Modern Web Browser EDGE Computing

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Abstract—**In this paper we will discuss about EDGE computing. because it is told as MODERN WEB BROWSER has evolved in to sophisticated edge computing plat forms acting as a distributed computing node that process data locally on the user device rather than relying solely on distant cloud servers. By leveraging local processing power, browser -based application and progressive web app (PWAs)achieve near -native performance reduced latency and improve the data privacy. because it is decentralized modern browser such as micro soft edge and chrome act as the "edge" where information is consumed and processed minimize the data transfer to the central server, by moving the computing closer to the user, browser enabled real-time application and faster load time, crucial for gaming AR (augmented reality) VR (virtual reality)and complex web app the browser can interact directly with the local resources and connected devices (IoT) using local API without installing dedicated mobile application because it is web of things(WoT) and also used web based AI/ML running on AI model (example face recognition, real-time filtering) directly with the browser using web assembly OR web GL(web graphical library). The micro soft edge is the default web browser an all-modern windows operating system and all apple devices (macOS, iOS, SAFARI) remaining the default web browser,**

Index Terms—**IoT, TCP/IP, HTTP, AR, VR, iOS,**

I. INTRODUCTION

The Modern web browser such as micro soft edge googles chrome and firebox have evolved beyond simple documents viewer is to sophisticated edge computing nodes. by shifting data processing, storage and application logic from centralized cloud server directly to the user devices, the modern browser act as the "EDGE" of the network reducing latency and increasing privacy. the web browser act as a edge computing platforms through several processing. the local processing client-side computing. browser now execute complex script, web assembly and AI models directly on the user computer or phone eliminating the need to send data to remote server for processing. web assembly allow near native spend for the application running inside the browser. the script run in the background allowing web application to cache content manage request networks and provide the off-line capabilities function similar to content delivery networks (CDN) EDGE. the service work allows web application to continue functioning ever when the internet connection is interrupted.in the modern web browser is a key component of decentralized internet pushing computation to the edge to delivery fast, more secure and more responsive user experience.

II. EDGE COMPUTING TECHNOLOGY IN BROWSER

Web-based edge AI/ web ML browser uses local web AI for task like real-time facial detection, speech reorganization or image processing. augmented reality without sending user data to the cloud.. the progressive web app (PWAs)these act like native app, capable of running off-line or with intermittent connectivity by using local storage and service workers a key aspect of edge computing. web assembly (WASM)enable running high-performance application (like Video editing or 3D games) in the browser at new native speed the browser has shifted from a single document viewer to an intelligence edge node that enable real-time, interactive and private web experience.

2.1 EDGE eco system: The modern web browser like micro soft edge, google chrome and Mozilla firebox are no longer just document viewer they act as local execution environment for the complex logic. Local processing browser executes script (example java

script, web assembly) directly as the use hardware ("device EDGE") allowing for the instant responses without a round-trip to a data Centre.

2.2 Data filtering: Browser can pre-process or filter user data locally sending only essential information to the cloud to serve band with the and enhanced privacy.

2.3 Off-line functionality: Through the technology like service workers modern browser can cache content and application even when internet connectivity is intermittent a core tent of edge reality.

III. BROWSER BASED-EDGE COMPUTING

3.1 Benefits:
- Reduced latency: action like from validation or image manipulation happen instantly or the device, eliminating the delay carried by long distant data travels.
- Band width efficiency: processing high value data (like video, or sensor feeds) locally prevent networks congestion and reduce the cost associated with cloud data transfer.
- Enhanced privacy: sensitive information can handle with in the browser, reducing the risk of exposer during transmission to extent services.
- Real-time engagement: essential for time-sensitive application like the time gaming, video conferencing and internet web tools.

IV. SEARCHING ENGINE

This is software system designed to carry out web services. Which means to search the world wide web in a systematic way for particular information specific field in a textual web service query, it uses automated software program (called crawler, bots. spider) to index, analysis the retrieve information presenting the most relevant result to the user.
Searching engine works three steps
1. Crawling
2. Indexing
3. Ranking/ Retrieval

Crawling: the searching engine sends out spider OR web crawler to browse the internet checking the information a billion of web pages

Indexing: the crawler information is stored in a giant database (index) organize content by key words freshness send quality.

Retrieval/ ranking: when a user enters a query the searching engine searches its index and uses algorithm (formulas)to rank the most relevant at the top.
Example; popular web search engine
Google, micro soft Bing, yahoo and Yantex.

V. BROWSER

The browser is a software application used to access, navigate and display the information on the world wide web, servicing as a windows to the Internet, it remains the data from web server and render HTML images and videos in to readable content common example google chrome, safari, Micro soft edge and firebox.

VI. SWITCHES

A network a suitable is a hardware dense that multiple devices (computer, printer, server) with in a local area network (LAN)to share the data efficiency, acting as smart, central hub. it operates at the data link layer (layer 2) of the OSI model by reading MAC address to send data only to the indented receipt reducing traffic.

VII. HUB

A hub is a basic networking hardware device that connect multiple computers or peripherals, device together In LAN (local area network). operating at the physical layer (layer 1) of OSI model. It functions as a multiport, running data on are port and broad casting it all other port.

VIII. GATEWAY

It is a network node either hardware (like router) or software that connect two or more separate networks that was different protocol enabling data transactions and flow between the server as an entering /exit point managing traffic, providing security (like FIREWALLS) and acting as the "default gateway" for local devices to access the internet.

Default gateway: The router that a connect a home or an off-line network to the internet service provider (ISP)

Cloud Storage Gateway: Translate storage request between local network and cloud API.

IoT gateway:

Connect the IoT server and device to the internet.

IX. ROUTER

Networking devices that connect multiple computer network (such as home, network and the internet) to each other's. directing the data packed efficiently between these acts as a "traffic controller "utilizing routing table to determine the best path for data travels.

X. HTTP/IP:

These are all fundamental distinct network protocol (internet protocol) IP is the network layer protocol responsive for addressing and routing packets across the network specific device. HTTP (hyper text transfer protocol) in an application-level protocol. that uses TCP/IP to send and retrieve the web content, managing requesting response example between client / browser and servers.

Relationship: HTTP function a top of the TCP/IP it relies on the reliable transport connection provided by TCP deliver the data.

XI. EDGE COMPUTING

It is distributed architecture that process data neat its source such as IoT devices a local server rather than in a centralized cloud data Centre by reducing the physical distance data travels it minimizes the latency save bandwidth enhance privacy and enable read time response for application like autonomous vehicle smart function and 5G networks.

XII. PROCESS

The edge computing process data locally on or near the IoT devices, sensor or edge server rather than sending all data to centralized cloud. this approach reduced latency and consuming bandwidth and improve the security by enabling time analysis and action with only summarized data send to the cloud.

XIII. DIFFERENCE BETWEEN BROWSER AND EDGE

It is entirely different technology designed for different process though they can some time work together, a browser is a software application used by a program to access internet. while edge computing is a network architecture that process data locally near it source rather than is a different centralized cloud.

Function: A browser is a user interface for navigating the web and viewing web content (HTML images and videos). Edge computing is a technology for processing storing and analyzing data quickly.

Location and activity: Browser run on end-user device (computer, printer) edge computing is run on infrastructure closure to the user. such as IoT gateway, local server or router.

Goals: The goal of browser is to render web site intuition application the goal of edge computing is to reduce latency reduce band width usage and enable real-time processing.

Example: Browser include google chrome, micro soft edge, and firebox.

Edge computing includes smart camera autonomous robot or an autonomous vehicle processing data from server; the edge computing can actively improve browser performance its example edge server can be placed closer to the user to cache web site content allowing a user's browser to load page much faster than if they had to connect to a distances central cloud server.

EDGE computing work process: It involved data generation by devices, local processing at an edge gateway, server and security data transformation to the cloud the architecture minimize the latency and reduce the distances allowing real-time analysis and faster action for IoT devices while using the cloud for long-term storage

Web browser architecture: The browser act as a gateway, allowing people to internet with business and other through WWW. a web browser gives you access to all platforms available on the internet, enabling you to view text, images and video worldwide.

By entering URL in to the searching engine you give you web browser towards a specific web browser fetch the required information and display it on a web page. Some popular web browser includes google chrome, micro soft edge, Mozilla firebox and apple safari and opera, micro soft edge each worker to provide access to counter web page available via the internet today.
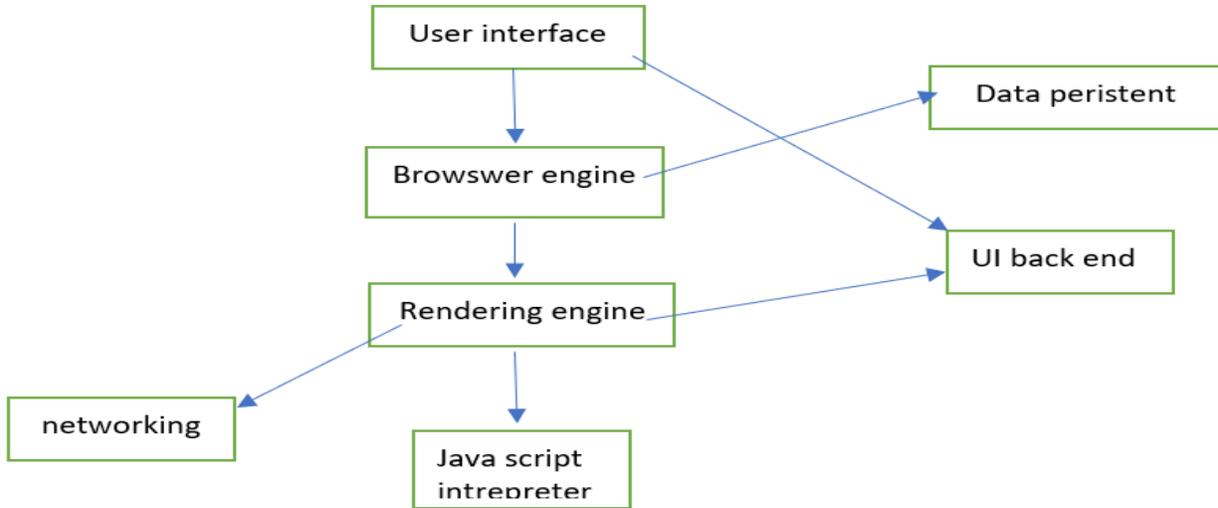
EDGE COMPUTING ARCHITECTURE:

CLOUD LAYER – big data processing
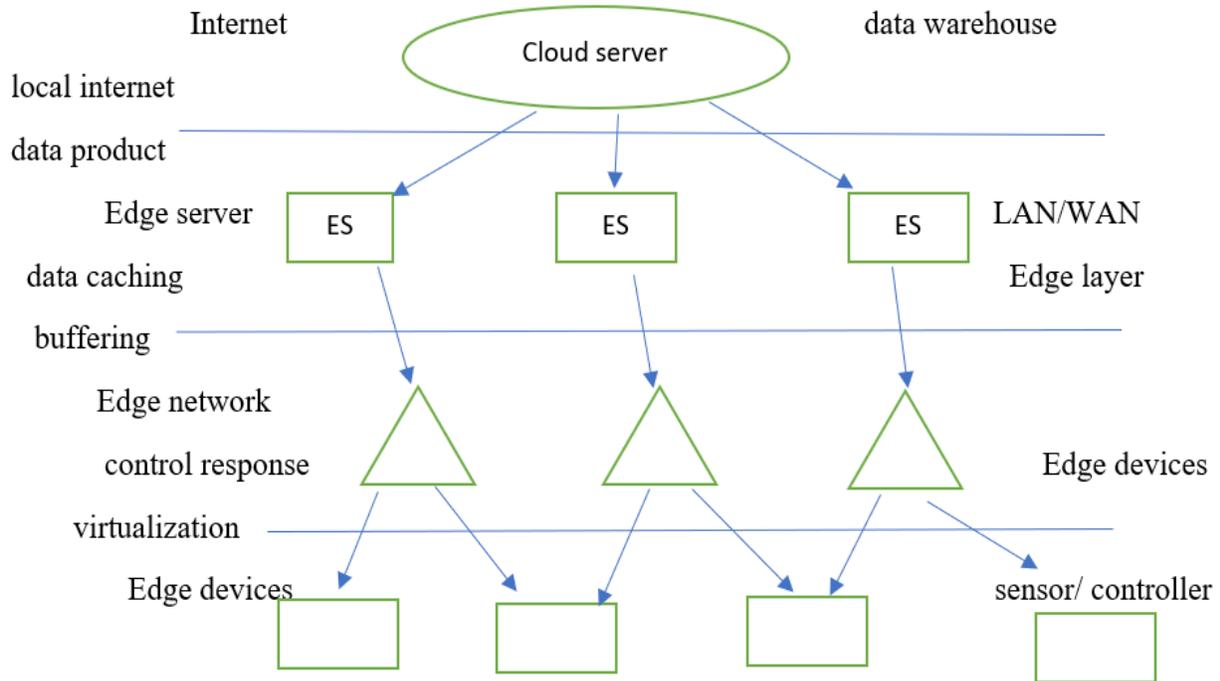
Edge computing is a distributed computing that bring the components and lack of storage choose to the location where it is needed this proximity to data source reduced latency and enhanced performance ensure the faster decision-making edge computing is especially useful in application requiring real-time data processing and low latency response such as autonomous vehicle, smart cities, and industrial automation.

XIV. MODERN WEB BROWSER AS An EDGE COMPUTING

The modern web browser such as chrome, edge and fire box) are increasing function as a powerful edge computing node.by shifting data processing from centralized cloud server to the user local device "THE EDGE"-modern browser pending future, more secure and personalized digital experience.

5G and IoT: Now the rise of 5G technology and IoT devices has accelerated the need for edge computing, managed through the browser interface.

XV. CONCLUSION

The modern web browser is increasingly recognized as a critical edge-computing node acting as a "utilize edge "where application logic data processing and user interaction converge by transition from mere document render to a powerful decentralized run the environment. the browser reduced latency, optimized bandwidth and improves user experience by bringing computation directly to the user devices.
The web browser is no longer just a personalized tool it has evolved in to a vital part of the edge computing ecosystem bridging the gap between decentralized data source and centralized could infrastructure to deliver faster, more secure and responsible web experience. The micro soft edge is the default web browser an all-modern windows operating system and also apple device (macOS, iOS, safari) remaining the default web browser.

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