Study & Analysis of various Protocols in popular Web Browsers

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ABSTRACT

The web browsers are the application software that are used to access information from the World Wide Web. With the increasing popularity of the web browsers, the modern web browsers are designed to contain more features as compared to the existing web browsers. For the transferring of information through these browsers, various protocols have been implemented on these modern web browsers to make these browsers more efficient. Different protocols used in different layers have different functions and by increasing the efficiency of these protocols we can make the working of browsers more efficient.

Keywords : TCP/IP, NetBIOS, UDP, FTP, SNMP.

1   INTRODUCTION

From the cellular phone to the desktop, the web browser has become a ubiquitous piece of software in modern computing devices. These same browsers have become increasingly complex over the years, not only parsing plaintext and HTML, but images, videos and other complex protocols and file formats. Modern complexities have brought along security vulnerabilities, which in turn attracted malware authors and criminals to exploit the vulnerabilities and compromise end-user systems. This paper attempts to show and contrast the current protocol posture of various major web browsers.

These browsers are the popular web browser because of following parameters:

- Operating system support
- Accessibility features
- Acid score
- HTML support
- Mobile web technology support
- Plugins and syndicated content support
- JavaScript support
- Protocol support
- Image format support
- Security and vulnerability

Mozilla Firefox

Firefox is an open-source project that is managed by the Mozilla Foundation. Each component is divided into submodules. Each of these modules is owned by a specific individual that is in charge of managing the development of that that module. It descended from Mozilla Corporation suite and is managed by Mozilla Corporation. Firefox includes tabbed browsing, a spell checker, incremental find, live bookmarking, a download manager, and an integrated search system that uses the user's desired search engine .Functions can be added through add-ons created by third party developers, which include the No Script JavaScript disabling utility, Tab Mix Plus customizer,

Foxy Tunes media player control toolbar, Adblock Plus ad blocking utility, Stumble Upon (website discovery), Foxmarks Bookmark Synchronizer (bookmark synchronizer), WOT: Web of Trust security site advisor, download enhancer, and Web Developer toolbar. With a market share of 45.5% in 2009 it is the most popular browser.

Internet Explorer

Windows Internet Explorer (formerly Microsoft Internet Explorer; abbreviated MSIE), commonly abbreviated to IE, is a series of graphical web browser developed by Microsoft and included as part of the Microsoft Windows line of operating system starting in 1995. It has been the most widely used web browser since 1999, attaining a peak of about 95%usage during 2002 and 2003 with IE 5 and IE6 and that percentage share has declined since in the face of renewed competition from other web browser developers. Internet Explorer uses DOCTYPE sniffing to choose between "quirks mode" (renders similarly to older versions of MSIE) and standard mode (renders closer to W3C's specifications) for HTML and CSS rendering on screen (Internet Explorer always uses standards mode for printing). It also provides its own dialect of ECMA Script called Jscript.Internet Explorer has been subjected to criticism over its limited support for open web standards.

Google Chrome

Chrome the latest browser released in 2008 already had a market share of 3.9% in Jan 2009. Chromium is the open source project behind Google chrome. Salient Features include:
1. Task Manager for Websites
2. Visual Browser History
3. Super Clean Contextual Menus
4. Search option from the Address Bar
5. Check Memory Usage by Different Browsers
6. Reopen Website tabs that you closed by mistake
7. Launch Websites from the Start Menu / Quick Launch Bar
8. Developers claim faster speed (Sunspider and v8 benchmarks), better stability and performance and high security.

Architecture of chrome provides insight into its security features. Chromium has two modules in separate protection domain: browser kernel and rendering engine. This architecture helps mitigate high severity attack without compromising the compatibility.

Opera

Opera has market share of 2.3%. But the features of this browser get it a place in our comparison chart. Claimed to be a fast and secured browser it, has the following new features in its latest version:
• Content blocking
• Bit Torrent support
• Widgets
• Search engine editor
• Site preferences
• New installer. One package—30 languages
• Integrated source viewer
• Opera: config for advanced settings configuration
• Tab use: Thumbnails when you hover the cursor over a tab
• Widgets in Opera are more like small standalone applications that can interact with the internet and live outside the browser, rather than interface elements that can change the basic behavior of the browser, as Firefox's extensions are.

Innovative Features in Opera

Opera was the first browser with tabs, RSS support, and built-in BitTorrent client and tab thumbnails. It allows for duplication of tabs, Goto URL feature for web address that is not hyperlinked, periodic reloading, fitting to window size (ERA), rewinding, crash recovery, page zoom, instant back, tab closing. Along with this it does the best on the Acid2 web standards test. Though the safari browser is been used more as per the statistics given above we have taken chrome and opera because chrome is the latest browser by Google which is popular and wanted to know the details of the new browser.

Safari

Safari is a web browser developed by Apple Computer for its Mac OS X operating system. The first version was released in January 2003. The main design goals for Safari are usability, speed, standards compliance, and integration with OS X. Safari reuses the KHTML rendering engine and the KJS JavaScript interpreter from the KDE project. The modified versions are called WebCore and JavaScriptCore, and are released under the GNU Lesser General Public License (LGPL). However, the rest of Safari's code is proprietary, including the user interface.

Lynx

Lynx is a one of the most popular text-only browsers in use today. It predates the WWW, first serving as an interface for an "organization-wide information system." Custom hypertext capabilities were then added, followed by support for the Gopher protocol. Finally, support for WWW protocols was grafted on, making Lynx into a true web browser. This incremental development process has resulted in a system composed of small fragments of code with no coherent overall structure. Furthermore, much of the code is low-level and platform specific, increasing its complexity.

Netscape

Netscape Browser is the name of a proprietary Windows web browser published by AOL, but developed by Mercurial Communications. It is the eighth major release in name of the Netscape series of browsers, originally produced by the defunct Netscape Communications Corporation.

While Netscape Browser's version numbers start at 8, it is based on Mozilla Firefox, whereas Netscape 6 and 7 were based on Mozilla Application Suite, itself a complete rewrite of the codebase developed in versions 1 through 4 - Netscape Navigator and Netscape Communicator. As with other recent versions, it incorporates support for AOL Instant Messenger, and other AOL-related features.

PROTOCOLS

Protocols are set of rules that governing how data is transferred, compressed and presented over networks. There are many protocols, each one governing the way a certain technology works. A network protocol defines rules and conventions for communication between network devices. Protocols for computer networking all generally use packet switching techniques to send and receive messages in the form of packets. Network protocols include mechanisms for devices to identify and make connections with each other, as well as formatting rules that specify how data is packaged into messages sent and received. Some protocols also support message acknowledgement and data compression designed for reliable and/or high performance network communication. Hundreds of different computer network protocols have been developed each designed for specific purposes and environments. In general, the Internet Protocol family contains a set of related (and among the most widely used network protocols. Besides Internet Protocol (IP) itself, higher-level protocols like TCP, UDP, HTTP, and FTP all integrate with IP to provide additional capabilities. Similarly, lower-level Internet Protocols like ARP and ICMP also co-exist with IP. These higher level protocols interact more closely with applications like Web browsers while lower-level protocols interact with network adapters and other computer hardware. Here we are going to discuss few protocols which is observed over the network . The following part of the paper provides more details on various protocols and its functional services.

NetBIOS Session Service over TCP/IP (NBSS): NetBIOS Session Services are part of the NetBIOS over TCP/IP (NetBT) family of protocols and is used for server message block (SMB). This is both the port that NULL Sessions are established over and the port that file and printer sharing takes place on.

Network Basic Input Output System (NetBIOS): Network Basic Input Output System (NetBIOS), created by IBM originally, defines a software interface and standard methods providing a communication interface between the application program and the attached medium. NetBIOS, a session layer

protocol, is used in various LAN (Ethernet, Token Ring, etc) as well as WAN environments, such as TCP/IP, PPP and X.25 networks.

Simple Network Management Protocol (SNMP): is the standard protocol developed to manage nodes (servers, workstations, routers, switches and hubs, etc) on an IP network. SNMP enables network administrators to manage network performance, find, solve network problems and plan for network growth. Network management systems learn of problems by receiving traps or change notices from network devices implementing SNMP.

Hypertext Transfer Protocol (HTTP): The Hypertext Transfer Protocol (HTTP) is an application level protocol with the lightness and speed necessary for distributed, collaborative, hypermedia information systems. HTTP has been in use by the World Wide Web global information initiative since 1990.HTTP is a request-response standard typical of client-server computing. In HTTP, web browsers or spiders typically act as clients, while an application running on the computer hosting the web site acts as a server. The client, which submits HTTP requests, is also referred to as the user agent. The responding server, which stores or creates resources such as HTML files and images, may be called the origin server. In between the user agent and origin server may be several intermediaries, such as proxies, gateways, and tunnels. HTTP is not constrained in principle to using TCP/IP, although this is its most popular implementation platform. Indeed HTTP can be "implemented on top of any other protocol on the Internet, or on other networks." HTTP only presumes a reliable transport; any protocol that provides such guarantees can be used. Hypertext Transfer Protocol Secure (HTTPS): HTTP can run on top of TLS or SSL for secured transactions, which is called HTTPS. HTTPS is not to be confused with S-HTTP, a security enhanced version of HTTP developed and proposed as a standard by IETF. HTTP interaction over an encrypted Secure Sockets Layer (SSL) or Transport Layer Security (TLS) connection. This ensures reasonable protection from eavesdroppers and man-in-the-middle attacks, provided that adequate cipher suites are used and that the server certificate is verified and trusted.

Internet Control Message Protocol (ICMP) is an integrated part of the IP suite. ICMP messages, delivered in IP packets, are used for out-of-band messages related to network operation or misoperation. ICMP packet delivery is unreliable, so hosts can't count on receiving ICMP packets for any network problems. CMP [1] relies on IP to perform its tasks, and it is an integral part of IP. It differs in purpose from transport protocols such as TCP and UDP in that it is typically not used to send and receive data between end systems. It is usually not used directly by user network applications, with some notable exceptions being the ping tool and trace route.

TELNET is a TCP-based, application-layer, Internet Standard protocol for remote login from one host to another. TELNET is a client server protocol, based on TCP, and clients generally connect to port 23 on the host providing the service (though like many protocols in use on the Internet, which port to use is fairly easy to change). Partly because of the design of the protocol and partly because of the flexibility typically provided by TELNET client programs, it is also possible to use a TELNET program to establish an interactive TCP connection to some other service on an Internet host. A classic use of this is telnetting to port 25 (where typically an SMTP server is to be found) to debug a mail server.

Spanning-Tree Protocol (STP) is as defined in IEEE 802.1D, is a link management protocol that provides path redundancy while preventing undesirable loops in the network. For an Ethernet network to function properly, only one active path can exist between two stations. Loops occur in networks for a variety of reasons. The most common reason for loops in networks is a deliberate attempt to provide redundancy—in case one link or switch fails, another link or switch can take over.

VOIP Protocols: Voice over IP (VOIP) uses the Internet Protocol (IP) to transmit voice as packets over an IP network. Using VOIP protocols, voice communications can be achieved on any IP network regardless of whether it is Internet, Intranet or Local Area Network (LAN). In a VOIP enabled network, the voice signal is digitized, compressed and converted to IP packets and then transmitted over the IP network. VOIP signaling protocols are used to set up and tear down calls, carry information required to locate users and negotiate capabilities. The key benefits of Internet telephony are the very low cost; the integration of data, voice and video on one network; the new services created on the converged network; and simplified management of end user and terminals.

Real-Time Transport protocol (RTP) provides end-to-end delivery services for data with real-time characteristics, such as interactive audio and video or simulation data, over multicast or unicast network services. Applications typically run RTP on top of UDP to make use of its multiplexing and checksum services; both protocols contribute parts of the transport protocol functionality. However, RTP may be used with other suitable underlying network or transport protocols. RTP supports data transfer to multiple destinations using multicast distribution if provided by the underlying network.
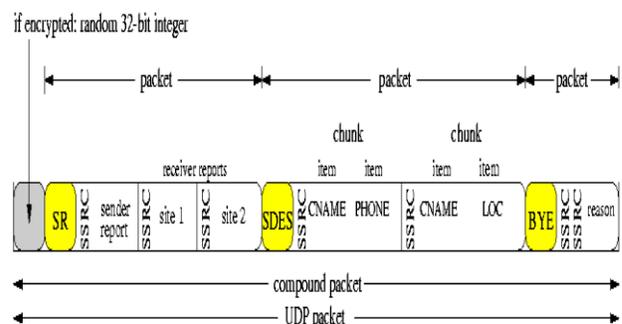

Fig. 1

Address Resolution Protocol (ARP) is a protocol for mapping an Internet Protocol address (IP address) to a physical machine address that is recognized in the local network. In an

Ethernet local area network, however, addresses for attached devices are 48 bits long. A table, usually called the ARP cache, is used to maintain a correlation between each MAC address and its corresponding IP address. ARP provides the protocol rules for making this correlation and providing address conversion in both directions. This is used to identify and monitor the packet communication across the network. This part of the work tries to optimize and construct the ARP sequence to detect the Intrusion.

2. EXISTING WORK

Worldwide Web, later renamed to Nexus to avoid confusion between the software and the World Wide Web, was the first web browser [1] and editor [2]. When it was written, Worldwide Web was the only way to view the Web.

The source code was released into the public domain in 1993. Some of the code still resides on Tim Berners-Lee's NeXT Computer in the CERN museum and has not been recovered due to the computer's status as a historical artifact. Worldwide Web was capable of displaying basic style sheets [3], downloading and opening any file type supported by the NeXT system (PostScript [2 3], movies, and sounds), browsing newsgroups, and spellchecking. At first, images were displayed in separate windows, until Next Step's Text class supported Image objects [3]. Worldwide Web was able to use different protocols: FTP [1], HTTP, [1] NNTP, [1] and local files [1].

Lynx is a very configurable text-based web browser for use on cursor-addressable character cell terminals.[4][5] It is the oldest web browser currently in use Lynx was a product of the Distributed Computing Group within Academic Computing Services of the University of Kansas,[6][7] and was initially developed in 1992 by a team of students at the university (Lou Montulli, Michael Grobe and Charles Rezac) as a hypertext browser used solely to distribute campus information as part of a Campus-Wide Information Server and for browsing the Gopher space.[8] Beta availability was announced to Usenet on 22 July 1992.[9] In 1993 Montulli added an Internet interface and released a new version (2.0) of the browser.[10][11] Browsing in Lynx consists of highlighting the chosen link using cursor keys, or having all links on a page numbered and entering the chosen link's number.[12] Current versions support SSL and many HTML features. Tables are formatted using spaces, while frames are identified by name and can be explored as if they were separate pages. Lynx cannot inherently display various types of non-text content on the web, such as images and video,[4] but it can launch external programs to handle it, such as an image viewer or a video player.[12]

Unlike most web browsers, Lynx does not support JavaScript and Adobe Flash,[13] which some websites require to work correctly.

Internet Explorer 1.0 was a graphical web browser that made its debut from Microsoft on August 16, 1995. It was a reworked version of Spyglass Mosaic which Microsoft had licensed,[14][15] like many other companies initiating browser development, from Spyglass Inc. It came with Microsoft Plus! for Windows 95 and OEM release of Windows 95. It was installed as part of the Internet Jumpstart Kit in Plus!.[16][17] The Internet Explorer team began with about half a dozen people in early development.[18][19] Internet Explorer 1.5 was released several months later for Windows NT and added support for basic HTML table rendering. However, by including it for free on their operating system they did not have to pay royalties to Spyglass, which resulted in a lawsuit and a US$8 million settlement on January 22, 1997.

Microsoft Internet Explorer 2 (abbreviated as IE2) is a graphical web browser released on November 22, 1995 by Microsoft for Windows 95 and Windows NT and in April 1996 for Apple Macintosh[20][dubious – discuss] and Windows 3.1. Version 2 launched with twelve languages including English but this expanded to 24 for Windows 95, 20 for Windows 3.1, and 9 for the Macintosh by April 1996.[21] It lacked many features that became common in later IE versions, including the Blue 'e' logo, integration with Windows Explorer, and bundled programs. Its market share was also much lower than later versions. During its tenure, IE market share only went up to about roughly 3-9% by mid 1996, before IE3 came out.[22][23] IE2 introduced new or improved features for its time period. Many soon became ubiquitous (such as cookies) while other features became obsolete.[24][25]

Microsoft Internet Explorer 3 (abbreviated as IE3) is a graphical web browser released on August 13, 1996 by Microsoft for Microsoft Windows and on January 8, 1997 for Apple Mac OS (see IE for Mac). It began serious competition against Netscape Navigator in the first Browser war.[26] It was the first more widely used version of Internet Explorer, although it did not surpass Netscape or become the browser with the most market share. During its tenure, IE market share went from roughly 3-9% in early 1996 to 20-30% by the end of 1997. In September 1997 it was superseded by Microsoft Internet Explorer 4.

Internet Explorer 3 was the first commercial browser with Cascading Style Sheets (CSS) support.[27] It also introduced support for ActiveX controls, Java applets, inline multimedia, and the Platform for Internet Content Selection (PICS) system for content metadata. This version was also the first version of Internet Explorer to use the blue 'e' logo, which later became a symbol of the browser. Version 3 also came bundled with Internet Mail and News, NetMeeting, and an early version of the Windows Address Book, and was itself included with Windows 95 OEM Service Release 2. There were 16-bit and 32-bit versions depending on the OS.

IE3 was the first version developed without Spyglass source code, but still used Spyglass technology, so the Spyglass licensing information remained in the program's documentation. In 1996 Microsoft said of its new browser "Microsoft Internet Explorer 3.0 adds many new features which are great for HTML authors and demonstrates our accelerating commitment to W3C HTML standards. " [28]

The history of the Opera web browser began in 1994 when it was started as a research project at Telenor, the largest Norwegian telecommunications company. In 1995, the project branched out into a separate company named Opera Software ASA,[29] with the first publicly available version released in 1996.[30] Since that time, Opera has undergone extensive changes and improvements, such as the relatively recent addition of built-in phishing protection.

The Opera browser was, until version 2.0, called MultiTorg Opera and was not available to the public—although online documents show it at The Third International WWW Conference in 1995.[31] It was known for its multiple document interface (MDI) and 'hotlist' (sidebar), which made browsing several pages at once much easier, as well as being the first browser to completely focus on adhering to the W3C standards.

Version 2.0, the first public release of Opera, was released as shareware in 1996.[32][33]

Due to popular demand, Opera Software showed interest in programming its browser for alternate operating systems such as Apple Macintosh, QNX and BeOS. On October 10, 1997, they launched "Project Magic", an effort to determine who would be willing to purchase a copy of their browser in their native OS, and to properly distribute funds to develop or outsource for such operating systems.[34] On November 30, 1997 they closed voting for which operating system to develop with. Project Magic then became a news column for updates for alternate operating systems until version 4.[35]

Opera 3 was the first version of Opera with JavaScript support, but Java was still missing. It was released for multiple operating systems on December 31, 1997.

In 1998, Opera 3.5 was released, adding Cascading Style Sheets (CSS) support and file upload capability.

Since version 3.5, Opera has supported CSS, and Håkon Wium Lie, one of the inventors of CSS, is the CTO at Opera.[36] Up to 6.0 Opera supported most common web standards, Netscape plugins and some other recent standards such as WAP and WML for wireless devices, but its implementation of advanced ECMAScript (better known as "JavaScript") and the HTML Document Object Model was poor.

Version 3.6 was released on May 12, 1999.[37]

On June 28, 2000,[38] Opera 4 for Windows (Elektra)[39] was released, introducing a new cross-platform core, and a new integrated e-mail client. On November 29, 2001, Opera 6 was released with new features including Unicode support, and offering a single document interface as well as the multiple document interface allowed by previous versions.

Microsoft Internet Explorer 4 (abbreviated as IE4) is a graphical web browser released in October 1997 by Microsoft, primarily for Microsoft Windows, but also with versions available for Apple Mac OS, Solaris, and HP-UX[40] and marketed as "The Web the Way You Want It".[41]

It was one of the main participants of the first browser war. Its distribution methods and Windows integration were involved in United States v. Microsoft. It was superseded by Microsoft Internet Explorer 5 in March 1999. Version 4.0 was included with Windows 95 OEM Service Release 2.5 and 4.01 in Windows 98, in addition the Internet Explorer layout engine Trident was introduced. It attained just over 60% market share by March 1999 when IE5 was released. In August 2001 when Internet Explorer 6 was released, IE4.x had dropped to 7% market share and IE5 had increased to 80%.[42] IE4 market share dropped under 1% by 2004.[43].Mozilla Firefox 3.6 was a version of the Firefox web browser released in January 2010. The release's main improvement over Firefox 3.5 is improved performance (due to further speed improvements in the TraceMonkey JavaScript engine). It uses the Gecko 1.9.2 engine (compared to 1.9.1 in FF 3.5), which improves compliance with web standards. It was codenamed Namoroka[48].

This release marked the beginning of a new development cycle for Firefox. As well as receiving major updates, the browser also received minor updates with new features. This was to allow users to receive new features more quickly and the dawn of a new roadmap that reflected these changes [44].

It was superseded by Firefox 4, released the next year, although FF 3.6 had a prolonged period of use and version 4 had noted user interface changes. Soon after 4, much less weight was given to major version numbers, with 6 numbers used by September of that year (4, 5, 6, 7, 8, and 9) compared to 3 in nearly a decade of Firefox development (1,2 and 3).

3. Result Analysis

Percentage usage of browsers by users

Year	Internet Explorer	Firefox	Chrome	Safari	Opera
2012	18.5 %	35.6 %	39.7 %	4.2 %	2.2 %
2011	23.6 %	41.4 %	31.3 %	4.3 %	2.2 %
2010	32.3 %	45.8 %	17.4 %	3.5 %	2.1 %
2009	40.9 %	47.3 %	8.4 %	3.4 %	2.1 %
2008	48.5 %	43.6 %	3.6 %	2.5 %	2.0 %

Table 1

As shown in the table above is the percentage usage of the popular web browsers of last five years.
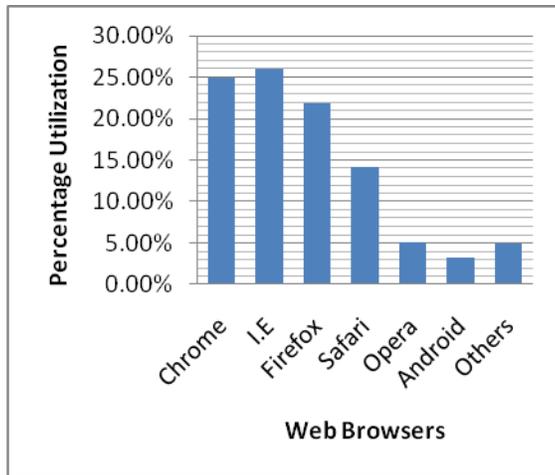
Fig. 3

As shown in the graph above is the percentage utilization of the modern web browsers. According to the above graph and the statically survey it was found that the Internet Explorer web browser has the highest utilization in terms of their performance and the features. The Internet Explorer contains most of the protocols integrated which increase its market share and is getting more efficient.

Protocols Integrated in various web browsers

brows ers\pr oto-cols	HT TP	E-ma il	FT P	N NT P	SS L	EV	I R C	Go-pher	ID N	UR I	IP V6
Googl e Chro me	Yes	No	Yes	No	Yes	Yes	No	No	Yes	Yes	?
Inter-net Ex-plorer	Yes	No	Yes	No	Yes	Yes	No	Dro ppe d	Yes	Par ti-al	Yes
Fire-fox	Yes	No	Yes	No	Yes	Yes	No	Drop ped	Yes	Yes	Yes
Safari	Yes	No	Par tial	No	Yes	Yes	No	No	Yes	Yes	Yes
Nets-cape	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Yes	?
Opera	Yes	Yes	Yes	Yes	Yes	Yes	Y es	No	Yes	Yes	Yes
Lynx	Yes	No	Yes	Yes	Yes	No	No	Yes	?	No	Yes

Table 2

As shown in the above table is the protocol implement in various web browsers. Here in the above table we have compared widely used protocols such as HTTP, E-mail, FTP, NNTP, SSL, EV, IRC, Gopher, IDN, URI, IPV6 and we have analysed in which web browser which protocol is implemented or not.

4. CONCLUSION

In this paper comparative study and analysis of different protocols used in the popular web browsers has been made as the protocols used for establishing different applications such as VPN at different layer of OSI model. Each protocol has its own merits and demerits. But here we have analysed that the with the development of different web browsers the implementation of different new protocols has been implemented in these browsers to make these browsers more efficient. These protocols are used to provide more effective way of communication, security, and the transfer of data in a more efficient manner in the web browsers hence these browsers will become popular.

5. FUTURE WORK

Although it was found that the percentage utilization of Internet Explorer browser is maximum but all the protocols are not yet implemented in this type of browser, So in the future we can implemented more sophisticated more protocol implemented web browser to make the web browser more efficient.

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