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INFORMATION DELIVERY SYSTEMS:

An Exploration of Web

Pull and Push Technologies

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TUTORIAL

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ABSTRACT

The Web is alive with news stories, pictures, music, and videos. How will organizations, managers, and other users find out what content is available, then locate it, analyze it, and make it meaningful? In this tutorial, we identify and classify eight types of information delivery systems (IDS) that we refer to as alpha, beta, gamma and delta and push technologies. For pull technologies we explain "surfing the Web", search engines, spiders and bots, personal agents, and finally evolutionary agents. For push technologies we explain Webcasting, channels and subscriptions, and data mining methods for determining preferences and filtering topics. We also examine the role of the evolutionary agents in push technologies. Throughout the paper, we provide examples of current pull and push technologies in each of the categories for pull and push. We include both personal and corporate applications. We then examine the managerial and social implications of higher-level IDS and suggest what is in store for users of information delivery systems in the future.

Keywords: Push technology, pull technology, Web, Webcasting, search engines, autonomous agents, evolutionary agents, data mining, information systems

I. INTRODUCTION

The revolution that we are partaking of daily is a noisy, graphical, textual, raucous carnival—full of color, music, slogans and information; charming in its capability to draw close and address us personally or to speak out loudly, broadcasting a message to the masses. The carnival is the development and use of information delivery systems (IDS) as an emerging technology in today's world. We use the term "information delivery systems," or IDS to describe the advanced form of both pull and push technologies for obtaining materials over the Internet (and its successors). In the first section of this tutorial, we explore the world of a person making use of pull technology, or seeking out information on the Web. The term pull technology can describe anything from personally surfing the Net to allowing an ever changing, independent evolutionary agent explore the Web for you.

The second part of the tutorial describes the development of push technology. The term push technology can be used to describe anything from Webcasting to selective content delivery using sophisticated evolutionary filtering. Push technologies will not be limited to visual display terminals. True push technologies will make use of a plethora of handheld and portable devices such as your Palm Pilot, digital pager, or mobile phone and inform you about a congested bridge on your route home, display a reminder to pick up milk when someone takes the last quart of milk out of the refrigerator; or on a wintry day will let you know that the thermostat inside your home has now been set to go up 5 degrees to ensure that the house is toasty warm when you return.

Push technologies will know your interests and preferences, they will be intelligent, and they will also be able to calculate your current location. The term push technology can be used to describe anything from broadcasting to selective content delivery using sophisticated evolutionary filtering agents.

We will first define and explain four different types of pull technologies and then investigate four different kinds of push technologies. Following that, we will explore the implications of Web-based emerging technologies specifically as they apply to managerial decision making and more broadly as they apply to the society as a whole. Our goal in writing this tutorial is to enhance the reader's understanding of information delivery systems and the future for research into IDS and their applications.

II. PULL TECHNOLOGIES

If you have searched for anything on the Web, you have used a pull technology. Pull technologies are commonly available and widely in use. The word pull connotes grabbing and yanking something from the Internet. If you look up someone's telephone number offline, you pull a phone directory off the shelf and turn pages until you locate the number. Similarly, you pull or grab information from the Web, and point, or turn, to other Web pages to locate the information you are looking for.

There are a variety of different pull technologies. One type may be more suitable for the tasks at hand than the other types. To make them easier to discuss, we created an original category system that classifies each of four technologies as shown in Table 1. We named the technologies alpha, beta, gamma, and delta and offer a brief description of each technology. We name each technology, describe it, provide a predominant metaphor being used in conjunction with the technology, and then add a statement about what aspects of user wants or needs the technology addresses.

ALPHA-PULL (α-PULL) TECHNOLOGY (SURFING THE WEB)

An example of α-pull technology is the basic searching technique of a surfer, who is navigating the Web by clicking on a hypertext link. The alpha-pull technology is the simplest form of searching and is equivalent to the manual transmission in automobiles. It is a low-cost, basic method that yields good,

Table 1. Pull Technologies, Their Descriptions, Metaphors, and Objectives

	Name	Description	Metaphor for the User	Accesses what users
α-pull	Alpha-pull	Clicking on links	Surfing the Net	Feel they want
β-pull	Beta-pull	Using a search engine	Using an information services guide; asking a Librarian	Think they want
γ-pull	Gamma-pull	Adopting a personal agent	Hiring a personal assistant (spider or bot)	Really want
δ-pull	Delta-pull	Creating an evolutionary agent	Creating a friendly bot that understands the user and changes over time	Really need

Adapted from Kendall & Kendall [1999].

perhaps optimal results when the user is trained to perform in an optimal way. But this approach also takes a great deal of effort.

This manual searching approach does not lend itself to any major support. Some software products such as WebWacker (www.bluesquirrel.com) aid the surfer in quickly downloading entire Web sites to a user's hard drive. This approach saves the browser time by viewing sites offline at a time that is more suitable. Microsoft's Internet Explorer 5.0 (http://www.microsoft.com/windows/ie/) now allows off-line browsing, and the user can choose the number of levels to ask the browser to download.

Browser accelerators are available to enhance the speed, but not the quality, of searching. Most of these accelerators are set up as proxy servers. Three popular accelerators are PeakJet (http://www.peaksoft.com/), Speed Surfer (http://www.speedsurfer.com/) and NetAccelerator (http://www.imsisoft.com/netaccelerator/index.html).

Other aids available serve as maps or gauges for the Web surfer. Bookmark managers like Starfish Utilities (www.starfish.com), Dragnet from Tikisoft (http://www.tikisoft.com/html/internet.html), and GrabNet (http://www.bluesquirrel.com/products/grabnet/grabnet.html) attempted to make bookmark (called favorites in Internet Explorer) administration but never really caught on. LyncSync (http://www.bluesquirrel.com/products/ls/linksync.html) makes it possible to synchronize links between Netscape Navigator and Internet Explorer. A new

approach is to store links remotely using a product like MURL (www.murl.com). Utilities, like GoZilla (www.gozilla.com), attempt to improve performance by finding the quickest site from which to download a file [Keller, Lake, & Littman, 1998]. All of the above utilities have one thing in common – they help users to pull material from the Web, in a simple alpha-pull manner.

Not everyone wants to take the time to find the best answer. Some users prefer to look up information in single-purpose sites. This "keep it simple" approach can be found in sites such as Roget's Thesaurus (www.thesaurus.com), Merriam Webster dictionary (www.m-w.com), or the Encyclopedia Britannica (www.eb.com). Users who need to get information quickly bookmark sites like these.

Alpha-pull technology (as shown in Figure 1) is simply going to the Web, seeking out sites of interest, pulling information from the Web, and bookmarking them for future reference. This process has been referred to as "surfing the Web."

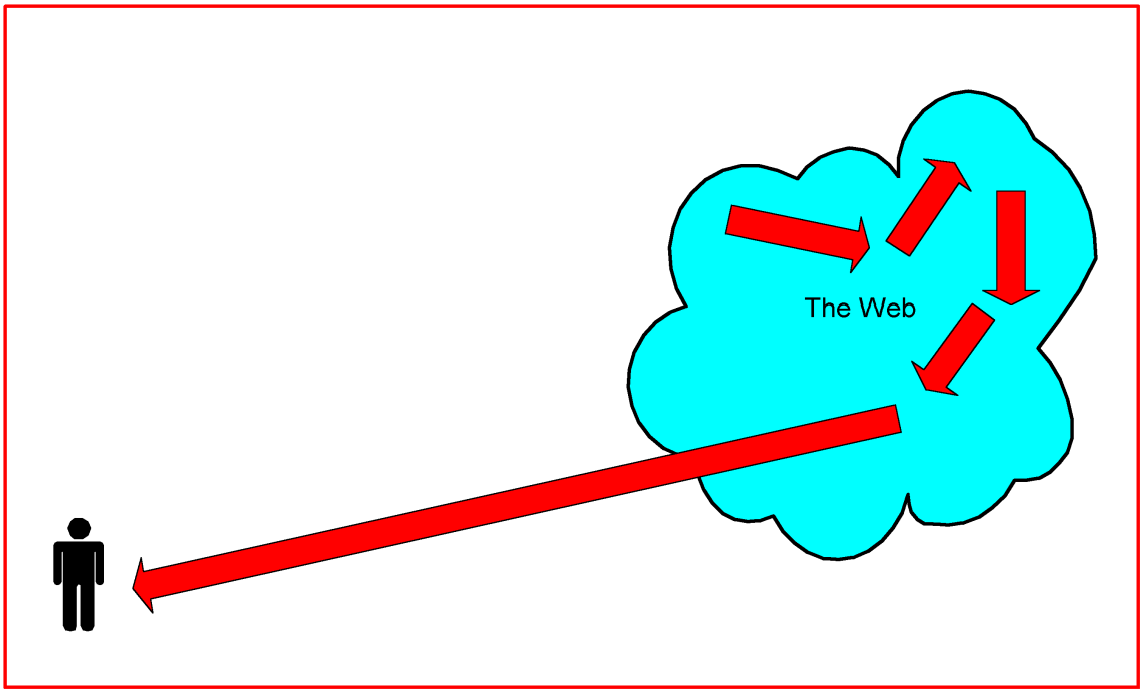

Figure 1. Using α-pull Technology, the User Pulls Information by Surfing the Web (adapted from Kendall & Kendall, [1999]).

BETA-PULL (β-PULL) TECHNOLOGY (USING SEARCH ENGINES)

Beta-pull technologies are also known as search engines. Examples include the early search engines of Infoseek (www.infoseek.com), Excite (www.excite.com), AltaVista (http://www.altavista.com/), Lycos (http://www.lycos.com/), HotBot (http://www.hotbot.com/), Yahoo! (www.yahoo!.com), and Northern Light (http://www.northernlight.com/). Partially because of the imprecise and misleading language that we have fallen into using when we look for materials on the Web (i. e. submitting a search form that says it will search the Web for our term) some users incorrectly assume that when they use a search engine the engine is truly wandering around the Web, ferreting out Websites that might have key words for which they are searching. They are instead searching one of the many databases, consisting of Website addresses that are set up in advance and periodically updated. Each of the databases has characteristics peculiar to it. (AltaVista allows users to limit languages, HotBot is particularly good in its ability to set page depth, and other engines are simply more flexible in Boolean searching). In 1997, HotBot claimed to have about 50 million pages in their database [Notess, 1997] at a time when there were an estimated 250-300 million Web pages in existence.

Google takes a different approach. It eliminates the “or operator,” doesn’t stem (in other words does not change “airline” to “airlines”) and eliminates common words (the, and, of) from the search. Google reports the results it gets using color bars, percentages, and text in order to help the user zero in on a site faster.

Search engines are text-oriented and concentrate on locating Websites based on user-supplied keywords. In the future, beta-pull technology may also allow users to find digital images and video clips on the Web. Chang et al. [1997] use an analysis of WebSEEk at Columbia University (http://disney.ctr.columbia.edu/WebSEEk/about.html), an Internet-based system, to examine current and future concerns about search and retrieval of information from large, distributed, online visual information repositories. In addition, they assess a prototype of an Internet meta-visual information retrieval system called MetaSEEk

(http://www.ctr.columbia.edu/metaseek/), which they describe as analogous to text-based meta-search engines on the Web.

Searches using search engines do not always produce satisfactory results. Users become frustrated because there are many false positives, or sites that appear but have little or no relevance to the topic of the user's search. Users also mistrust search engines, because they believe that there are Websites out there that the search engines just can not locate. An approach that evolved as a result of this dissatisfaction is the Web Ring [Basch, 1998]. In a Web ring (www.webring.com) each site is linked to the one before and after it. When a user follows links from the traditional search engines there is a tendency to drift far away from the original intent of the search. When users navigate an established ring, they can always get back to their starting point. This may seem to be a clear advantage, but Web rings have not become popular. Perhaps they are just too difficult to organize and maintain.

Search engines get their information about current Websites by using "spiders" or a "bot," short for robot. Bots (short for robots) or software agents are computer programs that have a variety of characteristics. They have been called on-line pseudo people, cited as popular testbeds for multiple aspects of AI; labeled as intelligent on-line assistants and group negotiators.

Over the past several years researchers at the MIT Artificial Intelligence Lab have studied and developed software agents as part of the intelligent room project; in particular they have been developing SodaBot/SodaBotL (http://www.ai.mit.edu/people/sodabot/sodabot.html and Coen [1994a]. One of the MIT researchers, Michael Coen [1994b] (http://www.ai.mit.edu/people/mhcoen/agents/chap5.html) describes software agents acting as on-line pseudo-people as possessing "beliefs, commitments, obligations, intentions and perhaps even confusion, stubbornness, etc." Some researchers [Shoham, 1993] have even developed formal languages for talking about the mental states of this type of agent.

When bots are acting as intelligent on-line assistants they handle high-volume, routinized tasks on the Web such as filtering e-mail, scanning NetNews,

and providing appointment reminders. Intelligent on-line agents can help simplify complex Web environments acting as artificial secretaries. More information about intelligent agents can be found in Maes [1994], Etzioni & Weld [1994], and Ein-Dor [1999].

Acting in groups, software agents can make decisions or negotiate situations. Coen [1994b] describes negotiating aspects of software agents by using the example of a group of people needing to arrange a meeting time. Rather than making people suffer the frustrations and juggle the complexities of trying to come up with a commonly agreeable time, groups of software agents can deal with the complex time constraints that such negotiations require. In these situations humans are not necessary to sort things out, and the software agents are duly occupied with a task at which they can outperform humans every time.

Most bots are created to serve useful purposes such as administering or policing a channel, although some are created to take over other bots or to send overly-cute messages to recipients (when an agent is functioning more as an annoyance rather than a menace). An example of a useful bot is Nickserv which tries to prevent random users from adopting nicknames already claimed by other others (FOLDOC - Free On-Line Dictionary of Computing, http://wombat.doc.oc.ac.uk/foldoc/index.html).

Search agent bots are very basic agents that gather information and organize it (as shown in Figure 2) in ways that may be useful to the general public. However, they are not personal agents that can help an individual user. They may find information more quickly than by simply surfing the net, but may fall short on quality. The impersonal nature of the bot or spider search means that the results may not be as good as a person performing a manual search.

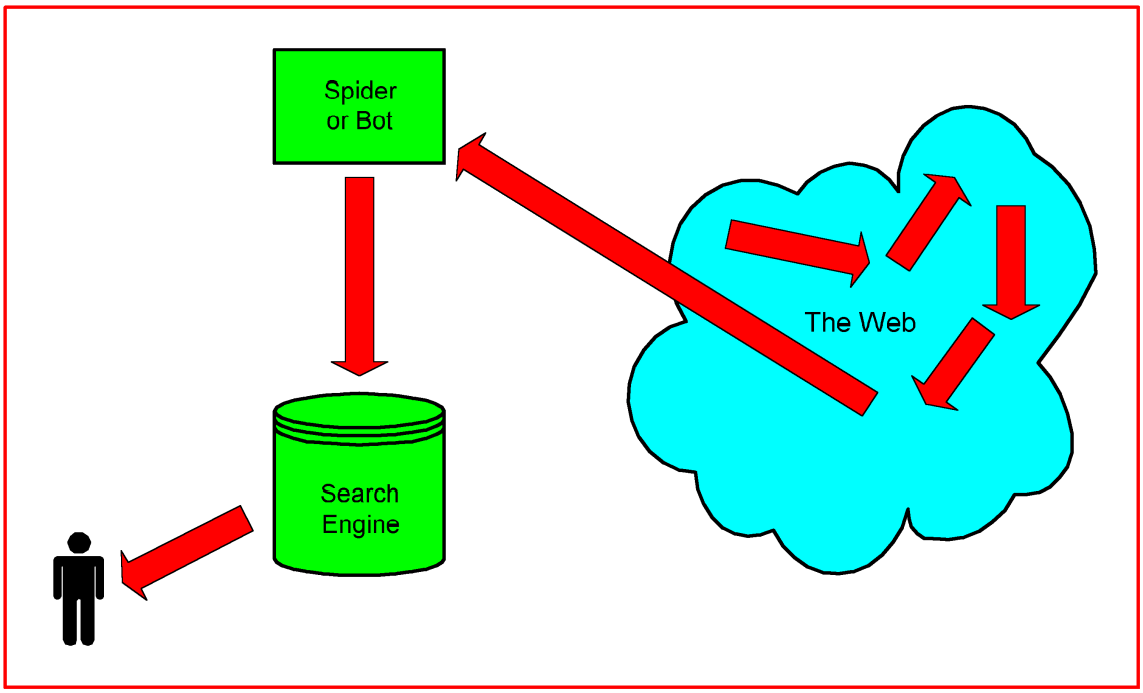

Figure 2. Using β-pull Technology, the User Pulls Information From the Search Engine Database, Which Obtained the Information From the Web Using a Spider or Bot
(adapted from Kendall & Kendall, [1999]).

GAMMA-PULL (γ-PULL) TECHNOLOGY (USING PERSONAL AGENTS)

Gamma-pull (γ-pull) technology uses agents to pull information from the Web, but the agents are different from the spiders and bots described earlier.

Gamma-pull technologies make use of personal agents, sometimes called independent agents to help users find information of interest. Metacrawler (http://www.go2net.com/search.html) is an on-line search engine that attempts to access other engines like Excite, AltaVista, and Lycos and combine and collate the results, but still it does not make it easy for a user to customize a search.

New categories of offline search programs are being called personal search engines or meta-search tools. With names like WebSleuth (www.promptsoftware.com), WebFerretPro (http://www.ferretsoft.com/netferret/index.html), and Webseeker (http://www.bluesquirrel.com/products/seeker/webseeker.html) they will help search from a dozen to over a hundred different search engines; help weed out duplicate or dead links; and assist in assigning values to the more promising sites. Some will allow you to save the results of the search, which will

then be updated automatically. By using Boolean logic, allowing users to save results, and allowing users to organize their searches, they have become more personal than the major search engines.

Each of these tools claims a different approach. WebSeeker refers to their technique for using quality keywords and phrases as a "results refining capability." Inforian Quest99 (http://www.inforian.com/) not only allows the user to combine search engines, but allows the user to preview the site content, then sort and rank the results.

Search engines also try to gather and report information that helps users in their searches. Copernic99 (www.copernic.com) uses predefined channels. Here, as sites are ranked by relevance, duplicate documents are eliminated, and statistics about a site such as title, description, hit count, date found, etc. are displayed. Copernic's configuration and search schemes can be customized for the user or search and a channel development kit (for configuring channel sets) is being developed.

Natural language interfaces are now possible, and a meta-search engine called "Ask Jeeves!"(http://www.askjeeves.com/index.asp) allows the user to type in a phrase such as "What is collaborative filtering?" This query recently resulted in 5 matches in Yahoo!, 9 in Webcrawler, 8 in Infoseek, 9 in AltaVista, and 6 in Excite. The least relevant was Yahoo, followed by Excite. The other search engines revealed some common, but mostly different results that were more useful.

News Clipping services have existed for some time now. An early news clipping service was Executive News Service from Compuserve (www.compuserve.com). ENS was based on key words and limited Boolean logic. Users incurred an additional cost and ENS did not seem to develop overall approval. Numerous other attempts were made and most failed. Two existing news clipping services are Newstracker (http://nt.excite.com) and Netscape's In-box direct (www.netscape.com) which allow users to select topics and receive news stories.

Personal search engines are not limited to finding text information or news content for users. Search engines such as TechSeeker (http://www.bluesquirrel.com/products/seeker/techseeker.html) searches the web for new drivers, updates, and technical solutions.

A project at IBM called "Clever" involves the development of an agent that locates a small set of the most authoritative information on a requested subject. Using algorithms developed by Kleinberg [1997] and Chakrabarti et al. [1998], the approach builds on Kleinberg's system called Hyperlink-Induced Topic Search (HITS) (www.cs.cornell.edu/home/kleinber/auth.ps).

In the "Clever" system, a standard search engine, such as AltaVista, is used to collect a root set of links, then expanded to include several thousand pages. Each page is assigned an "authority weight" and a "hub weight" according to the number of links that point to or from it within this group of links. After numerous calculations and recalculations a high quality list is generated. Rather than coming up with all possible sources, the list is in effect edited down to a concise (and hopefully trustworthy) collection.

An alternative approach to using search engines or directories is the service offered by a company called MiningCo.com (http://aboutus.miningco.com). This is a service that provides a network of comprehensive Web sites for over 600 special topics run by expert human guides in 20 different countries. Guides use standard templates and other established design tools and features to create Web sites on special topics, such as "home cooking" or "travel." Updated weekly and often daily, the goal is to make each MiningCo.com special interest Web site a destination page and a useful starting point for a user who is curious about a particular topic.

They market their guides as "company certified subject specialists" who can pull together, evaluate, and put into context Web sites in a way that automated search engines cannot. So in addition to creating and maintaining the special topic Web site and links, the guide hosts live chat rooms; oversees bulletin board discussions; makes book recommendations on related topics, pushes relevant news, sends a newsletter and handles email. The distinguishing

characteristics of this human-based service are, according to MiningCo.com, “finding information that is relevant to you,” and “knowing you can trust what you’ve found.”

As we write this tutorial we realize that gamma-pull technology still has a long way to go. Independent agents will develop so that they eventually can roam around the Web, maybe even visit other computers, reside there for a period of time, and return with useful information. Today we can send cookies to another computer and read those cookies at a later date to speed up business transactions, for example. The independent agent, Java enabled, can gather more information if we allow it to. IBM has developed such an agent based on Java applets, and thus combined the two to form something called an “aglet,” [*The Economist*, 1997].

The personal agent, shown in Figure 3, is the item that separates gamma-pull from other pull –technologies. At the time of this writing, independent agents are little more than meta-search agents. Customized startpages are now very basic. When these personal search engines allow users to specify more suggestions and relay information about depth and fuzziness of the search, then they will become true personal agents. The emphasis remains on the user’s wants, just like the other types of pull technology before this.

DELTA-PULL (δ-PULL) TECHNOLOGY (USING EVOLUTIONARY AGENTS)

Delta-pull technology extends the notion of the independent agent to an agent that evolves, changes, and mutates in order to refine the search. The goal is to improve the effectiveness of the search by providing not what the user wants, but what the user *needs*.

The evolutionary agent will be one that will observe, judge, act, and react in ways of its own to refine searches on the Web. The evolutionary agent of the future will initiate searches *sans* representation, that is, start without the underlying assumptions that tend to hold human thinking back.

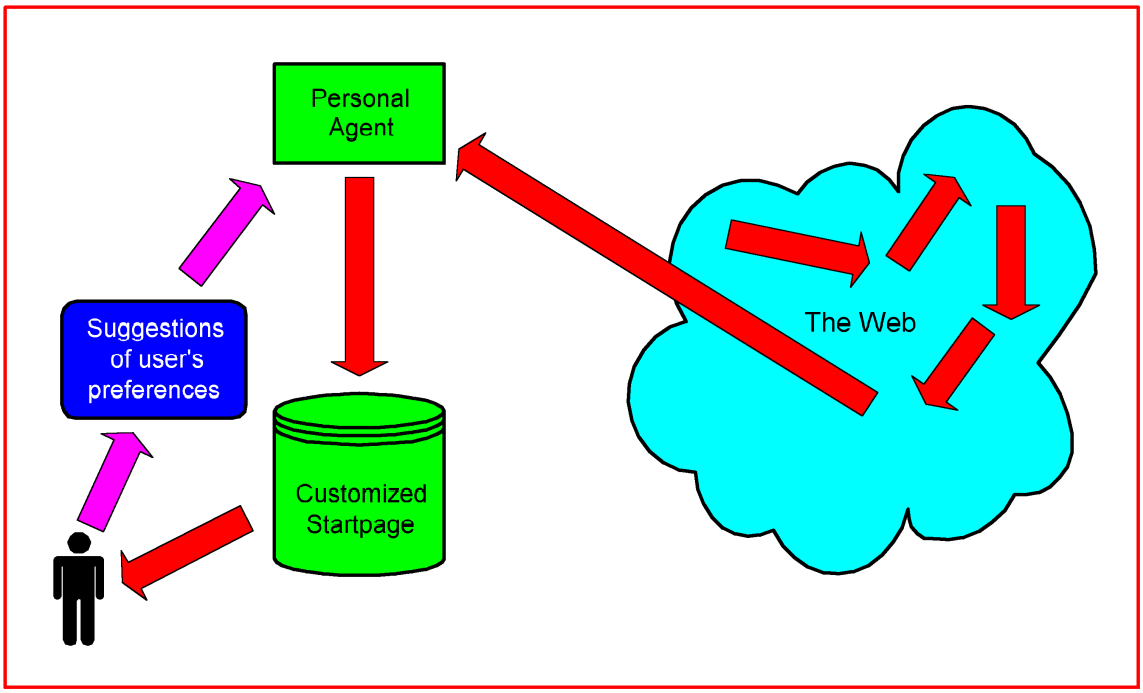

Figure 3. Using γ-pull Technology the User Sends Suggestions to a Personal Agent. The Agent Pulls More Specific Information from the Web and Sends It to a Customized Web Startpage
(adapted from Kendall & Kendall, [1999]).

Evolutionary agents will observe a user's pattern of interaction with information – not just what is searched, but also what is used, saved, and transformed as shown in Figure 4. The evolutionary agent will change over time, just as the user changes. In this way the evolutionary agent minimizes the dead-ends and useless information and focuses on the information needed by the decision maker.

The evolutionary agent may start out as a personal agent but will grow and change according to the results it gets, the behavior of the decision maker, and the changing world. So, if the agent observes a pattern, such as: the user is always searching the Web for universities, it will suggest a university when the user types in the name of a state. Since the agent will change based on experience, it will truly be, as the name implies, an evolutionary agent. A more complete discussion of the evolutionary agent appears in an earlier work on the future of artificial intelligence by Kendall [1996].

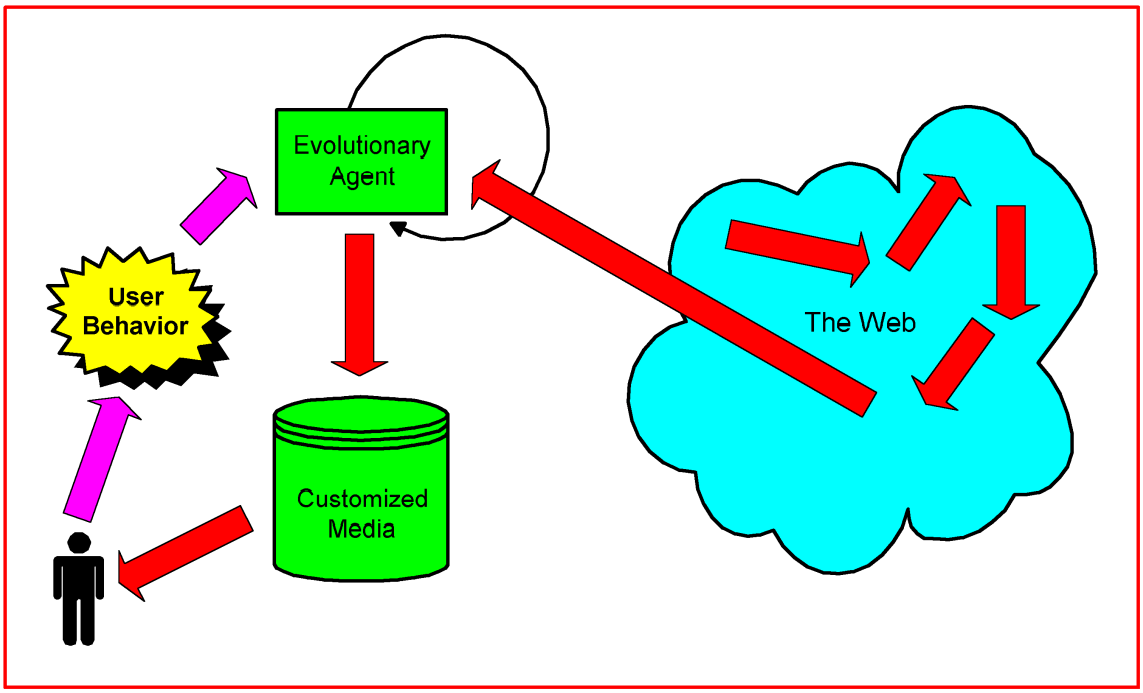

Figure 4. Using δ-pull Technology, the Evolutionary Agent Captures Data on User Behavior through an Iterative Process. The Agent Pulls the Information the User Needs from the Web and Sends the Information to Customized Media the User Can View
(adapted from Kendall & Kendall, [1999]).

There are reasons why delta-push technologies are superior to the less developed pull technologies. A surfer might type in the word sabre, expecting to obtain information about the online travel reservation and information system that originated with American Airlines. But the surfer might turn up many other non-related items. Our beta- or gamma-pull search engines each produced a list with a different item at the head of the list. One produced the name of a freelance art studio, another an automobile (actually two automobiles, a Honda Sabre and a Buick Le Sabre). A third listed a stairlift system. Other items that came up near the top of the list were a yacht company, a seminar program at the Nanyang Business School, and a foundation that donates books to needy individuals in Eastern Europe. One search found the Buffalo Sabres hockey franchise.

Depending on the beta- or gamma-pull search engine used, you will get strikingly different results.

Delta-pull technology, on the other hand, is able to observe the behavior of the user and then use that information to be more selective when identifying links. If the user has previously subscribed to a sports channel and indicated a preference for hockey stories, the evolutionary agent will observe the user's behavior and assume an interest in hockey and consequently will list all of the Sabres hockey pages first.

Would the evolutionary agent perform as well as a human on a particular task? Wegner [1997] provides a convincing argument that algorithms are inferior and that a paradigm shift will occur away from algorithms to interaction. But the lure of an automated personal evolutionary agent that will understand your wants and needs is powerful. In the next section, we introduce four categories of push technologies that we compare and contrast with the four pull technology categories. Push technologies push a variety of contents, in some instances personalized or customized, to the user.

III. PUSH TECHNOLOGIES

Push technologies can be divided into types analogous to the types in pull technologies. We have created an original category system that classifies each of the four push technologies as shown in Table 2. Once again, we name each technology, beginning with α-push (alpha-push) technology, which describes basic Webcasting. Each of the other types (beta, gamma, and delta push technology) builds on and refines the features of the technology in the preceding category. We provide a predominant metaphor being employed in conjunction with the technology, and then add a statement about what aspects of user wants or needs the technology attempts to reach.

Table 2: Push Technologies, Their Descriptions, Metaphors, and Objectives
(adapted from Kendall & Kendall [1999]).

	Name	Description	Metaphor for the Provider	Accesses what Users
α-push	Alpha-push	Broadcasting; (Webcasting)	Broadcasting content much like TV	Feel they want
β-push	Beta-push	Filtered messaging	Providing useful content though selective channel casting	Think they want
γ-push	Gamma-push	Directed messaging using personal filters	Knowing what the user wants and pushing that content in a timely manner	Really want
δ-push	Delta-push	Evolutionary push provider	Providing for the exact needs of the user	Really need

ALPHA-PUSH (α-PUSH) TECHNOLOGY (WEBCASTING)

Broadcasting is a push technology similar to television broadcasting. Content can be delivered over the Internet, where it is often referred to as Webcasting. Users who adopt alpha-push technology, the simplest form of push technology, are looking for an easy way to get the information they may want. The television industry does not have a monopoly on couch potatoes who do not want content choices but want some variety; there will always be a need for alpha-push technology.

Webcasting includes electronic news services, live streaming, and event reproduction. Webcasting has managed to earn a bad reputation among librarians and executives alike, not because of a dearth of content, but because of a lack of *quality* content [Bing, 1997]. Some writers even announced that "push is dead" [Pflug, 1997]. Other authors suggest that Webcasters ought to deliver less, more selective, content proclaiming that "less is more." [Cronin, 1997]. Poynder [1997] points out that push is perceived to be nothing new or special. Push technology, he goes on to say, is just a way of repackaging shortcuts to Web pages. It is understandable that the rush to push anything evokes a push backlash.

CNN Interactive (http://www.cnn.com/), *The London Times* (http://www.the-times.co.uk/), *The New York Times* (www.nytimes.com), and ABC News (www.abcnews.com) and other early on-line news services were simply passive

Websites. Users could visit them and read articles. The stories were not personalized in any way. Plug-ins such as Shockwave (from Macromedia www.macromedia.com) made it possible for animation, audio, and video clips to be incorporated into news channels quickly. RealPlayer (formally called RealAudio from RealNetworks, Inc.) became the prominent audio and video plug-in for browsers. RealNetworks (www.real.com) adopted a standard called RealTime streaming protocol (RTSP) while Microsoft is trying to compete with NetShow, which will have intelligent streaming at different bit rates.

Streaming is a method that allows users to enjoy audio or video content while they are receiving it. It has been the key to early success. Rather than downloading extremely large files to play later, streaming buffers the content yielding only a very slight delay. But since there is no feedback as to Web congestion, network performance can suffer [Radosevich & Fitzloff, 1998]. To improve streaming, service providers are teaming up with bandwidth management vendors. RealPlayerPlus uses presets, buttons that allow users to choose headline news channels such as CNN, NPR, and ABC as well as selecting among special interest channels in sports, finance, entertainment, and technology. In addition numerous audio music and news channels are preset. But the stories that are part of the channel are not filtered, so users have to listen to every story to catch the content for which they are actually looking. No indexing or fast-forward capabilities are included.

Acting as an on-line broadcasting guide, broadcast.com at the present time will simply guide you to the video or audio presentation or let you browse the schedule of upcoming events, some of which will be enhanced by other forms of communication - for example, text. Broadcast.com (previously called AudioNet) is a Website that serves as a home page or directory for live broadcasts on the Web.

Another twist on Webcasting is event reproduction. Event reproduction is claimed to be “better than seeing it live” and the 1999 Fiesta Bowl Enhanced TV Webcast experiment by the Go network (www.go.com) was over-subscribed. Go. com was simply not prepared for the amount of interest in enhanced TV. During

the broadcast of the championship college match-up, users were able to watch the football game while calling statistics on a particular player. The Internet opens an almost infinite number of channels for viewers to see.

It is possible for anyone to broadcast content over the Internet. The first Webcam is said to have been placed on a coffeepot at Cambridge University in or around 1991. [Wolff, 1999]. Now Webcams are placed at intersections where traffic problems may occur, malls, street corners, and even in dorm rooms. Internet videoconferencing comes to the desktop with software such as Microsoft NetMeeting and White Pine Software's CU-SeeMe (http://www.wpine.com/)

Webcasting has its off-putting aspects as well. Users often do not approve of cookies that are deposited on hard drives in order to keep track of subscriptions. Cookies are electronic files or tags placed on your computer by web sites you visit. Although cookies only take up a minimal amount of space on a hard drive, they 1) allow site tracking and 2) allow advertisers to accumulate user profiles and build market data.

Users fear a loss of privacy as commercial concerns or even governments may snoop to see what other cookies are stored on the computer. Some examples of software available to ensure user privacy are Guard Dog (www.mcafee.com),Cookie Crusher, and Cyber Clean. The last two are both from The Limit Software (www.thelimitsoft.com). Using this software one can keep track of cookies accepted and cookies rejected, view and delete cookies already on the system, and accept cookies from friendly sites.

Graphics are also stored on the client computer to speed up processing. But caches used for graphics take up space on hard drives and do not always clear out automatically. Finally, some feel that the advertising that goes along with push media is unsolicited garbage, or "spam." All in all, Webcasting is not a free good, and many people react negatively to this basic form of push.

In summary, alpha-push technology is simple broadcasting or Webcasting whether it is a news service, streaming video, or event reproduction. Alpha-push in the most basic form of push. The user has very little to do, but does not get

much choice either. Most users who have experienced alpha-push simply expect more. Alpha-push technology is depicted in Figure 5.

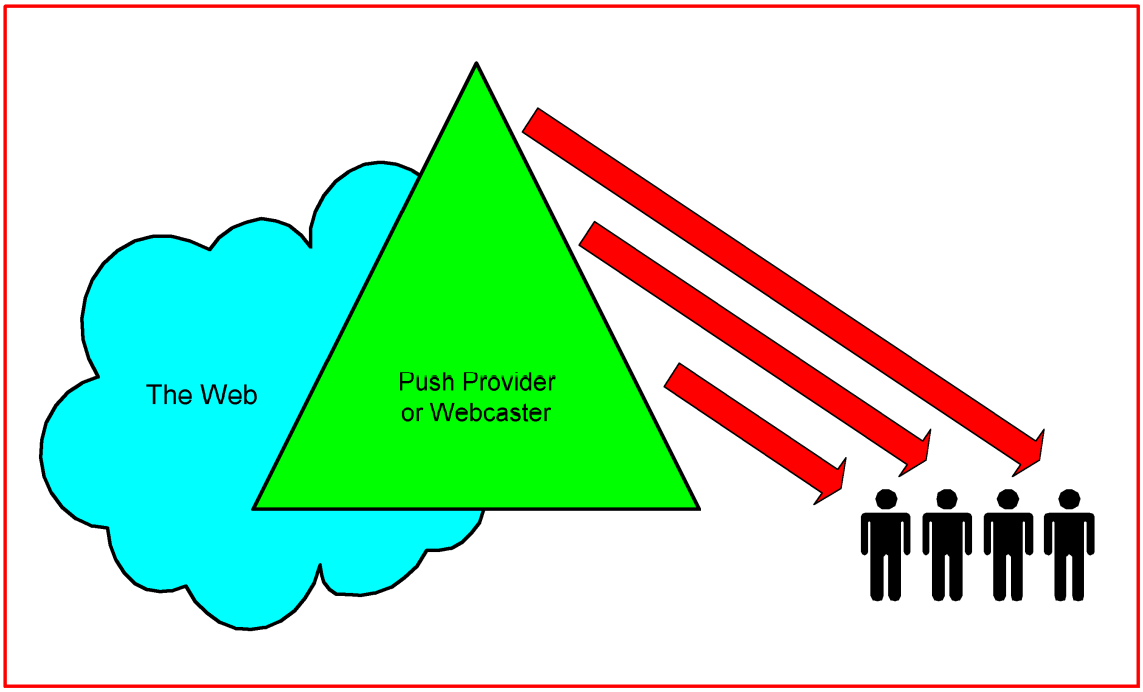

Figure 5. Using α-push Technology, the Webcaster Pushes Information by Broadcasting It to a General Audience.
(adapted from Kendall & Kendall, [1999]).

BETA-PUSH (β-PUSH) TECHNOLOGY (USING USER PREFERENCES)

Beta-push technology attempts to filter the content delivered to the user. It is not difficult to understand why filtering is desirable. Users have been known to get frustrated with long downloading times and the mindless cluttering of disk space with stories they do not care to read. When watching steaming video, the problems do not disappear. Users must wait until a number of irrelevant or uninteresting stories play out; then they can finally hear or see the story they want.

Push technologies with brand names such as PointCast (http://www.pointcast.com/), Marimba Castanet (www.marimba.com), Microsoft Webcaster (http://www.microsoft.com/ie/ie40), and Netscape's Netcaster (www.netscape.com/communicator) were all developed with the idea that the user

wants to exercise control over the channels received. Users are allowed to select channels and then further select the topics within channels.

But selecting channels isn't the same as choosing key words. Users still get a mix of stories, information, and, of course, commercials having little to do with their interests. PointCast allows users to choose up to 12 channels, but many of the stories in the news services are redundant. Another limitation can be seen in picturing a user in the United States who might want to read stories about England, but can only select "International" to filter the messages.

Furthermore, there is no agreed upon standard to deliver channels. Netscape is using an Apple format called MCF (Meta-Content format) while Microsoft is calling their format CDF (Channel Definition Format) [Dugan, 1998]. Marimba has a partnership with Netscape while PointCast and BackWeb (www.backweb.com) are leaning towards Microsoft. Various content providers will have to choose a format and the success of their service will depend on whether their selected format becomes accepted.

Beta-push, shown in Figure 6 takes into consideration what users want by asking the user to provide channel preferences, but push providers still choose the content on these channels so the push providers still determine what to broadcast. Users merely choose when to subscribe and when to update. Beta-push has its limitations, but the result is obtaining more specific and more useful information than can be captured by the volumes of data coming our way through simple Webcasting. For those users who are not couch potatoes, beta-push is an advancement.

GAMMA-PUSH (γ-PUSH) TECHNOLOGY (USING PERSONAL FILTERS)

While Beta-push (β-push) gives customers what *they* think they want, gamma-push (γ-push) gives customers what the *push provider* thinks they want.

Gamma-push technology is now used to push software patches (euphemistically called "upgrades") automatically if users set up their program to always check the manufacturer's Website. Examples include Quicken98

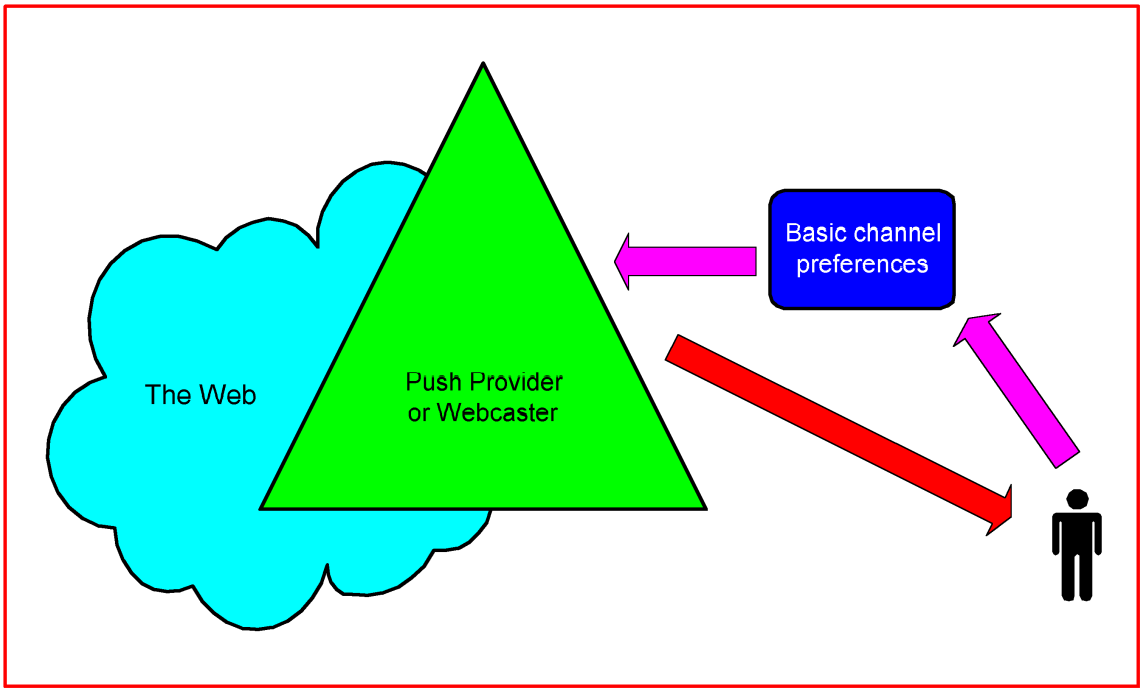

Figure 6. Using β-push Technology, the Webcaster Pushes Channels of Information the User may Want Based on User Preferences
(adapted from Kendall & Kendall, [1999]).

(www.quicken.com) and McAfee's VirusScan (www.macafee.com) which automatically remind the user when updates are available. Products such as OilChange (www.macafee.com) or Norton Web Services (www.norton.com) attempt to locate and update all software, but not all manufacturers participate in their respective programs. To speed up processing and make the procedure more unobtrusive, certain information is stored on a user's hard drive in the form of cookies. In this way the push provider can quickly determine whether an upgrade is needed.

XML can be used in push systems to get information out quickly. XML, or Extensible Markup Language, is a markup language which is especially useful for structured data. Essentially it is a way in which data is described or exchanged over the web. Whereas Hypertext Markup Language (HTML) allows users to *view* data over the Web, XML provides users with ways to *work* with data.

Integration of all sorts of data is made possible through XML. Information about customers, invoices, payments, sales, inventory, and information extracted from data warehouses can all be exchanged over the Web just as easily as we now view text and photos or Web pages. XML can handle diverse items such as a data record from a query, a Java object, a structured record (like an appointment record), meta-content about a Web site, and links. XML is a simplified version of the ISO Standard Generalized Markup Language (SGML) which allows the creation of a single document or database that can be viewed or printed in a number of different ways. SGML, however, is not suited for use on the Web.

Several companies are introducing software that allows users to convert their data to the XML format. Data channel www.datachannel.com has introduced Rio 3.0, which adds meta-data tags to data originating from end users or databases. It enables end users to publish content directly into push channels without the help of a Webmaster.

Softquad, www.softquad.com, has announced HotMetal Application Server, HotMetal Personal Server, and a series of products: HotMetal Quick Apps adds address books and calendars, and survey generators to a Web site. HotMetal Power Parts adds mail-to forms, banner ad rotators, and statistical tools. Hotmetal Quick DB Pages allows users to Query databases and output the results as XML tables. Xmetal allows users to directly create and edit XML documents. Also, Web Methods, Inc., www.webmethods.com , has announced that its Web Automation Toolkit will be available on their Website at no charge.

Even Pointcast and other beta-push technologies are evolving. The latest approach comes in the form of a user's "personal startpage." Although Microsoft tried to get users interested in a product called InternetStart and Netscape tried to promote Netcenter, users found appealing personal startpages developed out of search engines such as Yahoo, Excite, Infoseek, and Lycos. Highly promoted sites such as Snap.com (www.snap.com) and Go.com (www.go.com) are trying to capture the imagination of users so they can choose and customize their services.

These personal startpages (also known as portal sites because they are a door to the Internet) not only allow shopping, they encourage it. On Excite's personal startpage several column inches are dedicated to "My Services." (Note that these are not actually services chosen by the user, rather they are services recommended by Excite —and at the present time the user cannot change this list.)

Customization is encouraged, but it is still rather limited. For example, in Excite you can choose the general type of entertainment (the arts) but not the specific art (opera); or you can select the type of sport (NHL Hockey) but not the team (Buffalo Sabres). Consequently, the user ends up with an oddly fragmented collection of stories holding little or no interest.

The goal of gamma-push is ultimately to steer the user in the direction it thinks the user needs to go. For example, Amazon.com, the large online bookseller uses bots to track customers' preferences and suggest books that the user might want to purchase. This approach is very useful for people who have a narrow interest in books, but annoying for someone whose interests are broad or who might depend on the service for gift-giving.

The process Amazon.com uses to recommend and encourage site visitors to buy books is based on collaborative filtering. These approaches, also called recommendation systems, are software and database systems that allow decision makers to reduce the number of alternatives by ranking or counting or some other method. A restaurant guide, such as Zagat's is an example of a recommendation system. It surveys diners and report the results both on-line and in a book.

Collaborative filtering systems [Stohr & Viswanathan, 1999] often allow users to rate the alternatives using a numeric system (such as 1 to 7) or an alphanumeric system (A-F, like grades). Some products that are proprietary recommendation systems are Firefly (www.firefly.net), Preference Server (www.andrmedia.com), and Group Lens (www.netperceptions.com) [Konstan et al, 1997]. A recommendation system does not need to depend on assigning weights. Rather the system can count the number of occurrences of user

behaviors, such as how many people bookmarked a certain web site or how many users mentioned an author. Products that use other types of evaluation schemes are PHOAKS (www.phoaks.com) [Terveen, et al, 1997], ReferralWeb (http://akpublic.research.att.com/~kautz/referralweb/) [Kautz, Selman, and Shah, 1997], and Siteseer (http://www.freshsoftware.com/SiteSeer.htm).

Are bots as helpful for push technologies as they are for pull technologies? It is obvious that bots are very valuable for pull technologies. They can be used in pull technology to locate cheaper airfares, books to purchase, parts to fix that broken phone, stock tips, and other opportunities.

When bots are used for push technologies they can send travelers special offers for low fares and other targeted offers. And bots suggest books to read (Amazon.com keeps track of user behavior by placing cookies on user machines). Although bots may not know when your phone breaks, bots may send a telephone catalog advising you of the latest new phones. In the investment world, bots may filter and broadcast stock prices, indices, and news items to users, especially in the form of alerts when stocks move in certain patterns. Of course, bots may notify a stock broker that a user was curious about a particular stock. The broker might in turn generate a cold call to the user.

While advertising and cold calls are intrusive irritations, the potential abuse of gamma-push technology does not reside in minor annoyances, but rather with the possibility of broadcasting destructive propaganda. Webcasters can broadcast memes that are potentially dangerous. We will discuss some of these concerns later.

Gamma-push technology takes into consideration a user's desire for both content and channel subscriptions. Then push providers use filters to limit what is being broadcast back to the users. Gamma technology, as depicted in Figure 7, tries to match up what the push provider wants to send and what it thinks users want to receive. This approach still assumes a lot about the push technology actually *knowing* what the user wants. Powerful models as well as insights about human behavior are necessary to capture, analyze, and act on information collected about users.

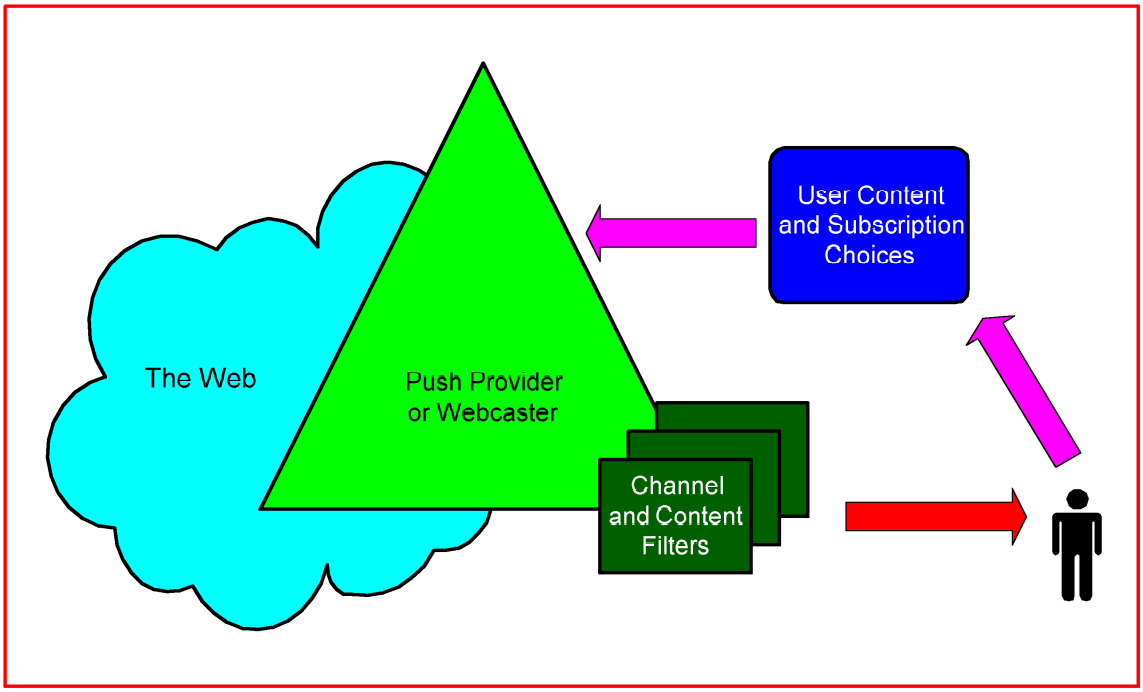

Figure 7. Using γ-push Technology, the Webcaster Pushes Specific Content That the User Wants Based on Choices the User Made
(adapted from Kendall & Kendall, [1999]).

DELTA-PUSH (δ-PUSH) TECHNOLOGY (USING EVOLUTIONARY AGENTS)

The promise of delta-push technology lies in the ability to customize the content, amount, and timing of messages pushed to the user. Based on demographics and data mining, numerous stories, services, and advertising will be targeted directly toward the user. The links featured on startpages will come from an autonomous, evolutionary agent observing the user clicking on links and then choosing similar sites the user might find interesting. Delta-push does not attempt to determine what users or even a particular user wants. Instead it tries to determine what the particular user really needs.

The schemes that are part of delta-pull resemble techniques being developed in data mining. The data mining literature is addressing issues concerning obtaining

and using information about people [Codd, 1995; Gray & Watson, 1998; and Watson & Haley, 1997].

No software at this time can be said to possess delta-push technology. The closest product on the market is Alexa (www.alexa.com). Described by the press as a "navigation utility," this information bar plug-in works with a browser to accomplish what the search engines do and more. Alexa gives detailed statistics about the sites (owner address, quality, and popularity) and explanations about where the data came from. Alexa suggests where you might want to go next by attempting to match up related sites for the user. Of course, Alexa does not actually look at or analyze individual decision making behavior, so it can not be called a true delta-push technology. Alexa is still in development, and still a long way from achieving the potential of delta push.

Alexa received a boost from Microsoft since Microsoft's Internet Explorer 5.0 now incorporates Alexa technology. IE 5.0 uses Alexa when a search does not reveal a hit. One can also access the Alexa service by clicking on a "What's related" button.

Another company that is trying to get the right information to the right user is Autonomy (www.autonomy.com) which is aimed at corporate Intranets. Autonomy will be able to categorize a piece of information, automatically hyperlink it, allow natural language searches, deliver information to the right employee, alert employees via email, pager, fax, or push. It will be able to fuse information, personalize it, take advantage of profiling, and provide views to visualize data.

In the future, delta-push technology will involve bots to help gather and push information to the user. Each time a user reads a story that was downloaded from a push channel, the bots observe what the user was doing. Next the bots will deliver content and continue to observe user behavior in order to evolve (change and mutate) based on those reactions, sending new channels or information back to the user. Advances in research on genetic agents in AI, described in Franklin [1995], Levin & Zahavi [1996], and Kendall [1996], are

making this possible. Agents can evolve quickly, as a generation occurs each time the user makes another purchase or changes a preference.

Some of the difficult problems with alpha-, beta-, and gamma-push technologies disappear in a delta-push technology world. Users have always been concerned that value systems that contradict their own may be forced upon them in an unfiltered Webcast. A liberal might prefer not to be bombarded with conservative viewpoints and the opposite also holds true.

At first glance, delta-push technology can be highly effective in screening out propaganda harboring a particular bias. However, it might be in the better interests of the person and the society to see multiple facets of an issue in order to make a more intelligent choice when a decision is needed.

Similar problems can occur in the corporate world. If companies push the data they *think* their employees need, they may filter out useful information that would be in the best interest of the company in the long run. Therefore, we must take an attitude of curiosity about this new technology while simultaneously guarding against any misuse or abuse.

Delta-push technology observes user behavior and uses data mining filters to limit the content to be broadcast as shown in Figure 8. The push provider, now properly described as an "evolutionary push agent," examines the behavior of the user – in this case what the user reads, saves, and uses in decision making – to further fine tune the information that is pushed to them.

Push providers using delta-technology focus on what they think users *need*. This viewpoint is very different from that of early types of push technologies. It presents a dilemma. As long as the push providers' motives are honorable, useful information (and only useful information) is passed on to users. But then, when push providers are less than honorable, the users can be subject to a barrage of memes or even become infected by virus memes.

Memes are a basic unit of cultural transmission. A meme is a unit of information in a mind which influences events in a way so that a meme makes copies of itself in other people's minds. A successful meme spreads easily. Memes can be used to influence other people's behavior in a good way (for

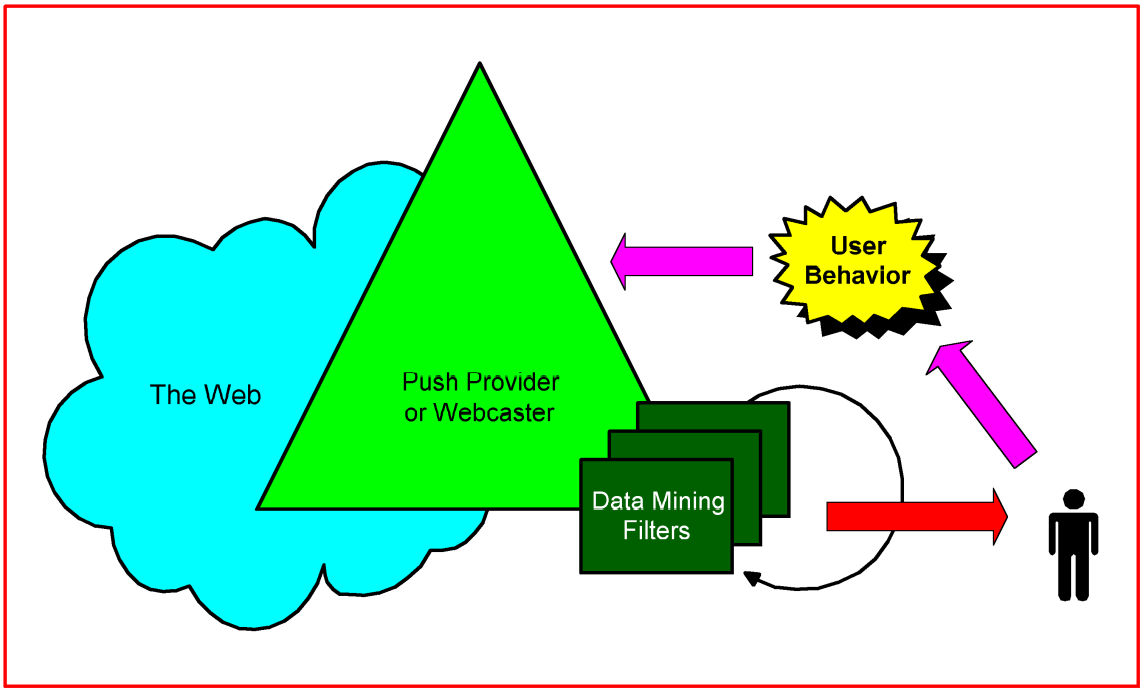

Figure 8. Using δ-push Technology, the Webcaster Pushes What the User Needs After Analyzing User Behavior Through an Iterative Process
(adapted from Kendall & Kendall, [1999]).

example, to be taught a moral code) or in a bad way (to influence a person to commit a crime). (See Brodie, 1996 for a further explanation of the science of memetics.)

The advantages of delta-push appear at the corporate, consumer, and commercial levels. In a few years, executives will use truly dynamic executive information systems (EIS) made possible through the use of delta-push technology. Executives will be able to get the information they need in the view they want. These tailored reports will be made possible, in part, through Extensible Markup Language, or XML.

The changes will not be limited to the corporate world. Delta-push will ensure that consumers will receive only the information they need to make their purchases. Merchants will be pleased that they can target their audience with

precision and efficiency. The general public will be pleased because evolutionary, data mining bots will do what was once unproductive and frustrating work for them, with much greater success. Any annoyances of delta-push technology will disappear, it will be claimed, because users actually will *need* the information they get.

Assessments of delta-push technology should not be limited to overly optimistic scenarios of the future. Clear disadvantages of delta-push become obvious. Not only do we have the risk of having destructive memes thrust upon us; these memes can further mutate or evolve. Memes have the potential for becoming "thought viruses," ideas we willingly pass on and even preach to others. It is possible for push technologies to push ideas too far.

IV. CORPORATE DECISION MAKERS AND INFORMATION DELIVERY

Push technologies will serve a transforming function in corporations. We are just now seeing the beginning of this transformation and change process. Some of the early corporate leaders have been National Semiconductor, Wheat First Securities, MCI and Church & Dwight (the maker of Arm and Hammer baking soda products) [Sliwa & Stedman, 1998]. Many of these first and early efforts involve the use of corporate intranets to get information to managers quickly so that decisions can be made in a competitive manner and so that any emergency or fluctuating situations can be monitored. For example, MCI uses PointCast to send outage information to 7,000 long-distance network operations employees. Intermind Communicator (www.intermind.com), BackWeb (www.backweb.com) and Marimba Castanet (www.marimba.com) are all Push platforms that can be used with corporate intranets [Strom, 1997].

Push technologies adapted with corporate intranets can deliver product-related data. They can also efficiently deliver information that is generated by Website activity such as providing a frequency count for the number of hits, what type of product information is being searched by the consumer, and sending along the content of relevant, filtered e-mail messages regarding products. These

are the functions that National Semiconductor is fulfilling with its own channel added to Pointcast [Cronin, 1997].

Advantages of Push systems include improving the timeliness of information delivery. Another advantage is that Push systems can deliver information to people who actually need it. In addition, the liveliness and color associated with Push content combined with their ubiquitous nature may relieve some of the tedium associated with office environments [*Wired*, 1997].

Push also has the advantage of being extremely flexible. Although at first glance a mass or broadcast medium, pushed content has an advantage of being personally customizable. When an employee has information pushed to them from the Web via a corporate intranet, they can do what they want with the information, including altering its format to view it in graph form and so on.

V. WHAT IDS MEANS FOR MANAGERS' WORK

A manager's tasks and work life will change when push and pull technologies are adopted. Much managerial work will be made easier and some of it will become more interesting. More of the data displays that are customary will become customizable. This in turn will permit managers to experiment with data in ways never before possible. Industry data, daily user statistics from hits on a Website, and the most recently enunciated corporate objectives can be easily brought together with push technologies for use in a forecasting model. This information certainly frees the decision maker to think about how to achieve goals creatively, combining sources and strategies in new ways, rather than solving problems with standard linear or one-dimensional approaches.

Sharing one's thoughts with colleagues at any time, from any location will become a reality and will forever alter the way users conduct and construe the term "meetings." For example, corporate uses of push technology mean that rather than sending a text-only e-mail message you can send a hyperlinked multimedia message to a number of other users via e-mail. In this case the decision maker becomes the content creator and provider by being able to create and send this complex type of communication.

Downes and Mui [1998] describe a “killer app” using push technology, stating “Why not send everyone in the company a copy of the complete text of an interesting article, including active hyperlinks to the references, when doing so takes only a few keystrokes, no matter if the recipients are down the hall or in Sri Lanka? E-mail, as a killer app, starts by taking out the post office but may end by redefining human communications.” (p. 19). Managers need to be empowered to work in new ways that can improve their competitiveness, give them easier access to information, provide new products or services to customers, and improve the flexibility of information requests. These ways of working are new and as yet only hinted at in the research. A survey by Lederer, Mirchandani, and Sims [1998] indicates that businesses adopting Web-based information systems (WISs) responded that the most important benefit of being on the Web was to “Enhance competitiveness or create strategic advantage.”

What should good managers be able to do in the era of Push systems? They should be able to not only consume and interpret data, they should be able to create content and communicate it in a meaningful way. Push material must be created in such a way that it impels organizational members to look at and solve problems in ways that are creative, innovative and cost effective. Part of the evaluation of a manager’s performance will ultimately rest on how effective that person is in using the Push media to work toward articulated goals.

VI. THE FUTURE OF IDS TECHNOLOGY

Push and pull technologies are being greeted with a wide spectrum of reactions. Some even proclaim, “Push is dead” [Pflug, 1997]. But there are users and organizations that are fascinated with current and potential information delivery systems. Some companies have encouraged toying with IDS. Often their view is that employees will tire of the new toy of push and pull technologies, abandoning it for whatever the next fad will be.

If information delivery systems (IDS) continue to emerge and evolve we need not assume that the evolution and spread of this new technology will unfold in the same old (predictable) patterns. One way that IDS is gaining acceptance

on the grass roots level is by making all of the personal information devices such as palmtops, digital watches, pagers, mobile phones (and other intriguing combinations) deliver a greater quantity of customized information in a more personalized manner. This in effect is a departure from older models of the adoption of new information technologies, which dictated that because of the cost of the technology, it would be a mass medium, broadcasting to the masses, depersonalized and originally targeting non-segmented groups.

Soon hand held or portable devices like those mentioned above will be able to communicate to each other in an *ad hoc* way. Old barriers of mass media including the tether of cables may not be viewed as barriers any longer if Bluetooth (www.bluetooth.com) accomplishes its mission. Bluetooth (named for Harald Bluetooth, a tenth-century Viking king) is the project name for an international consortium composed of telecommunications and computing companies including Ericsson, IBM, Intel, Nokia, and Toshiba.

The new technology this consortium is developing consists of a low-cost, low-power radio based wireless link. Along with this link, the consortium hopes to define a global specification for wireless connectivity [Kelly, 1998 and www.bluetooth.com]. Only one of the user's personal information devices needs to possess ISP dial-up capability for all of the remaining devices to be connected to the Internet. Bluetooth technology encourages the use of IDS by delivering the information to more personal destinations. Users will prefer to use pull technology and receive push technology as the situation demands, and when the situation demands. It is almost a "point-of-sale" orientation or perhaps "point-of transaction" orientation is a more apt characterization.

If information is not displayed on one of these personal devices, then it is certainly easiest to visualize information appearing on one's computer monitor. However, users who consider that the book is dead will be in for a surprise. As an alternative to screen displays, information may come to users on what some have dubbed "the last book" which is an electronic information display medium "…comprised of hundred of electronically addressable display pages printed on real paper substrates. Such pages may be typeset *in situ*, thus giving such a

book the capability to be any book." [Jacobson et al., 1997, p. 457]. The medium electronically changes the charges displayed when the user has read through the content and is ready to move on. In this conceptualization, the media can be electronically recycled even though it will have the look and feel of traditional paper. This type of flexible, lightweight, and rechargeable paper is already being prototyped at MIT in conjunction with a company called E Ink Corp (www.eink.com) [Peterson, 1998].

For those individuals and organizations that seize the multiplicity of opportunities for improvement and advancement, the future of information delivery systems is challenging and brimming with possibilities. IDS is an emerging technology that will continue to evolve. The barriers that will exist are many. While some can be identified others are difficult to anticipate. It is at this confluence of emerging technologies, unexpected benefits and barriers, and new adoption patterns that the most fruitful research can and should take place.

VII. CONCLUSION

The term "information delivery systems" or IDS means emerging information technologies including push and pull technologies. With these technologies providers enable users to work with information on the Web in meaningful ways. Users concerned with competitive advantage can use IDS organizations to search out information on the Web, perform critical analysis of the information and use subjective and objective decision analysis to make the content meaningful in a particular organizational context. Specific types of emergent push and pull technologies will mean that users can feel confident in the information they are using to make all types of decisions from the operational to the strategic. With Web-based information they can glean insights that are immediate, reliable, complete and accurate.

In this tutorial, we have identified and classified eight types of information delivery systems, which we refer to as alpha, beta, gamma and delta-pull technologies as well as alpha, beta, gamma and delta-push technologies.

Corporate intranets will enable managers to push a variety of visual displays and other data together in new and stimulating ways. This feature will be one of the most striking of push technology. As searches become more sophisticated through the use of evolutionary agents, pull technologies will also grow in use and acceptance. Easier to customize and even personalize, searches will yield better and more accurate results.

Future pull technologies will feature an evolutionary agent, which will change according to what it observes, and improve as time goes on. This agent, the essence of delta-pull technology, will seek out not what the users want, but the information the user *needs*. Using data mining techniques, the evolutionary agent will observe a user's pattern of interaction with information – including what is searched, what is used, what is saved, and how it is transformed into information used in decision making. More satisfying results from initial searches by evolutionary agents will translate into more effective searches.

Delivering information, software upgrades, corporate data, and of course, advertising are all to be anticipated with the coming of delta push. Evolutionary push agents will enable Webcasters of all sorts, including those in corporate settings to deliver what users need, at the time when they actually want it. But the influence of push providers on users will extend far beyond this. An obvious application may find the technology putting a new product in the path of the user, but the deeper influences will be significantly more compelling. For instance, an organization may filter data and messages in specific ways in order to ensure that decision makers focus on issues of great strategic import.

One major benefit of delta-pull and delta-push technologies will be the potential to substantially reduce the amount of useless information now being received by users who do not want it. It is to be hoped that users will thus be satisfied with the amount of information they receive and so increase their approval of the decision data they are receiving.

The future of information delivery systems is promising. Users will continue to pull and receive pushed information from the Web. The delivery technology may change and users may receive more information on networks of

personal portable devices or reusable digital paper, but it is certain that users will want and need information to make daily corporate and personal decisions.

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EDITOR'S NOTE: The following reference list contains hyperlinks to World Wide Web pages. Readers who have the ability to access the Web directly from their word processor or are reading the paper on the Web, can gain direct access to these linked references. Readers are warned, however, that
1. these links existed as of April 1, 1999 but are not guaranteed to be working thereafter.
2. the contents of Web pages may change over time. Where version information is provided in the References, different versions may not contain the information or the conclusions referenced.
3. the authors of the Web pages, not CAIS, are responsible for the accuracy of their content.
4. the author(s) of this article, not CAIS, is (are) responsible for the accuracy of the URL and version information.

ABC News (www.abcnews.com)

Alexa (www.alexa.com)

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