built specifically to support Web applications. Amazon provides a Content Distribution Network called CloudFront.

Google App Engine (http://code.google.com/appengine) lets you build and run Web applications on Google's infrastructure. Google also offers Google Online Storage, providing the availability of massive cloud-based storage at affordable prices, both for end users and developers.

Microsoft's Azure Services Platform is a set of cloud computing services that provides computing, storage, hosting, and management capabilities. Windows

Azure is described as a "cloud operating system" that serves as the development, service hosting and service environment. The services are hosted in many global Microsoft datacenters.

Azure Storage provides a scalable storage service, on which to place your content. Azure also makes available Microsoft's IIS (Internet Information Server) Web server, a CDN (Content Distribution Network), which is an add-on service for placing copies of data closer to users (provides better response time for content delivery, with fewer long internet trips necessary for users further away from the primary hosting center of the application.)

Databases provided by Microsoft include SQL Azure, which provides many of the advantages of the company's SQL Server environment along with the highly available, scalable benefits of cloud computing and cloud storage. Another database offering, called Azure Tables provide the ability to store structured, non-relational (also known as noSQL) entities in the highly scalable Windows Azure Storage service

Rackspace provides two offerings: Cloud Server, and Cloud Storage. The company's approach is simple and direct, with exact configuration options and pricing posted on their retail website. Choose Cloud Server sizes (ie., RAM), the operating system you wish to employ (from several flavors of Linux and Microsoft OS), and you can be up and running very quickly. There are several approaches to managing the servers, and there are a variety of programs that let you accommodate scalability, reliability, backups and more.

Essential Technologies
Important technologies that make Cloud Printing possible today include Application Programming Interfaces (APIs, of various shapes and sizes), email messaging protocol POP (Post Office Protocol), and XMPP (an Instant Messaging Protocol, Extensible Messaging and Presence Protocol.) Additionally, some printing technologies like PPD and XPS are being leveraged in Cloud Printing.

APIs (Application Programming Interfaces) are (very generally) a defined set of specifications that allow one software application to access and use services provided by another system. APIs have been around for years, but their use and utility has accelerated with the growth of the Internet.

Some of the most popular examples of the use of APIs are in sharing content and/or data between "Web 2.0" social applications, in which content is created in a particular Web application and then posted and updated from/to multiple sites. For example, videos shared from YouTube on a social network site like Facebook. Similarly, sharing postings made on Twitter via LinkedIn, is enabled by Twitter's API.

In the context of the Cloud Computing infrastructure providers mentioned above, the "provisioning" of the resources in the Cloud (on which your own applications run) can be controlled via APIs. This is a big part of what allows Cloud resources to scale on demand in seconds or minutes, and similarly be "torn down" when the demand is no longer present.

Email protocol POP is used by HP ePrint devices. Each HP ePrint-capable printer has a unique email address that is assigned by the HP ePrint software infrastructure in the cloud when you "register" the printer. After registration, the printer uses this standard protocol for checking email to see if it has new print jobs. Since each printer is enabled to check its own email address to receive jobs, this empowers the printer's owner to send any new print job via email. This simplifies print job initiation for users, as well as for applications software that wishes to enable HP ePrint.

XMPP (the instant messaging protocol) is used by Google Cloud Print to provide real-time job notifications, but uses a "chat" network infrastructure. When a subscriber declares interest in receiving print jobs it establishes a persistent XMPP or "chat" connection with publisher. When a new print job becomes available, the publishing application says "hey we have a job" ... then the subscribing application can pull the job via an API (Application Programming Interface).

The venerable PPD specification is also used to provide printer capabilities in Cloud Printing, notably by Google. PostScript Printer Description (PPD) files, is used to describe features and capabilities available for Cloud-enabled printers.

Although Microsoft is notably absent from today's Cloud Printing infrastructure (with the exception of their Cloud Computing services being deployed to support applications), the company's unique intellectual property is being employed. OpenXPS, which is based on the original page description language originally developed by Microsoft as XML Paper Specification (XPS) that was later standardized by Ecma International as international standard ECMA-388, is used in a similar way to PPD by some Cloud Printing services, under certain circumstances.

Applications

Applications for Cloud Printing infrastructure range from simply providing the ability for post-PC devices to print at all, to new applications that employ ground-breaking business models.

Mobile Devices

An emerging use of Cloud Printing is the ability to print from mobile devices, and applications that serve mobile users, delivered via Cloud Computing infrastructure. The simplest applications involve hardcopy output of things like maps or boarding passes. Mobile and Cloud-based applications need to be able to generate richly formatted pages and direct them to the appropriate output device for the user to collect.

Other uses include printing a datasheet or a training outline on a local network attached printer, such as when staying in a hotel, visiting a customer site, or working at a remote office location. Functionality could also include "collecting" documents while working mobile, and sending them directly to your home/office printer for output later.

Direct Printing from Cloud-based Applications

Applications like Google Docs, and other SaaS (Software as a Service) or Cloud applications would be made capable of printing on connected devices in an office setting, or in a home. This is in contrast to downloading the content and using the capabilities of a personal computer operating system to direct the output to a printer.

These capabilities are extremely important when the device on which the applications run is a Cloud-based (post-PC Era) device, such as Tablet computers and other "alternative" devices, or laptops running operating systems other than Microsoft Windows or Macintosh OS X.

In addition, the capabilities here can be used by Print Service Providers to capture pages from these applications in the cloud. The use case is similar the "File-Print" drivers (such as EFI Print Messenger, or Adobe Job Ready); instead of the user being required to export a PDF, and then be upload it to the service provider's Web-to-Print system, the PSP's system would mimic the way a local printer appears in the Cloud-based application interface. The user would then simply choose that "printer," and the output would be sent to the PSP.

Publishing Opportunities

The amount of content on the Internet continues to grow, virtually exponentially. Companies both established and new are creating new publishing paradigms. Google Books, and the new Google eBookstore, (http://books.google.com) allow some books to be downloaded and printed; whether or not the books can be printed depends on the Digital Rights Management (DRM) parameters set by the author or publisher, which Google respects. "User Generated Content" is being "published" on sites like Scribd (http://www.scribd.com), and a variety of other similar sites; PowerPoint-like presentations can be found at SlideShare (http://www.slideshare.com), as well as many other sites.

New printers from HP come with simple Internet access capabilities built in that can be accessed directly from a small screen on the printer itself. The higher end models even include basic Tablet computers that can both control the functions of the printer, and can be detached and used stand-alone with wireless Internet connectivity. These are new access points for content, so the user doesn't even have to be in front of a computer, or even a mobile device, to obtain content they wish to use.

The difference with the new Cloud Print technologies is that now, an HP ePrint device can provide for on-demand downloading, or scheduled prints of online content from a variety of sources. Numerous publishers have signed up to provide content for the new ePrint service, including MSNBC news, Disney, Yahoo, Crayola, KoL.com for coloring pages; Picasa for printing photos; and PBS KIDS literacy, math and science activities. Announcements have described support for printing user's photo album or listed events from Facebook, MapQuest for maps and directions, Artsonia for images from a "kids art museum"; Arrival Guides for destinations around the world; Live Nation for access to concert tickets and promotions, and Fandango for move schedules and tickets. This sort of thing has been discussed and described for years. Now it is technically possible. Is it a business? That remains to be seen, but HP is certainly hoping it is.

Commercial Print

Emerging commercial printing applications in which a PSP is connected to the Cloud Printing infrastructure to enable document building, production and distribution capabilities can be accessed from mobile, alternative operating system devices, and non-PC devices, as well as from Cloud-based applications.

Until the very recent introduction of usable Cloud Printing infrastructure (discussed below), most printing (whether personal, workgroup or commercial) assumes computer-printer proximity. This means a workflow that involves first creating a document (in the "traditional desktop computing model," in a desktop application), and then "saving it" in an output format (e.g., PDF), or using another software package to convert it to the output format, then sending it (using a variety of methods) to a PSP.

"Distribute and Print" has been a concept that has been around for some time, but there has never been a standardized way to accomplish it. An Internet company that supports the "self-publishing" model, providing the ability for authors to create books in both printed and eBook formats, built a distribute and print network around open standards. The company (let's call them an Internet book publisher) uses JDF (Job Definition Format, http://www.cip4.org) and the old PrintTalk specification for e-Commerce (now part of JDF), to enable a

network of seven print service providers who can produce the books at various US and International locations.

This is, in effect, a "Private Cloud." The print service providers are pre-qualified; their capabilities and equipment are specified by the publisher, who also dictates the paper they use, finishing methods, and other technical requirements. Furthermore, the Internet book publisher also specifies which jobs each company gets, and how they ship them to the customer. There are several other examples of this in the industry. In addition to this specific "publisher/manufacturer" model, there are others in which a PSP has set up and controls a Private Cloud on behalf of a photobook retailer. In another instance, a company that controls both the sales and manufacturing of a print products can decide in which location connected to their own private Cloud a particular product should be manufactured.

The difference between Public and Private Clouds is the ad-hoc nature inherent in the Public Cloud environment. Wherein a Public Cloud infrastructure will be based upon open standards, and be freely accessible by companies or individuals who wish to participate, a Private Cloud is more likely to require direct negotiation and specific technical implementation.

Technical Capabilities for Cloud Printing

Let's take a look at three platforms for Cloud Printing, and their capabilities. Apple, Google and HP have immediately emerged as leaders, as one would expect, and we will discuss their capabilities here. In the case of Apple and HP, their decades-long leadership in printing prefaces their innovation in Cloud Printing. In the case of Google, the company neither manufactures printers nor did it "invent" desktop publishing, but instead is motivated by the needs of its emerging Cloud-based operating systems and applications that need printing to be able to succeed with customers.

There are many other companies, large and small, who are adding capabilities to the Cloud Printing ecosystem, participating in building functionality that accesses and adds to the three platforms, as well as in developing additional infrastructure.

Before we get into what is going on today, let's take a quick trip into the past—to 2001, the height of the dotcom era. A company called EFI (http://www.efi.com), known back then as "Electronics for Imaging," created a new system called PrintMe Networks (http://www.printme.com), that it described as "the first complete Internet printing solution that enables remote printing without requiring print drivers, cables or complex setup." The company further described the solution as "enabling (sic) users to print documents from their personal computers, personal digital assistant (PDA) devices, two-way

pagers and even cell phones by simply "dialing" in to any printer on the PrintMe Network." Thus was born the first real incarnation of Cloud Printing. In fact, the authors' employer, Mimeo.com, was also part of the PrintMe network. The two companies announced their collaboration in May 2003, EFI described how by submitting print jobs via PrintMe Overnight to Mimeo's global printing center in Memphis, Tennessee, customers could order bound and custom printed jobs delivered the next day to "virtually any destination in the United States." EFI has always been very forward-looking, and PrintMe was no exception. It was literally a decade ahead of its time. PrintMe is still around; and its time has come—EFI has recently restarted development of the technology. We can expect to hear more about PrintMe in the near future.

| Vendor/ Technology	Platform	Printing Capabilities
Apple AirPrint	Mac OS X, IOS 4.2 or Later	iPhone, iPad are almost the definition of Cloud-connected (post-PC) devices. Airprint can only print locally at the current time. Today, Apple AirPrint can only print to HP Web connected printers.
Google Cloud Print	Android platform, Google Apps, Google Chrome OS, Apple IOS 4.2 and later, iPhone and iPad, HP ePrint devices	Google provides support for any printer, new or old. Can be easily extended to provide access to commercial printers or other Cloud-based services. Open, published specifications. Create your own Cloud Printing infrastructure, using the same open standards.
HP ePrint	HP Printers, Apple Computers, Blackberry mobile devices, more to come	Provides the ability for Apple Computers and Mobile devices to print to HP ePrint-ready printers. Can print any PDF attached to an email. Supports receiving output from Google Cloud Print infrastructure. ePrint devices run a version of the Linux OS on which applications may be installed.

Table 1. Printing capabilities and destinations of popular Cloud Print platforms.

The three companies have published technical specifications to varying degrees, and links to relevant technical literature is provided in the bibliography at the end of this paper. Apple's information is delivered in two areas, in their public tech support communities online, and in documentation that is available under their substantial developer program (http://developer.apple.com), which requires membership to access. Google Cloud Print has an extensive developer community with sample code available, and is also referenced in the bibliography.

Apple AirPrint

Apple Airprint provides printing on IOS (Apple's operating system for iPhone, iPad, iPod Touch), version 4.2 or later, and Mac platforms over a local network, today only to certain HP printers. Apple AirPrint finds printers on WiFi networks and allows printing text, photos and graphics to them without the need to install drivers or special software.

At this writing, AirPrint only works with HP printers that support ePrint (discussed below in the HP ePrint section.) iPad, iPhone and iPod Touch users running the IOS 4.2 or later software will find a new print function within apps on their device. They can tap the "action" icon, then tap the "Print" button, configure printing options, then tap "Print" (more details below.)
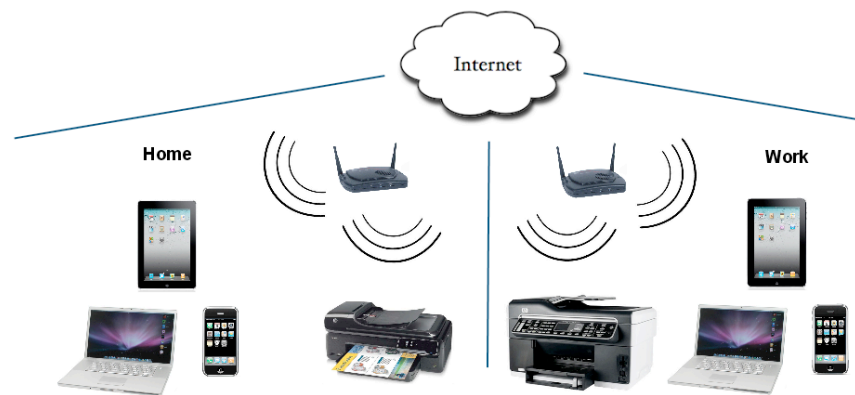
Figure 1. Apple AirPrint.

AirPrint and the underlying technologies in IOS and on Macintosh computers are included here because they represent important building blocks for the Cloud Printing world. Today, though, the technologies "out of the box" are only capable of printing on a WiFi Network. A printer must be specifically ePrint enabled and on that same network. Printing to a device attached to another computer is not possible with AirPrint. A smart developer is likely to be able to "hack" the technology to print to a Cloud-connected printer or service. It is

likely that extensions will be made by Apple and possibly third-party developers to enable this directly.

Apple has been at the forefront of printing with Macintosh computers for many years. They've similarly created a very robust printing infrastructure for the newer IOS-based devices. A technology called the UIKit printing API lets the developer assemble the elements of a print job, including the content to print and information related to the print job.

When the user goes to print, they are presented with a "printer-options view." They then make choices and tap Print. In some cases, where content is to be generated, the application draws the content to be printed and the UIKit software records what the application draws as PDF data. It is then handed off to the printing subsystem.

The printing system starts by taking the print data from UIKit, and spools it. It also captures information about the print job. The printing system manages the combined print data and metadata for each print job in a queue. When a print job rises to the top of the queue, the system looks at the target printer's requirements and capabilities, and if necessary converts the print data to a form that is usable by the printer. The printing system reports error conditions such as "Out of Paper" to the user as alerts. It also reports the progress of print jobs programmatically to the IOS Print Center, which displays information such as "page 1 of 2" for a print job.

Google Cloud Print

As we briefly discussed before, Google needs a way for its operating systems (Android, Chrome OS), and applications (Google Docs and more) to be able to print, without the need for a local printing infrastructure in which a printer is directly connected to a legacy operating system-based computer. To enable this capability, they created a simple and innovative service called Google Cloud Print (GCP). Google Cloud Print provides printing over the Internet to any local, office or commercial printer (PSP.)
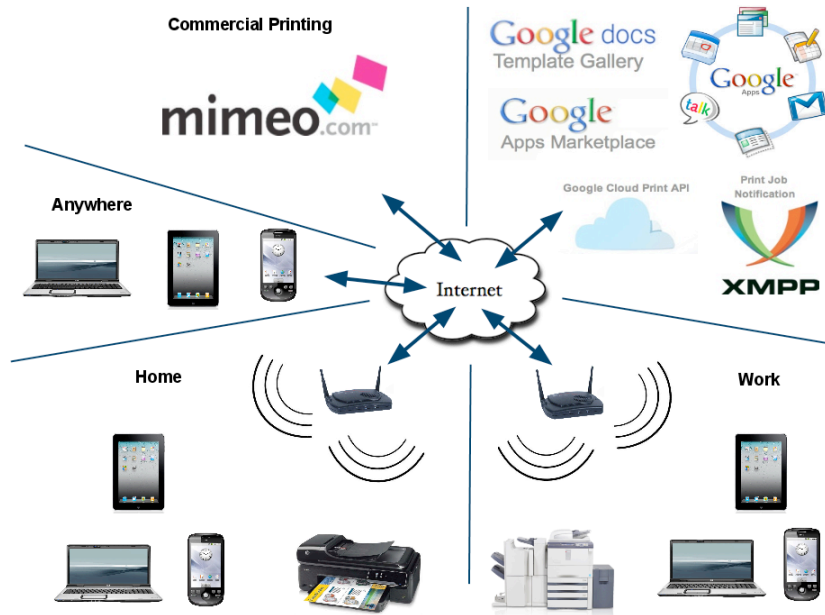
Figure 2. Google Cloud Print.

Users associate printers with their Google Accounts. The underlying paradigm is that printers are treated in a similar way to documents in Google Docs. The capabilities of each particular printer you associate with your account are stored, so the user may be provided options when submitting a print job. Once the GCP service receives a print job, it sends it to the printer. The service also receives regular updates on the status of the print job, which are then available to applications (presumably, to be shown to the user).

At this writing, only the recently announced connection between new HP ePrint devices and GCP could result in what could be considered "Cloud-aware" printers. But Google's strategy is to engage the industry and developer community with open protocols so many output devices (printers) will emerge that can communicate with cloud print services. Google rightly believes that implementing such open protocols based on industry standards are the way the benefits of cloud printing will be realized. It is almost assured that in the near future many output devices, from many companies, will have the ability to natively connect to GCP services.

All Existing ("Legacy") Printers

Where HP has a vested interest in new printers being natively able to connect to Cloud infrastructure (i.e., they want to sell printers and consumables), Google has the desire for their infrastructure to work with "all" output devices.

This includes printers connected directly to PCs, or connected to a LAN (Local Area Network, i.e., Ethernet or WiFi). Printers that do not natively support the GCP features set, but can access certain Web services (such as maps and coloring book pages) directly from their control panel LCD (see discussion of Applications), are also considered legacy because they don't know how to talk to a cloud print service to get print jobs and status updates. The HP ePrint devices (see below) would have been in this category up until right before this writing, when HP announced updates to its printer-resident software to allow those devices to become "Cloud-aware" via GCP.

What enables Cloud Print for legacy OS devices (such as Windows PCs) is the use of a proxy, which is a small piece of software that sits on a PC where the printer is installed. The proxy handles registration of the printer with Google Cloud Print and receiving print jobs from the service. When a job arrives, it submits the print job to the printer using the PC operating system's native printing capabilities and sends job status back to the printer. Google has proxy software for Windows, Macintosh, and plans support for Linux, as well. The proxy is delivered with the Google Chrome Web browser, so enabling the feature in Chrome lets users print via Google Cloud Print.

HP ePrint

HP has a broad vision for its Imaging and Printing Group (IPG) business. Today, this business represents over 20% of the company's revenue. Furthermore, HP's involvement in print is entirely Digital, and the percentage of print that is manufactured digitally today is extremely small versus traditional Analog methods. This means the opportunity is great for HP. According to Louella Fernandez, a principal analyst at Quocirca, HP is building an "ecosystem for on- and off-ramps and a comprehensive Cloud-based platform." They want to enable users to connect to any HP networked printer, multifunction peripheral (MFP), any print shop or retail storefront from any device, securely and seamlessly wherever the user is at any given time.

There are three major initiatives in the HP ePrint world. First, the company has created ePrint-enabled devices. Second, the company has created a public ePrint service, HP ePrint Mobile Printing Solutions, which basically lets you print to a public ePrint-enabled output device, from mobile devices and PCs. Finally, the company has announced HP ePrint Enterprise, as part of its Management Print Services offerings.

The likely-to-be ubiquitous HP ePrint services provide printing over the Internet to any HP Web connected printer. It appears that, moving forward, virtually all of HP's very popular printers, whether for the home, Small Medium Enterprise (SME) or corporate enterprise/workgroup use, will incorporate ePrint capabilities moving forward. Printers are registered with the HP ePrint Center

and get assigned an email address. Print jobs are delivered via email to the printer. According to HP, ePrint evolved from CloudPrint, an innovative technology created by HP Labs, the company's central research and development group.
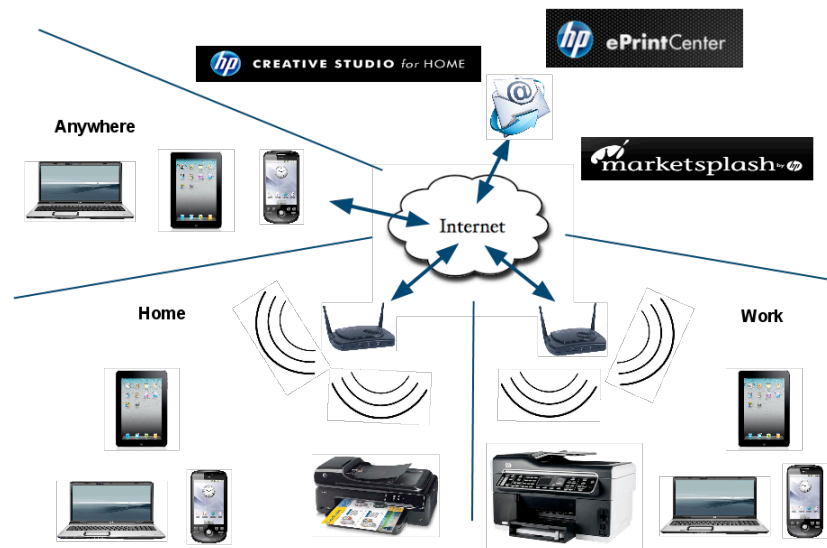

Figure 3. HP ePrint.

Even before Apple created the IOS printing capabilities discussed above, HP had enabled printing from devices like the iPad via email to their new class of Web-enabled printers that they began shipping last year (2010).

HP ePrint-enabled printers can also output jobs originating in Google Cloud Print. HP printers can be associated with a Google account natively, using the printer's email unique email address. Printing is then exactly the same as GCP—the user simply selects from the list of printers associated with their account.

HP says they are making a three-front attack on the Cloud: collaborating with cloud providers, collaborating with existing cloud users, and offering its own cloud services and cloud-enabled products. The big vision for HP's cloud research is focused on delivering an application and computing end-state of "Everything-as-a-Service."

The (Not-Too-Distant) Future

This has been a fascinating exploration, and this technology is at the very beginning today. We can expect that capabilities will expand dramatically in the short run. There are many technologies that still need to be developed—in numerous areas, such as:

- Discovery—Finding Cloud Printers and Print Service Providers, to which jobs may be directed.
- Communicating Intent—XPS and PPD are fine for simple jobs. JDF is out there, but may or may not be suitable for more complex jobs in this environment. It's being used by some "private" cloud print service providers (in which the relationship between the content creator and the print manufacturer is predefined), but not in publically available services that could be used "ad-hoc."
- e-Commerce—Because currently, the exciting technologies of Cloud Printing are oriented more toward simple output devices, rather than "print-for-pay," where does the integration of e-commerce fit? This must be invented.
- Integrating order specifics; production intent—Once the problems of capturing the customer's intent are handling, then how does a PSP translate that into its own production intent?

Perhaps the most thrilling thing about this whole new area of innovation is the energy that is being focused on printing by Google. Obviously, HP's innovation is truly wonderful, and so is Apple's, but their histories and contributions to print make us almost expect their contributions. One hopes that Microsoft also begins to contribute here, as well as companies in the graphic arts industry. In any case, we can expect much more in the future, in this area. Google, on the other hand, is almost the "poster child" of things going digital, so it is truly wonderful to see them become involved in printing. Remember that all of this is new in just the last two years.

Google is working with industry participants to build native support for cloud print services into their printers. There are other uses for which the technology Google has built can be brought to bear, for example in commercial print applications. Mimeo, in participation with Google's efforts, has created a proxy that lets users "print-to-Mimeo" from any application that supports GCP, by adding Mimeo as a printer in their Google account, just like any other output device in Google Cloud Print.

This is the future of printing. Because of this, Mimeo has dedicated significant resources over the last few years to building technology that enables our ability to participate in this ecosystem in a meaningful way. Kin Lane, one of the authors of this paper, was hired specifically as a "Cloud Printing API

Evangelist" to get other companies excited about Cloud Printing and help them use APIs and other resources, and to encourage anyone with content or print capabilities to participate in this new ecosystem being developed.

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