# Smart Browser: A framework for bringing intelligence into the browser

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HP Laboratories
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smart browser, Firefox extension, XML message, information extraction

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# Smart Browser:<br>A framework for bringing intelligence into the browser

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## ABSTRACT

Smart Browser is a framework that supports the easy integration of customized background services within a Web browser. The framework utilizes a set of extendable XML message schemas to communicate between the browser and the background services. Based on this framework, a set of background services are integrated into Firefox browser. These services can bring the intelligence of crowd and machine, which are usually logic complicated, data intensive and computing complex, to each end user by utilizing light weighted and daily used browser. It's obvious that applications built on this framework can improve users' experiences when surfing the Web.

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## 1. INTRODUCTION

Nowadays, we can access numerous information and applications on the Web. Web browser has gradually become an indispensable component on any web accessible devices that everyone uses everyday and everywhere. For example, we read interested articles from news, blog and twitter websites. However, we often encounter unknown or unfamiliar names (acronyms, person names, locations and etc.) and concepts (historical related events, background information and etc.) while browsing web pages. Traditionally, we will open a new browser window or tab, search the unknown name or concept in Google or Wikipedia for a detail explanation, and then go back to the original page to continue reading it. It's really annoying if we repeat this again and again. Similarly, in enterprise intranet, many web pages mention employee names, organization name, product names and weird acronyms. As it's impossible for an employee to know all of them, we may not fully understand the content easily. It would be very helpful if an employee can get the related knowledge of unfamiliar information conveniently. As above mentioned, it will significantly improve the user experiences if the web browser can show more related information intelligently while browsing the web page.

There are some browser plug-ins and extensions to mark words in a web page, which can popup a window to show useful information [1][2][3]. However all these plug-ins and extensions are individually developed and can only be used in their own web sites or using proprietary message format.

Therefore, a framework called Smart Browser is designed and implemented as a Firefox extension. The framework can easily bring intelligence from background services direct into the user's web browser. There are four important features which make the Smart Browser very useful:

1) Open and extendable XML message for exchanging information between extension and background services.
2) Flexible design, all necessary parts of the process can be configured and customized to meet various requirements.
3) Auto-updating configurations. The extension can be installed in many browsers. Auto-updating configurations can guarantee all the extensions have the same and latest configurations.
4) Easy-to-use GUI for enabling and disabling extension, switching services and changing configurations.

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## 2. SMART BROWSER FRAMEWORK

Since Firefox is a very popular web browser, and opening for the extension development by the third party, we implement our Smart Browser based on Firefox in this paper.

### 2.1 Previous approach based on Greasemonkey extension

At first, we implement some user scripts for Greasemonkey [1] extension in Firefox, as well as a set of XML messages, to accomplish the goal of showing more intelligence information for users while browsing.

However, there are some drawbacks for this approach:

- It is not a good design for mix the logic and configuration in user scripts.
- There is no auto-updating approach for user scripts. Users must manually re-install the user scripts to accommodate changes.

Therefore, we determine to develop our own Firefox extension, as extension gives us more flexibility to design and implement to fulfill our requirements.

### 2.2 Architecture and workflow of Smart Browser

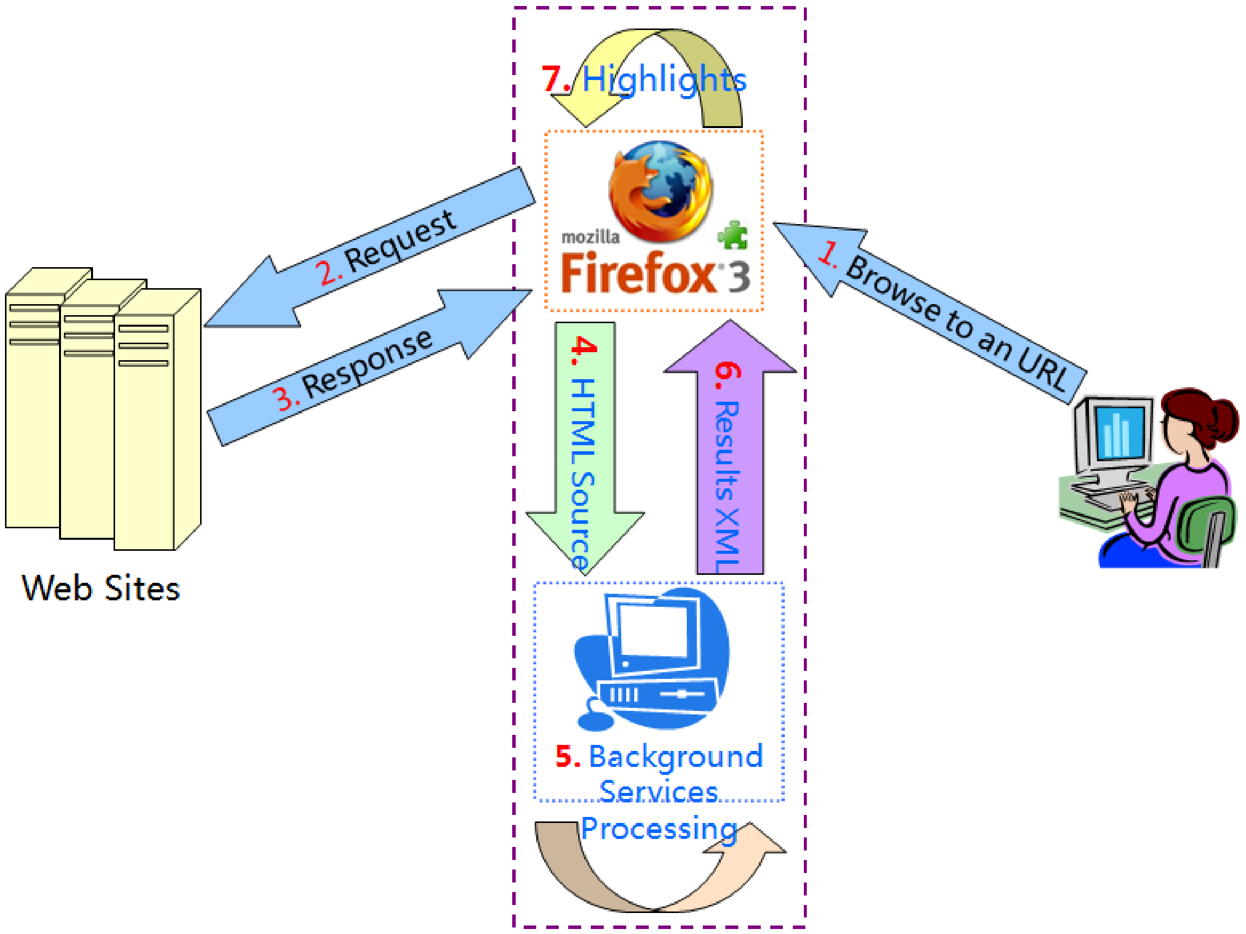


Figure 1. Architecture of Smart Browser

The architecture of Smart Browser is shown in Figure 1, which includes both the browser extension and the background services. The steps 1 to 3 are the common steps of web page browsing, while the steps 4 to 7 are the places where the Smart Browser does its work.

1) A user submits the web page URL to browser. Here, the browser is Firefox.

2) The browser sends the URL request to the destination web site.

3) The destination web site answers the request and responses the browser with the requested web page.

4) Full or part of the web page are sent to the background service using HTTP POST request immediately after the web page has been loaded. The HTML of web page are fetched by Firefox browser and parsed by its powerful and smart parser. We can get a clean and well formatted HTML for background service.

5) The background service works on the well formatted web page.

6) The results get from the background service are formatted to XML message and return to browser as HTTP Response.

7) The browser extension modifies the web page, such as highlighting texts or adding mouse events, according to the received XML message.

The detail workflow (step 4 to 7) of Smart Browse is shown in Figure 2. For example, if the background service is a person name extraction service, the background service will extract all mentioned person names from the web page in step 4, send back all extracted person names as well as the positions in step 5, and the browser extension will wrap the recognized person names for highlighting and set pop-up information and mouse hover event in the web page in step 7.

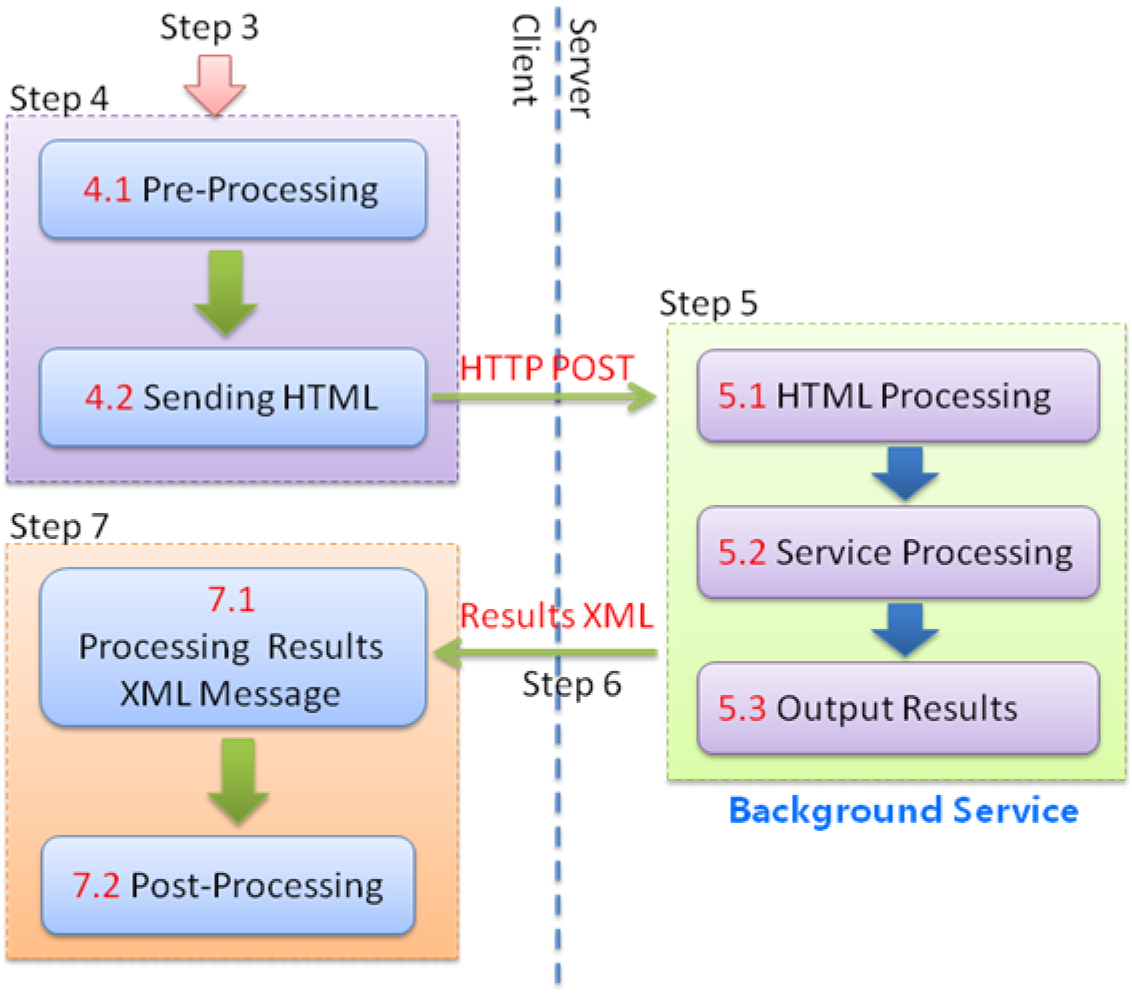


Figure 2. Workflow of Smart Browser

### 2.3 XML message schema

A set of XML schemas is defined for sending back the processing results from background services to the browser extension:

- (XPath, Word, Position) Message: This message is used to highlight text in HTML page according to the information of XPath, words and word positions. An example of the message is shown in Table 1, and this is used in the “celebrity recognition” service introduced in section 3.
- Full HTML Message: This message is used to send back the entirely HTML page to the browser extension. An example of the message is shown in Table 2 and this is used in the “Wikipedia concept linking” service introduced in section 3.
- Info Message: This message is used to send back simple information to the browser extension. An example of the message is shown in Table 3 and this is used in the “movie recognition” service introduced in section 3.

Table 1. An example of (XPath, Word, Position) Message

```xml
<?xml version="1.0" encoding="UTF-8" ?>
<message type="xpath_word_position">
    <highlights>
       <highlight
           xpath="/html/body/table[5]/tbody/tr/td[3]/table[2]/tbody/tr/td/
           div/table/tbody/tr/td/div[1]/a/b/text()">
           <word value="Wesleyan" position="16">
               <startTag>
                  <![CDATA[<span class='keyword_highlight'
                  onMouseOver="TagToTip('Tip_Keyword_4096', CLICKCLOSE,
                  true, STICKY, true, CLOSEBTN, true)">]]>
               </startTag>
               <endTag><![CDATA[</span>]]></endTag>
           </word>
       </highlight>
    </highlights>
</message>
```

Table 2. An example of Full HTML Message

```xml
<?xml version="1.0" encoding="UTF-8" ?>
<message type="html" position="html">
    <html>
        <![CDATA[<html><head>head…</head><body>html content with
        highlighted results…</body></html>]]>
    </html>
</message>
```

Table 3. An example of Info Message

```xml
<?xml version="1.0" encoding="UTF-8" ?>
<message type="info">
    <result>
        <![CDATA[IS_Movie: The Princess and the Frog (2009)]]>
    </result>
</message>
```

## 2.4 Pre-processing and post processing

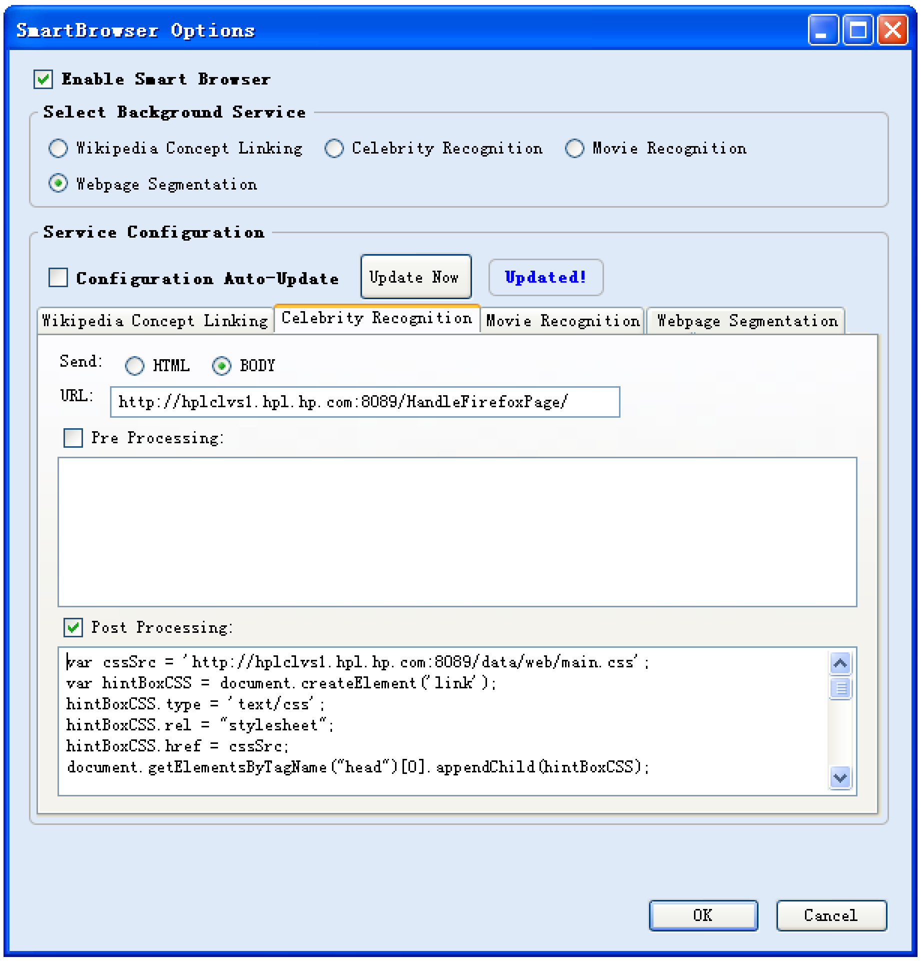
As shown in Figure 2, the Smart Browser also supports user defined pre-processing before sending HTML to the background service (step 4.1), and user defined post-processing after XML message is received (step 7.2). Both pre-processing and post-processing are snippets of JavaScript codes, which are run in the context of the current HTML web page. The design of pre-processing and post-processing gives more flexibility to services to do various jobs.

Pre-processing is usually used to do some check or acquire client side information which will be used in the background service. For example, in "web page segmentation" service, pre-processing is used to acquire the visual information (coordinates, size, font style, font size, etc.) of all DOM nodes. This kind of information is very useful for the background service to identify the visual blocks and separations.

Post-processing is usually used to set up environment (importing JavaScript and CSS to the page), such as for highlighting text and popping up information.

## 2.5 Service configuration

In the Smart Browser framework, background services can be defined and configured. A background service is a function of doing specific work for web pages. For example, "celebrity recognition" is a service which recognizes and highlights all celebrities appeared in a web page. Though multiply background services may be provided, only one of them can be activated at a time in the client side.


SmartBrowser Options

✓ Enable Smart Browser

Select Background Service

Wikipedia Concept Linking Celebrity Recognition Movie Recognition [✓ Webpage Segmentation]

Service Configuration

☐ Configuration Auto-Update

Send: HTML [✓ BODY]

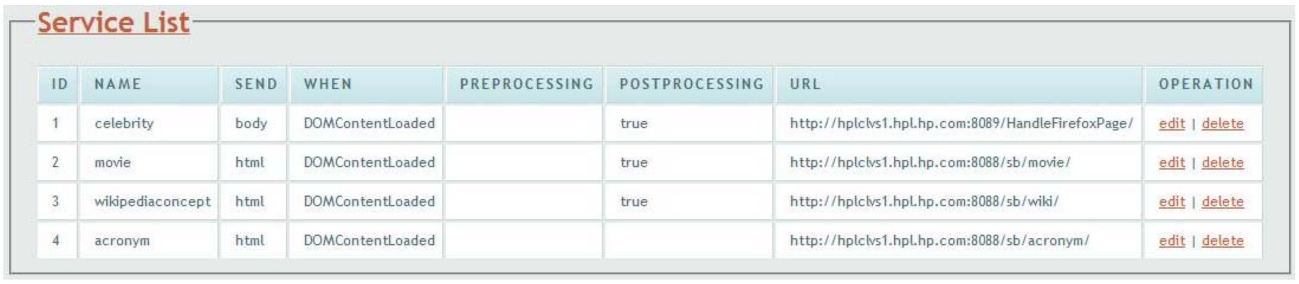
URL: http://hplclvs1.hpl.hp.com:8089/HandleFirefoxPage/

☐ Pre Processing:

✓ Post Processing:

```
var cssSrc = 'http://hplclvs1.hpl.hp.com:8089/data/web/main.css';
var hintBoxCSS = document.createElement('link');
hintBoxCSS.type = 'text/css';
hintBoxCSS.rel = "stylesheet";
hintBoxCSS.href = cssSrc;
document.getElementsByTagName("head")[0].appendChild(hintBoxCSS);
```

Figure 3. Client based configuration for Smart Browser



Service List

| ID | NAME | SEND | WHEN | PREPROCESSING | POSTPROCESSING | URL | OPERATION |
|---|---|---|---|---|---|---|---|
| 1 | celebrity | body | DOMContentLoaded | | true | http://hplclvs1.hpl.hp.com:8089/HandleFirefoxPage/ | edit \| delete |
| 2 | movie | html | DOMContentLoaded | | true | http://hplclvs1.hpl.hp.com:8088/sb/movie/ | edit \| delete |
| 3 | wikipediaconcept | html | DOMContentLoaded | | true | http://hplclvs1.hpl.hp.com:8088/sb/wiki/ | edit \| delete |
| 4 | acronym | html | DOMContentLoaded | | | http://hplclvs1.hpl.hp.com:8088/sb/acronym/ | edit \| delete |

Figure 4. Web based configuration for Smart Browser

For each service, there is a running background service that does the real intelligent work, a set of XML messages for sending back results, and also pre-processing and post-processing for its additional requirements. All of these are configurable. This kind of design gives service providers very much flexibility to accomplish various functions.

All the configurations can be done in both the client (browser) side and the server (background service) side (shown in Figure 4). Figure 3 shows the UI of configuration on the client side. This is useful for developing and debugging a service before releasing it or customizes a service by advanced users. Figure 4 shows the UI of configuration on the server side. In most of the time, the configuration can be auto-updated by fetching a universal configuration file in XML format from a web site each time the Smart Browser is being launched. It's often that service providers change their configuration for fixing bugs or adding new features, the configuration should propagate to all installed extensions to avoid inconsistent state. It's necessary to have an auto-updating universal configuration, because the browser extension may have been installed in many users' browsers. Therefore, a simple web administration interface of universal configuration is implemented, through this interface service providers can change any item of the configuration they want. All the browser extensions will be notified and keep their configurations updated automatically.

## 3. EXAMPLE SERVICES FOR SMART BROWSER

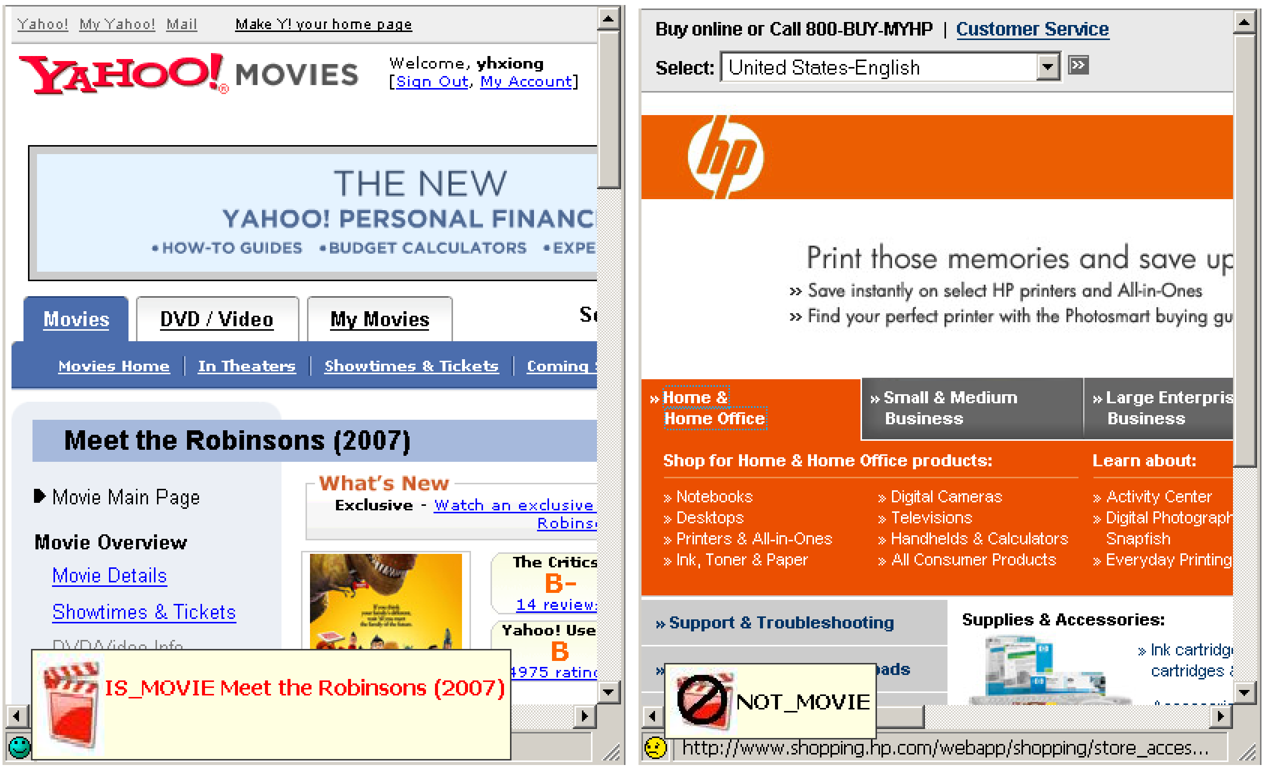
Based on the research results in the fields of web data mining, text classification and entity extraction by the researchers in HP Labs China, we implement the following background services based on Smart Browser framework for general web page browsing:

- Movie recognition (Figure 5): This service classifies a web page to a movie introduction page or not. If it's a movie introduction page, the movie name is extracted.
- Celebrity recognition (Figure 6): This service recognizes celebrities mentioned in the web page. The recognized celebrities and the words support the celebrities are highlighted. When the pointer hovering over a celebrity, a window is popped up to show his/her related Wikipedia article, news and videos.
- Wikipedia concept linking (Figure 7): This service highlights important concepts in the web page, and links them to the corresponding Wikipedia articles. This definitely enhances user experiences of web surfing.
- Web page segmentation: This service returns the web page layout segmentation results. A web page is segmented into a set of functional blocks.

We also implements several other background services for HP internal use. These services are helping HP employees to surf the HP Intranet:

- HP acronym dictionary (Figure 8): This service looks up all possible expansions of an acronym in the web page. A user can select an acronym in the web page by double clicking it, then the acronym is highlighted, and a window is popped up to show all possible expansions of the acronym.
- HP acronym disambiguation: This service recognizes and disambiguates all acronyms in the web page. When the pointer hovering over an acronym, a window is popped up to show the expansion of the acronym.
- HP employee recognition (Figure 9): This service recognizes all HP employee names in the web page. When the pointer hovering over an employee name, a window is popped up to show the employee information (such as organization, location, telephone, email), the HP intranet search results and the Google News search result of the employee.

- HP web page tagging (Figure 10): This service helps to collect HP intranet web page tagging information for HP intranet search. If clicked the “Tag me” link at the top-left corner, a “Tag web page” window is popped up. The URL and title of the page are extracted automatically, and some tags are also recommended. A user can also freely input title, description and tags of the web page.



Yahoo! My Yahoo! Mail Make Y! your home page
YAHOO! MOVIES
Welcome, yhxiong [Sign Out, My Account]
THE NEW YAHOO! PERSONAL FINANC
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Shop for Home & Home Office products:
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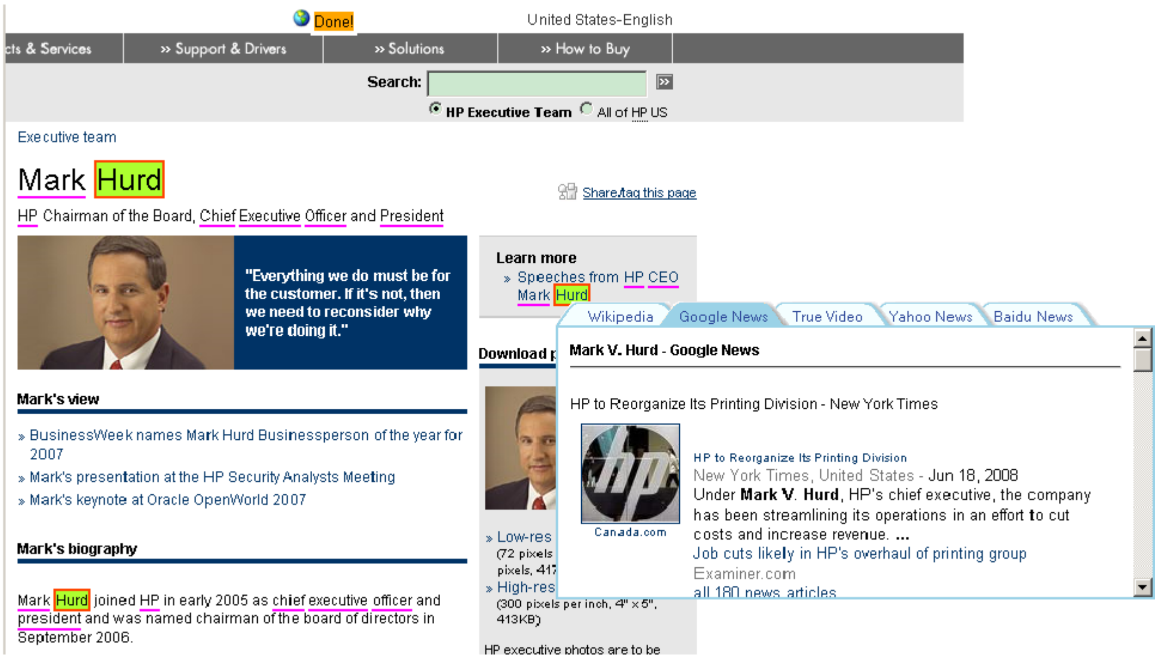
» Digital Cameras » Televisions » Handhelds & Calculators » All Consumer Products
» Activity Center » Digital Photograph Snapfish » Everyday Printing
» Support & Troubleshooting
Supplies & Accessories:
» Ink cartridg cartridges
NOT_MOVIE
http://www.shopping.hp.com/webapp/shopping/store_acces...

Figure 5. Screen shoot of movie recognition



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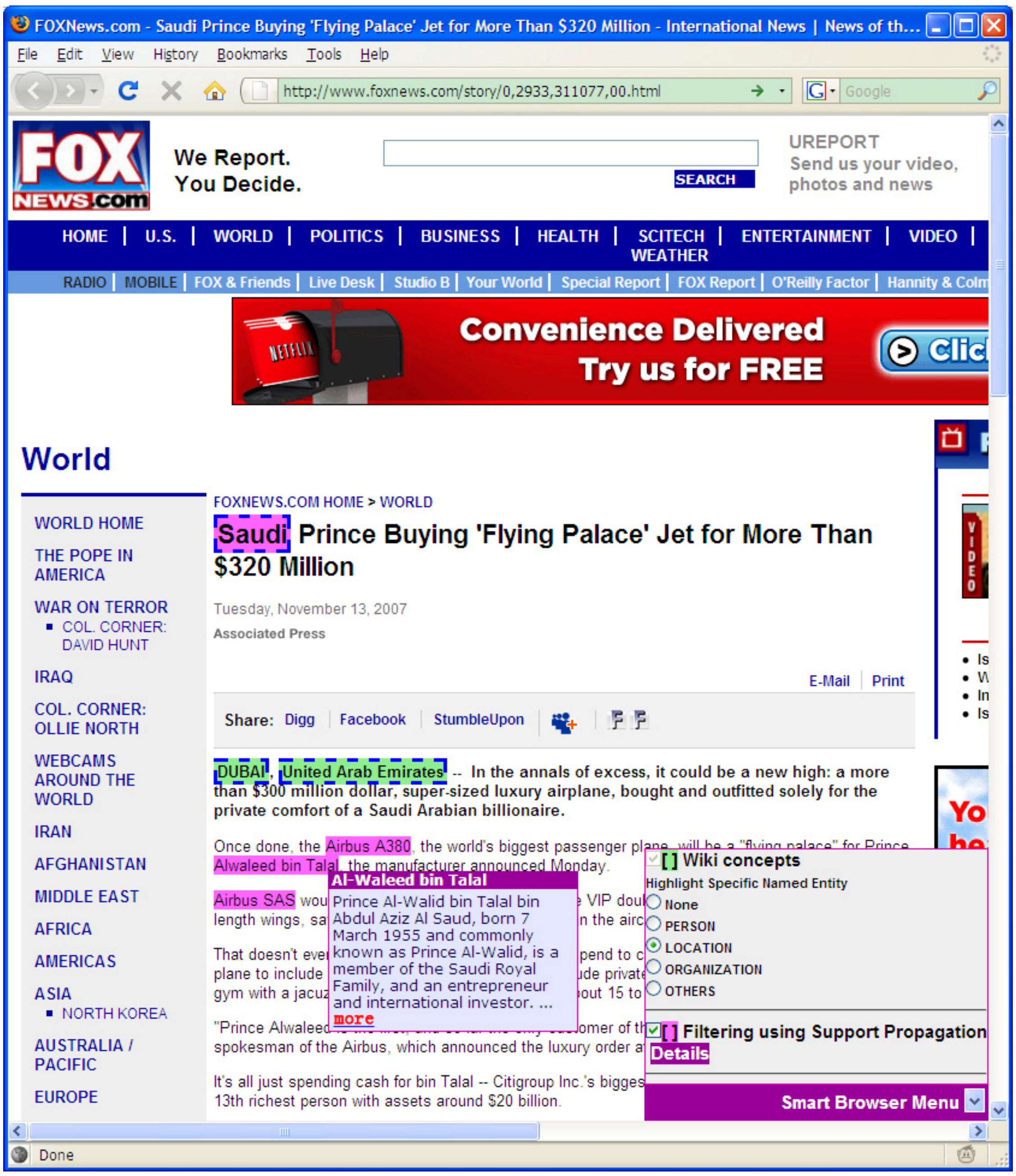
New York Times, United States - Jun 18, 2008
Under Mark V. Hurd, HP's chief executive, the company has been streamlining its operations in an effort to cut costs and increase revenue. ...
Job cuts likely in HP's overhaul of printing group
Examiner.com
all 180 news articles
Canada.com
Mark's view
» BusinessWeek names Mark Hurd Businessperson of the year for 2007
» Mark's presentation at the HP Security Analysts Meeting
» Mark's keynote at Oracle OpenWorld 2007
Mark's biography
Mark Hurd joined HP in early 2005 as chief executive officer and president and was named chairman of the board of directors in September 2006.
» Low-res (72 pixels pixels, 417
» High-res (300 pixels per inch, 4" x 5", 413KB)
HP executive photos are to be

Figure 6. Screen shoot of celebrity recognition


FOXNews.com - Saudi Prince Buying 'Flying Palace' Jet for More Than $320 Million - International News | News of th...

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Saudi Prince Buying 'Flying Palace' Jet for More Than $320 Million

Tuesday, November 13, 2007

Associated Press

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DUBAI, United Arab Emirates -- In the annals of excess, it could be a new high: a more than $300 million dollar, super-sized luxury airplane, bought and outfitted solely for the private comfort of a Saudi Arabian billionaire.

Once done, the Airbus A380, the world's biggest passenger plane, will be a "flying palace" for Prince Alwaleed bin Talal, the manufacturer announced Monday.

Airbus SAS wou[...] VIP doul[...] length wings, sa[...]n the airc[...]

That doesn't eve[...]pend to c[...] plane to include[...]ude privat[...] gym with a jacuz[...]out 15 to[...]

"Prince Alwalee[...]omer of th[...] spokesman of the Airbus, which announced the luxury order a[...]

It's all just spending cash for bin Talal -- Citigroup Inc.'s bigges[...] 13th richest person with assets around $20 billion.

Al-Waleed bin Talal

Prince Al-Walid bin Talal bin Abdul Aziz Al Saud, born 7 March 1955 and commonly known as Prince Al-Walid, is a member of the Saudi Royal Family, and an entrepreneur and international investor. ... more

[ ] Wiki concepts

Highlight Specific Named Entity

None
PERSON
[✓ LOCATION]
ORGANIZATION
OTHERS

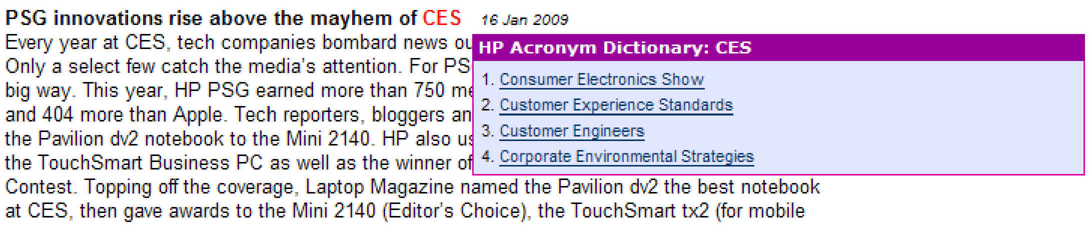
[✓] [ ] Filtering using Support Propagation

Details

Smart Browser Menu

Done

Figure 7. Screen shoot of Wikipedia concept linking

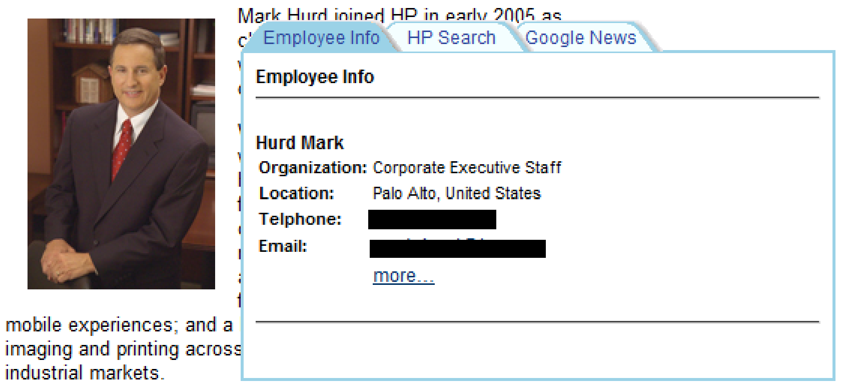

PSG innovations rise above the mayhem of CES 16 Jan 2009

Every year at CES, tech companies bombard news ou[...] Only a select few catch the media's attention. For PS[...] big way. This year, HP PSG earned more than 750 me[...] and 404 more than Apple. Tech reporters, bloggers an[...] the Pavilion dv2 notebook to the Mini 2140. HP also us[...] the TouchSmart Business PC as well as the winner of[...] Contest. Topping off the coverage, Laptop Magazine named the Pavilion dv2 the best notebook at CES, then gave awards to the Mini 2140 (Editor's Choice), the TouchSmart tx2 (for mobile

HP Acronym Dictionary: CES

1. Consumer Electronics Show
2. Customer Experience Standards
3. Customer Engineers
4. Corporate Environmental Strategies

Figure 8. Screen shoot of HP acronym dictionary


Mark Hurd joined HP in early 2005 as

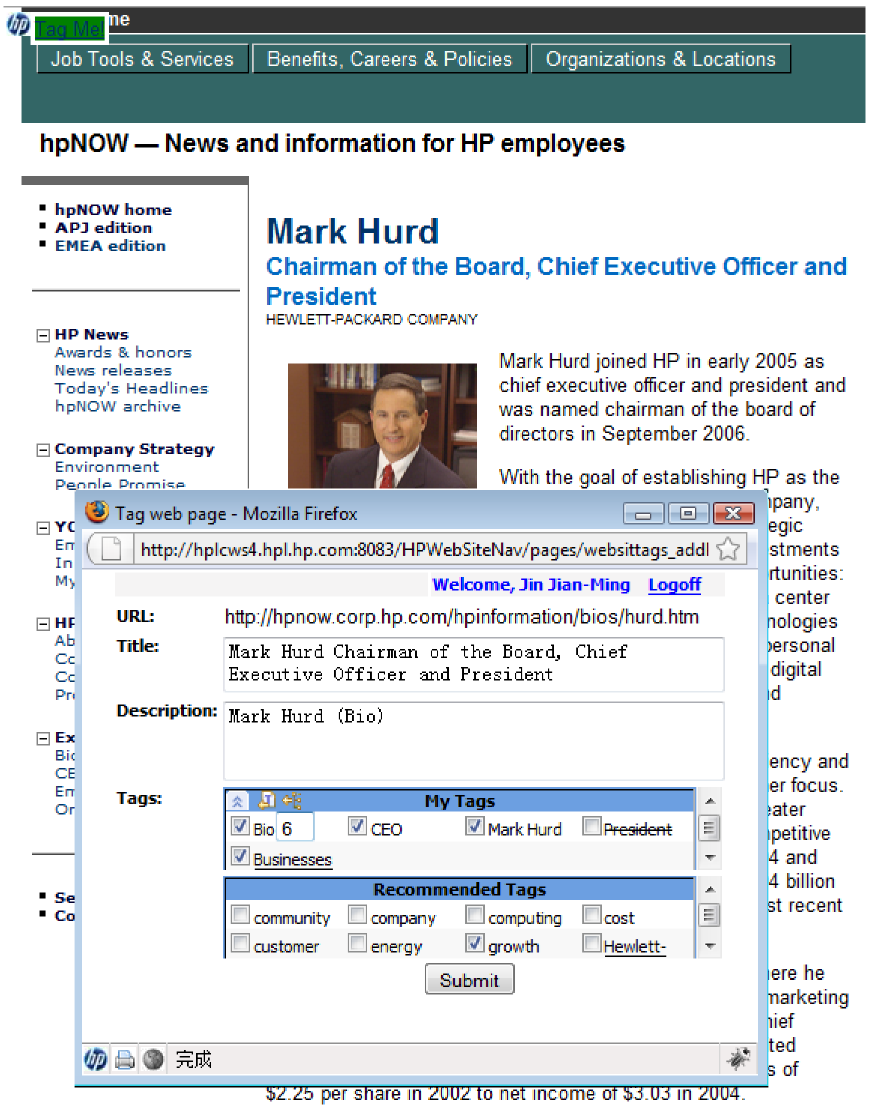
**Employee Info**

**Hurd Mark**

| | |
|---|---|
| **Organization:** | Corporate Executive Staff |
| **Location:** | Palo Alto, United States |
| **Telphone:** | [redacted] |
| **Email:** | [redacted] |
| | more… |

mobile experiences; and a
imaging and printing across
industrial markets.

Figure 9. Screen shoot of HP employee recognition



**hpNOW — News and information for HP employees**

**Mark Hurd**

**Chairman of the Board, Chief Executive Officer and President**

HEWLETT-PACKARD COMPANY

Mark Hurd joined HP in early 2005 as chief executive officer and president and was named chairman of the board of directors in September 2006.

With the goal of establishing HP as the

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Welcome, Jin Jian-Ming Logoff

| | |
|---|---|
| **URL:** | http://hpnow.corp.hp.com/hpinformation/bios/hurd.htm |
| **Title:** | Mark Hurd Chairman of the Board, Chief Executive Officer and President |
| **Description:** | Mark Hurd (Bio) |

**Tags:**

**My Tags**

[✓ Bio 6] [✓ CEO] [✓ Mark Hurd] ☐ ~~President~~ [✓ Businesses]

**Recommended Tags**

☐ community ☐ company ☐ computing ☐ cost ☐ customer ☐ energy [✓ growth] ☐ Hewlett-

$2.25 per share in 2002 to net income of $3.03 in 2004.

Figure 10. Screen shoot of HP web page tagging

## 4. CONCLUSION

In this paper, a framework called Smart Browser which supports the easy integration of customized background services within a Web browser is proposed. A Firefox extension is implemented based on the framework. Several intelligent services are provided based on the Smart Browser framework. These services bring the intelligence of crowd and machine, which are usually logic complicated, data intensive and computing complex, to each end user by utilizing light weighted and daily used browser. The four important features of Smart Browser framework make it very easy to use and give service providers very much flexibility to accomplish their functions. The framework can also be implemented in other browsers. We plan to open-source the Smart Browsing framework in the future.

## REFERENCES

[1] Greasemonkey. https://addons.mozilla.org/firefox/748/

[2] Dict.cn. http://dict.cn/

[3] ClearForest Gnosis. https://addons.mozilla.org/en-US/firefox/addon/3999