

REVOLUTIONARY POWER OF INTERNET TECHNOLOGY IN RESEARCH DEVELOPMENT

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Abstract

Internet technology is a set of technologies ranging from network protocols to browsers that have been developed to support Internet operations. Internet, also known as Web technologies have revolutionized information storage and sharing by granting access and connections from a graphical user interface (GUI) or browser from different locations across the globe. The ability to transfer information is also a great user convenience. Users can print materials, download information, and/or send the material electronically to an e-mail address. Libraries' home pages provide links to both print, in-house, and remote electronic database and Internet sources from one central access point. Alliances among information creators, publishers, aggregators, portal vendors, and Internet service providers through the web have increasingly blurred the content distribution chain. However, it has also made the process more seamless to library users. This has increased both the use and utility of information resources especially in the academic environments for research purposes. The purpose of this paper, therefore, is to highlight all the basic technology tools on which the internet thrives.

Keywords: *Internet, technology, protocols, browsers, database, ARPANET, Python, ActionScript*

1.0 Introduction

History/Evolution of Internet

Internet - An internet can be defined as a global connection of computer networks for the purposes of data and information exchange [1]. It is world-wide network of computer networks. It is the largest internetwork. Internetwork is a connection of multiple computer networks [2].

The Internet started in the 1960s as a way for government researchers to share information. Computers in the '60s were large and immobile and in order to make use of information stored in any one computer, one had to either travel to the site of the computer or have magnetic computer tapes sent through the conventional postal system [3].

Another catalyst in the formation of the Internet was the heating up of the Cold War. The Soviet Union's launch of the Sputnik satellite spurred the U.S. Defense Department to consider ways information could still be disseminated even after a nuclear attack. This eventually led to the formation of the ARPANET (Advanced Research Projects Agency Network), the network that ultimately evolved into what we now know as the Internet. ARPANET was a great success but membership was limited to certain academic and research organizations who had contracts with the Defense Department[4]. In response to this, other networks were created to provide information sharing.

January 1, 1983 is considered the official birthday of the Internet. Prior to this, the various computer networks did not have a standard way to communicate with each other. A new communications protocol was established called Transfer Control Protocol/Internet work Protocol (TCP/IP)[1]. This allowed different kinds of computers on different networks to "talk" to

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each other. ARPANET and the Defense Data Network officially changed to the TCP/IP standard on January 1, 1983, hence the birth of the Internet. All networks could now be connected by a universal language[5].

Internet Architecture

The architecture of the Internet is ever-changing due to continuous changes in the technologies as well as the nature of the service provided. The heterogeneity and vastness of the Internet make it difficult to describe every aspect of its architecture. However, it is a client-server architecture system[6].

The overall architecture can be described in three levels –

- i. Backbone ISP (Internet Service Provider)
- ii. Regional ISPs
- iii. Clients

Backbone ISP (Internet Service Provider) – Backbone ISPs are large international backbone networks. They are equipped with thousands of routers and store enormous amounts of information in data centers, connected through high bandwidth fiber optic links. Everyone needs to connect with a backbone ISP to access the entire Internet. There are different ways through which a client can connect to the ISP. A commonly used way is DSL (Digital Subscriber Line) which reuses the telephone connection of the user for transmission of digital data. The user uses a dial-up connection instead of the telephone call. Connectivity is also done by sending signals over cable TV system that reuses unused cable TV channels for data transmission. For high-speed Internet access, the connectivity can be done through FTTH (Fiber to the Home), that uses optical fibers for transmitting data. Nowadays, most Internet access is done through the wireless connection to mobile phones from fixed subscribers, who transmit data within their coverage area.

Advantages of internet



Figure 1: Advantages of Internet

Internet covers almost every aspect of life, one can think of. Here, we will discuss some of the advantages of Internet[1,6]:

- i Internet allows us to communicate with the people sitting at remote locations. There are various apps available on the web that uses Internet as a medium for communication. One can find various social networking sites such as: Facebook, Twitter, Yahoo, Google+, Flickr, Orkut
- ii One can surf for any kind of information over the internet. Information regarding various topics such as Technology, Health & Science, Social Studies, Geographical Information, Information Technology, Products etc can be surfed with help of a search engine.
- iii Internet also serves a medium for entertainment. Following are the various modes for entertainment over internet: Online Television, Online Games, Songs, Videos, Social Networking Apps
- iv Internet allows us to use many services like: Internet Banking, Matrimonial Services, Online Shopping, Online Ticket Booking, Online Bill Payment, Data Sharing, E-mail
- v Internet provides concept of **electronic commerce**, that allows the business deals to be conducted on electronic systems

Disadvantages of internet



Figure 2: Disadvantages of Internet

Internet has proved to be a powerful source of information in almost every field, yet there exists many disadvantages discussed below:

- i There are always chances to loose personal information such as name, address, credit card number. Therefore, one should be very careful while sharing such information. One should use credit cards only through authenticated sites.

- ii Another disadvantage is the **Spamming**. Spamming corresponds to the unwanted e-mails in bulk. These e-mails serve no purpose and lead to obstruction of entire system.
- iii **Virus** can easily be spread to the computers connected to internet. Such virus attacks may cause your system to crash or your important data may get deleted.
- iv Also a biggest threat on internet is pornography. There are many pornographic sites that can be found, letting your children to use internet which indirectly affects the children healthy mental life.
- v There are various websites that do not provide the authenticated information. This leads to misconception among many people.

2.0 Internet Variants

Intranet

An intranet is a private computer network for sharing information and data and other computing services within an organization only.

Extranet

Extranet is a controlled organizational private computer network established for the use of both the organization and its external but authorized customers for the purpose of data and information exchange.

2.1 What is Internet Technology?

Technology –The application of scientific knowledge in the production of methods, systems, and devices that can be used for practical purposes.

Internet Technology – Technology behind the internet. The technology on which the internet leverages. The group of technologies on which the internet revolves. Technology that makes internet possible. *Internet* technology is a set of *technologies* ranging from network protocols to browsers that have been developed to support *Internet* operations[5,4].

2.2 Network protocols

Network protocols are a set of rules, conventions, and data structures that dictate how devices exchange data across networks. In other words, network protocols can be equated to languages that two devices must understand for seamless communication of information, regardless of their infrastructure and design disparities[2].

To understand the nuances of network protocols, it's imperative to know about the Open Systems Interconnection (OSI) model and its TCP/IP counterpart first. Considered the primary architectural model for internet working communications, the majority of network protocols used today are structurally based on the OSI model[2]. Network protocols divide the communication process into discrete tasks across every layer of the OSI model. One or more network protocols operate at each layer in the communication exchange.

Following are the detailed descriptions of the functioning of network protocols in each layer of the OSI model:

Table 1: OSI model

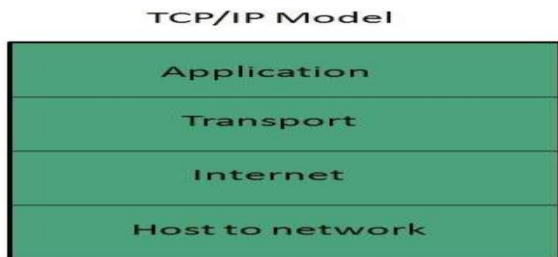
Layer 7:Application layer network protocols	Provides standard services such as virtual terminal, file, and job transfer and operations.
Layer6:Presentation layer network protocols	Masks the differences in data formats between dissimilar systems. Encodes and decodes data, encrypts and decrypts data, and compresses and decompresses data.
Layer 5: Session layer network protocols	Manages user sessions and dialogues. Establishes and terminates sessions between users.
Layer 4: Transport layer network protocols	Manages end-to-end message delivery in networks. Renders reliable and sequential packet delivery through error recovery and flow control mechanisms.
Layer 3: Network layer protocols	Routes packets according to unique network device addresses. Renders flow and congestion control to prevent network resource depletion.
Layer 2: Data link layer network protocols	Frames packets. Detects and corrects packet transmit errors.
Layer 1: Physical layer network protocols	Interfaces between network medium and devices. Defines optical, electrical, and mechanical characteristics.

TCP/IP Model

TCP/IP model is practical model and is used in the Internet. TCP/IP is acronym of Transmission Control Protocol and Internet Protocol.

The TCP/IP model combines the two layers (Physical and Data link layer) into one layer i.e. Host-to-Network layer. The table 2 shows the various layers of TCP/IP model:

Table 2 TCP/IP model



Application Layer. This layer is same as that of the OSI model and performs the following functions:

- i It provides different services such as manipulation of information in several ways, retransferring the files of information, distributing the results etc.
- ii The functions such as LOGIN or password checking are also performed by the application layer.

Protocols used: TELNET, FTP, SMTP, DN, HTTP, NNTP are the protocols employed in this layer.

Transport Layer:

It does the same functions as that of transport layer in OSI model. Here are the key points regarding transport layer:

- i It uses **TCP** and **UDP** protocol for end to end transmission.
- ii TCP is reliable and **connection oriented protocol**.
- iii TCP also handles flow control.
- iv The UDP is not reliable and a **connection less protocol** also does not perform flow control.

Protocols used: TCP/IP and UDP protocols are employed in this layer.

Internet Layer

The function of this layer is to allow the host to insert packets into network and then make them travel independently to the destination. However, the order of receiving the packet can be different from the sequence they were sent.

Protocols used: Internet Protocol (IP) is employed in Internet layer.

Host-to-Network Layer

This is the lowest layer in TCP/IP model. The host has to connect to network using some protocol, so that it can send IP packets over it. This protocol varies from host to host and network to network.

Protocols used: ARPANET, SATNET, LAN, packet radio are the protocols which are used in this layer.

Classification of network protocols

Now that you know how the OSI model works, you can dive straight into the classification of protocols. The following are some of the most prominent protocols used in network communication [7,8]

Application layer network protocols

3.0. DHCP: Dynamic Host Configuration Protocol

DHCP is a communication protocol that enables network administrators to automate the assignment of IP addresses in a network. In an IP network, every device connecting to the internet requires a unique IP. DHCP lets network admins distribute IP addresses from a central point and automatically send a new IP address when a device is plugged in from a different place in the network. DHCP works on a client-server model.

3.1 DNS: Domain Name System protocol

The DNS protocol helps in translating or mapping host names to IP addresses. DNS works on a client-server model, and uses a distributed database over a hierarchy of name servers.

Hosts are identified based on their IP addresses, but memorizing an IP address is difficult due to its complexity. IPs are also dynamic, making it all the more necessary to map domain names to IP addresses. DNS helps resolve this issue by converting the domain names of websites into numerical IP addresses.

3.2 FTP: File Transfer Protocol (used for file transfer)

File Transfer Protocol enables file sharing between hosts, both local and remote, and runs on top of TCP. For file transfer, FTP creates two TCP connections: control and data connection. The control connection is used to transfer control information like passwords, commands to retrieve and store files, etc., and the data connection is used to transfer the actual file. Both of these connections run in parallel during the entire file transfer process[8].

3.3 HTTP: Hyper Text Transfer Protocol (content retrieval technology=send and response ---client sends req then server respond)

HTTP is an application layer protocol used for distributed, collaborative, and hypermedia information systems. It works on a client-server model, where the web browser acts as the client. Data such as text, images, and other multimedia files are shared over the World Wide Web using HTTP. As a request and response type protocol, the client sends a request to the server, which is then processed by the server before sending a response back to the client[8].

HTTP is a stateless protocol, meaning the client and server are only aware of each other while the connection between them is intact. After that, both the client and server forget about each other's existence. Due to this phenomenon, the client and server can't both retain information between requests[7].

3.4 IMAP and IMAP4: Internet Message Access Protocol (version 4)

IMAP is an email protocol that lets end users access and manipulate messages stored on a mail server from their email client as if they were present locally on their remote device. IMAP follows a client-server model, and lets multiple clients access messages on a common mail server concurrently. IMAP includes operations for creating, deleting, and renaming mailboxes; checking for new messages; permanently removing messages; setting and removing flags; and much more. The current version of IMAP is version 4 revision 1[7].

3.5 POP and POP3: Post Office Protocol (version 3)(for email retrieval and downloading)

The Post Office Protocol is also an email protocol. Using this protocol, the end user can download emails from the mail server to their own email client. Once the emails are downloaded locally, they can be read without an internet connection. Also, once the emails are moved locally, they get deleted from the mail server, freeing up space. POP3 is not designed to perform extensive manipulations with the messages on the mail server, unlike IMAP4. POP3 is the latest version of the Post Office Protocol[7].

3.6 SMTP: Simple Mail Transfer Protocol (for sending emails)

SMTP is a protocol designed to transfer electronic mail reliably and efficiently. SMTP is a push protocol and is used to send the email, whereas POP and IMAP are used to retrieve emails on the end user's side. SMTP transfers emails between systems, and notifies on incoming emails. Using SMTP, a client can transfer an email to another client on the same network or another network through a relay or gateway access available to both networks.

3.7 Telnet: Terminal emulation protocol (enables remote login)

Remote login and commands to a distant computer

Telnet is an application layer protocol that enables a user to communicate with a remote device. A Telnet client is installed on the user's machine, which accesses the command line interface of another remote machine that runs a Telnet server program.

Telnet is mostly used by network administrators to access and manage remote devices. To access a remote device, a network admin needs to enter the IP or host name of the remote device, after which they will be presented with a virtual terminal that can interact with the host[7].

3.8 SNMP: Simple Network Management Protocol

SNMP is an application layer protocol used to manage nodes, like servers, workstations, routers, switches, etc., on an IP network. SNMP enables network admins to monitor network performance, identify network glitches, and troubleshoot them. SNMP protocol is comprised of three components: a managed device, an SNMP agent, and an SNMP manager[8].

The SNMP agent resides on the managed device. The agent is a software module that has local knowledge of management information, and translates that information into a form compatible with the SNMP manager. The SNMP manager presents the data obtained from the SNMP agent, helping network admins manage nodes effectively [9].

Currently, there are three versions of SNMP: SNMP v1, SNMP v2, and SNMP v3. Both versions 1 and 2 have many features in common, but SNMP v2 offers enhancements such as additional protocol operations. SNMP version 3 (SNMP v3) adds security and remote configuration capabilities to the previous versions.

Presentation layer network protocols

3.9 LPP: Lightweight Presentation Protocol

The Lightweight Presentation Protocol helps provide streamlined support for OSI application services in networks running on TCP/IP protocols for some constrained environments. LPP is designed for a particular class of OSI applications, namely those entities whose application context contains only an Association Control Service Element (ACSE) and a Remote Operations Service Element (ROSE). LPP is not applicable to entities whose application context is more extensive, i.e., contains a Reliable Transfer Service Element.

Session layer network protocols

RPC: Remote Procedure Call protocol: RPC is a protocol for requesting a service from a program in a remote computer through a network, and can be used without having to understand the underlying network technologies. RPC uses TCP or UDP for carrying the messages between communicating programs. RPC also works on client-server model. The requesting program is the client, and the service providing program is the server.

Transport layer network protocols

- TCP: Transmission Control Protocol(end-to-end data transfer)[10]

TCP is a connection-oriented protocol, as it requires a connection to be established between applications before data transfer. Through flow control and acknowledgement of data, TCP provides extensive error checking. TCP ensures sequencing of data, meaning the data packets arrive in order at the receiving end. Retransmission of lost data packets is also feasible with TCP.

- UDP: User Datagram Protocol[10]

UDP is a connection-less transport layer protocol that provides a simple but unreliable message service. Unlike TCP, UDP adds no reliability, flow control, or error recovery functions. UDP is useful in situations where the reliability mechanisms of TCP are not necessary. Retransmission of lost data packets isn't possible with UDP[11].

Network layer protocols

- IP: Internet Protocol (IPv4)

IPv4 is a network layer protocol that contains addressing and control information, which helps packets be routed in a network[12][12]. IP works in tandem with TCP to deliver data packets across the network. Under IP, each host is assigned a 32-bit address comprised of two major parts: the network number and host number. The network number identifies a network and is assigned by the internet, while the host number identifies a host on the network and is assigned by a network admin. The IP is only responsible for delivering the packets, and TCP helps puts them back in the right order[13].

- IPv6: Internet Protocol version 6

IPv6 is the latest version of the Internet Protocol, a network layer protocol that possesses addressing and control information for enabling packets to be routed in the network. IPv6 was created to deal with IPv4 exhaustion. It increases the IP address size from 32 bits to 128 bits to support more levels of addressing[14].

- ICMP: Internet Control Message Protocol

ICMP is a network layer supporting protocol used by network devices to send error messages and operational information. ICMP messages delivered in IP packets are used for out-of-band messages related to network operation or misoperation. ICMP is used to announce network errors, congestion, and timeouts, as well assist in troubleshooting. ICMP is used to diagnose network issues.

4.0 Data link layer network protocols

4.1 ARP: Address Resolution Protocol

The Address Resolution Protocol helps map IP addresses to physical machine addresses (or a MAC address for Ethernet) recognized in the local network. A table called an ARP cache is used to maintain a correlation between each IP address and its corresponding MAC address[15]. ARP offers the rules to make these correlations, and helps convert addresses in both directions.

4.2 SLIP: Serial Line IP

SLIP is used for point-to-point serial connections using TCP/IP. SLIP is used on dedicated serial links, and sometimes for dial-up purposes. SLIP is useful for allowing mixes of hosts and routers to communicate with one another; for example, host-host, host-router, and router-router are all common SLIP network configurations. SLIP is merely a packet framing protocol: It defines a sequence of characters that frame IP packets on a serial line. It does not provide addressing, packet type identification, error detection or correction, or compression mechanisms.

5.0 The World Wide Web

World Wide Web was created by Timothy Berners Lee in 1989 at **CERN** in **Geneva**. World Wide Web came into existence as a proposal by him, to allow researchers to work together effectively and efficiently at **CERN**. Eventually it became **World Wide Web**[12].

The World Wide Web is a part of the Internet, which is a universe of network-accessible information, an embodiment of human knowledge organized into web pages[16].

5.1 Web Page

Web page is a document available on world wide web. Web Pages are stored on web server and can be viewed using a web browser. A web page can contain huge information including text, graphics, audio, video and hyper links. These hyper links are the link to other web pages.

A collection of linked web pages stored on a web server is known as **website**. There is unique **Uniform Resource Locator (URL)** is associated with each web page. A page can either be static or dynamic[17].

5.2 Static Web page

Static web pages are also known as flat or stationary web page. They are loaded on the client's browser as exactly they are stored on the web server[19]. Such web pages contain only static information. User can only read the information but

can't do any modification or interact with the information. Static web pages are created using only HTML. Static web pages are only used when the information is no more required to be modified.

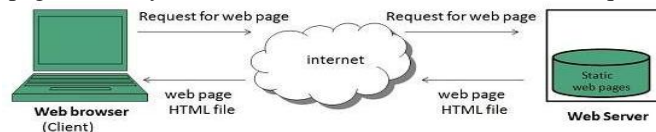


Figure 3: Architecture of Static Web page

5.3 Dynamic Web page

Dynamic web page shows different information at different point of time. It is possible to change a portion of a web page without loading the entire web page. It has been made possible using **Ajax** technology.

Server-side dynamic web page. It is created by using server-side scripting. There are server-side scripting parameters that determine how to assemble a new web page which also include setting up of more client-side processing[20].

Client-side dynamic web page. It is processed using client side scripting such as JavaScript. And then passed in to Document Object Model (DOM).

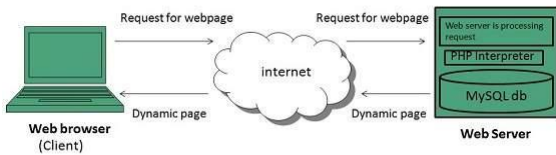


Figure 4: Client-side dynamic web page

6.1 Scripting Languages

Scripting languages are like programming languages that allow us to write programs in form of script. These scripts are interpreted not compiled and executed line by line.

Scripting language is used to create dynamic web pages.

6.2 Client-side Scripting

Client-side scripting refers to the programs that are executed on client-side. Client-side scripts contains the instruction for the browser to be executed in response to certain user's action[21].

Client-side scripting programs can be embedded into HTML files or also can be kept as separate files.

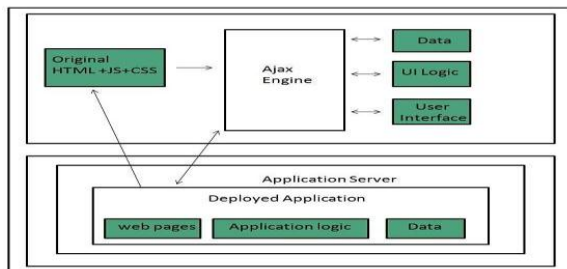


Figure 5: Architecture of Client-side Scripting

6.3 Server-side Scripting

Sever-side scripting acts as an interface for the client and also limit the user access the resources on web server. It can also collect the user's characteristics in order to customize response.

Table 3: Commonly used Client-Side scripting languages description

S/N	Scripting Language Description
1.	JavaScript. It is a prototype based scripting language. It inherits its naming conventions from java. All java script files are stored in file having .js extension
2.	ActionScript. It is an object oriented programming language used for the development of websites and software targeting Adobe flash player.
3.	Dart. It is an open source web programming language developed by Google. It relies on source-to-source compiler to JavaScript
4.	VBScript. It is an open source web programming language developed by Microsoft. It is superset of JavaScript and adds optional static typing class-based object oriented programming.

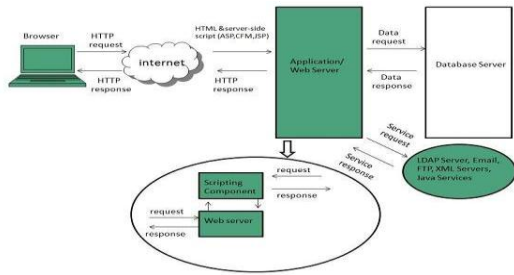


Figure 5: Architecture of Server-side Scriptings

Table 4: Commonly used Server-Side scripting languages description [22]:

S.N.	Scripting Language Description
1.	ASP Active Server Pages (ASP) is server-side script engine to create dynamic web pages. It supports Component Object Model (COM) which enables ASP web sites to access functionality of libraries such as DLL.
2.	ActiveVFP It is similar to PHP and also used for creating dynamic web pages. It uses native Visual Foxpro language and database.
3.	ASP.net It is used to develop dynamic websites, web applications, and web services.
4.	Java Java Server Pages are used for creating dynamic web applications. The Java code is compiled into byte code and run by Java Virtual Machine (JVM) .
5.	Python It supports multiple programming paradigms such as object-oriented, and functional programming. It can also be used as non-scripting language using third party tools such as Py2exe or Pyinstaller .
6.	WebDNA It is also a server-side scripting language with an embedded database system.

7.0 Web Browser

Web browser is an application software that allows us to view and explore information on the web. User can request for any web page by just entering a URL into address bar[23].

Web browser can show text, audio, video, animation and more. It is the responsibility of a web browser to interpret text and commands contained in the web page.

Earlier the web browsers were text-based while now a days graphical-based or voice-based web browsers are also available. Following are the most common web browser available today[24]:

Browser	Vendor
Internet Explorer	Microsoft
Google Chrome	Google
Mozilla Firefox	Mozilla
Netscape Navigator	Netscape Communications Corp.
Opera	Opera Software
Safari	Apple
Sea Monkey	Mozilla Foundation
K-meleon	K-meleon

8.0 Web Hosting

When a website is created, it has to be hosted so that it can be accessible to people all over the world. The process of connecting a website to the internet is called web hosting, which is done by a Web hosting service provider/company who helps to connect the Web Site to the web while providing such services as: Server, Web server software, Firewall, Disk space, Email server/storage, etc. with certain amount of money[25].

The website must have a name with which it can be referenced usually known as the URL. The URL has the following parts[18].

- Protocol – indicates the method of communication to be used e.g. http://
- Domain name – the name of the website e.g. www.3gigoption.com
- Port – the connection interface between the client and the server e.g. 8080
- The path or the name of the file e.g. sec/index.php

A complete URL may look like <http://www.3gigoption.com/sec/index.php>. it is a unique id of a resource on the web. The DNS maps an IP address to each domain name[14].

Domain Name System helps to resolve the host name to an address. It uses a hierarchical naming scheme and distributed database of IP addresses and associated names

IP Address

IP address is a unique logical address assigned to a machine over the network

CONCLUSION

Research has been defined as searching for knowledge through information, which makes the global communication system that connects millions of users hard to ignore. Therefore, the Internet is the lowest cost system ever developed to communicate with a potential audience of hundreds of millions of people all over the world. As a news medium, the Internet is faster and more flexible than a newspaper or magazine and More so, story can be added to a Web site instantly at any time of the day or night, one can say that Internet is the most powerful and useful medium for obtaining latest information on variety of subjects published online for a number of purposes inclusive of Research. To this end, the set of technologies that have been developed to support the workings of the internet cannot be disparaged

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