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Role of Node.js in Modern Web Application Development

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ABSTRACT:

Node.jsisanofficeenvironmentbuiltontheChromeV8 JavaScriptengineandhasbecomethemostpopularand usefulserversideprogrammingplatforminrecentyears. Thisresearch article takes an indepth look at the various features and uses of Node.js in the context of modern webdevelopment.We'vedoneacomprehensivereview of Node.js,focusing on its architecture, asynchronous event driven nature, and powerful ecosystem of packages and modules available through npm (Node Package Manager).We also explore the impact of Node.js on the development and deployment of cloud basedapplicationsbyexaminingitsroleinmicroservices and serverless architectures. We also discuss the challenges and best practices of using Node.js, addressing issues related to security,performance, and scalability.

KeyWords:JavaScript,Node.js,eventdriven,single- threaded, non-blocking, asynchronous

INTRODUCTION :

Node.js is a JavaScript framework. It is powered by Chro me'sV8JavaScriptengine.Itisacrossplatformofficecrea ted by Ryan Dahl in 2009 for developing server-
sideapplications.UsingNodewecaneasily
develop scalable, fast and wearable applications. V8 and Node are written mostly in C and C++, with an emphasis on low memory and performance. **Serverside** can be **thoughtof**asJavaScript.It**isdesigned**to**solveproblems that may arise if** the platform spends too muchtime pro cessing webrequests andresponses over network conne ctions. Node.js allows end to end use of JavaScript **on** both client and **server.** JavaScript has **evolved tremendo usly** and has become an important part of server-
sidescripting[1][2].

Node.jsInternalStructure

V8:Itisan**opensource**project**developed** byGoogle.
The goal of this open source projectis to run JavaScriptco deoutsidethebrowser.Itprovidesaccess totheunderlyin g network and helps nodes manage many aspects of conc urrency.(Weknowthatthe coreofNode.jsisconcurrency
).70%ofthe code**for**thisprojectiswritteninC++and the other 30% in JavaScript.

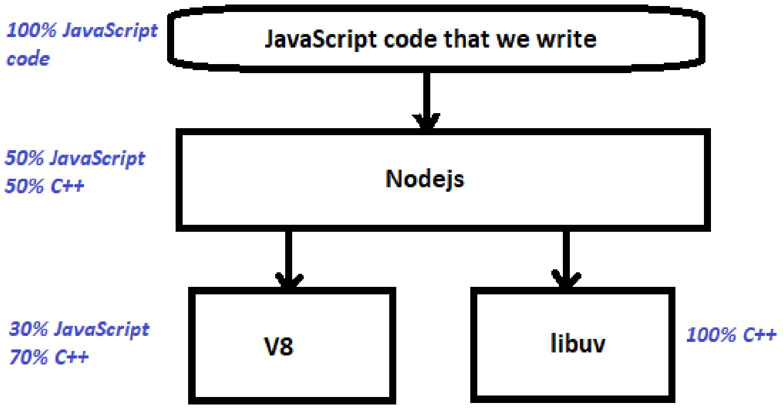


Fig-1:Node.jsinternalstructure-I Libuv:It is an abstraction layer .

LibUv **controls**andmanages all **input, output** andevent sinthe**event.**IfI **had** toput **it**insimple **terms, I'd** say li buv isatool fornetwork operations,whether it'snetwo rkoperations,computeoperations,etc.Regardless,I'ds ay it allows your JavaScript code to perform **I/O.** All **dat a/transaction** and TCP level **connections** are **handled** b ythislibrary.**The**libraryiswritten**entirely**in**C++.**Give a look in Fig-2

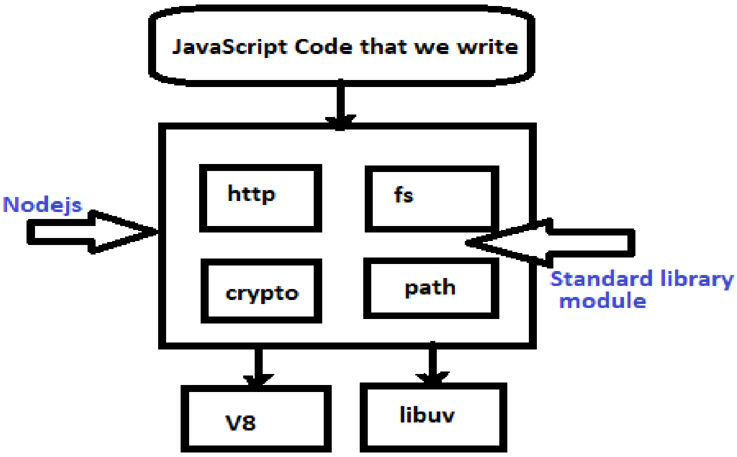


Fig-2:Node.jsinternalstructure-II

developer, you will write projects in JavaScript and wa nt to write and execute them. So you can see that Nod e.js is a combination of the JavaScript code we wrote a nd other open source code (V8 and libuv) written in Jav aScriptorC++.ForJavaScriptdevelopers,theydonotdi rectly interact withC/C++ code.So, thanksto this nice l ink, we can use JavaScript and write and run our JavaS cript code by combining the actual C++ code running o nourcomputer.NodealsoprovidesacommonAPItha t can be used in our JavaScript projects.

LibrarymodulesinNode.js(likefs,http,methods, crypto

, etc.) are similar APIs. They all generally use functions a vailableinthelibuvproject,soyoucannotdirectlyacces

sthefunctionswritteninit.C++code.YouuseonlyJavaS criptfunctionsandfunctionstocall theNode.jslibuv proj ect. You don't have to worry aboutinternal functionswri tten in C++, libuv will take care of itself.

ModuleSystem

JavaScript does not represent a module- dependentandisolated**APIinits**directives.

Therefore.Letstakean

example,youcanadda**jQuerymodule**toan**HTMLf ile by** adding **thisline** to **the** header **(script** src=https

://code.jquery.com/jquery1.6.1.js) Tom then adds a globaljQueryobject**tothismodule**fromReferences

.**Thisprocess**makes**the**worldnamelookbad**andc an** lead to name conflicts.

Noderepresents**amodular**systemratherthandefin ing many global variables. People **can define their o wn** mods **or use** basic mods or third-partymods.Node.js**modulesareadd-**

ons, and extensions of **Node** that aid development. Nodemodulesexpose**apublicAPI**(applicationprogr amming interface) **. It can be** divided into traditional modules,coremodules,andthird-party**modules**[7].

Node.jshassupportforpackagemanagementusing NPM, a tool that comesbydefault with everyNode.js installation. The idea of NPM modules is sort of almost likethatofRubyGems:easyinstallationviaweb repository, with version and dependency management. Acompletelistofmostmodulescanbefound on thenp m website or accessed using the npm CLI tool installed with Node.js. The mod ecosystem is friendly, anyone ca n publish their own mod and it will be listed in the npm repository.

Someoftheforemostusefulnpmmodulestoday are:

- Express-
- Express.jsisaSinatra-
- inspired Node.js web development platform and thedefactostandardformostNode.jsapplicatio ns.
- Connect- -
- LinkisanextendedHTTPserverframeworkforN ode.js that provides a collection of high- performance "plugins" called middleware.
- socket.ioandsockjs–
- Serversidecomponentsontwosocketsarecom mon these days.
- Mongodb and Mongojs – ProvideAPI forMongodbobject databaseinNod e.js.
- Bluebird- -
- Alllyrics/A+appwithoutstandingperformance.
- Moment- -
- JavaScriptdatelibraryforvalidating,parsing,ma nipulating and formatting dates

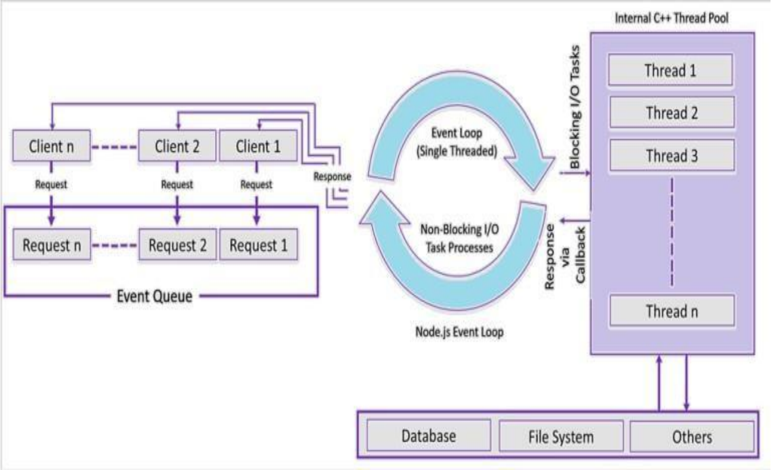
Thepapercontinues.Therearemanyusefulpackagesa vailableforanyonetouse(sorryfortheomissionhere).

KeyFeaturesofNode.js Non-blockingI/O:

I/OmethodsintheNode.jspatternlibraryprovid e an asynchronous, non-blockingpatternandacceptfunctioncallbacks.S omemethodsevenblockcandidateswhosenam es end in Sync, **for example:**
const fs=require('fs'); constcontent=fs.readFileSync('/file.txt);//Block here until **File** is **Read**
console.log(content); moreWork();//willrunafterconsole.log Asynchronous example:
constfs=**require('fs');fs.readFile('/file.txt,(err**
,content)=>{if**(error)**throwerr;console.log(

SingleThreadedEvent Loop

Node.js Stage doesn't follow Solicitation/Reaction Multi-Strung State less Model. It follows Single Strung with Occasion Circle Model. It Handlingmodel mostly upheld JavaScript Occasion based model with JavaScript get back to component.
As it follows this engineering, it can deal with numerous simultaneous clientdemands withoutany problem.



The"EventLoop"isheartofNode.jsProcessingmodel.

Fig-3:Node.jsApplication/Server

SingleThreadedEventLoopModelProcessingSteps:

- UserSendrequesttotheServer.
- Node.jsWebServerinsidekeepsupaRestricted String pool to offer types of assistance to the Client Requests.
- Node.jsWebServergetsthosesolicitationsand spots them into a Line. It is called as "Occasion Line".
- Node.jsWebServerinsidehasaPart,knownas "OccasionCircle".Gotthisnamesinceitutilizes endless circle to get demands and interaction them. (Pseudo code to fathom this under).

```
publicclassEventLoop{ while(true){
if(EventQueuereceivesaJavaScriptFunction Call){
ClientRequest request= EventQueue.getClientRequest();
If(requestrequiresBlokingIOortakesmore computationtime)
AssignrequesttoThreadT1Else
```

- Itchecksany ClientRequestisputinQueue.Assuming no, atenwait for incoming requests for indefinitely.
- If yes, at that point get one ClientRequest from Event Queue
- StartsprocessthatClientRequest
- Iftherequesterdoesnot wanttheIOoperation tob eblocked,doeverything,scheduletheresponse,and send it back to the client.
- Iftheclientneedssomeblocking IOoperationssuch as connecting to files,file systems,external services, etc., it will follow a different method.
- Checks accessibility of Threads from Internal Thread Pool.
- Takeone Thread and allot to the Client Request to thatstring.
- ThatThreadisanswerablefortakingthatdemand, processit,performBlockingIOtasks,getreadyreaction and send back to the Event.

Reasons for why Node.js used widely by Modern Web Developers.

GoogleV8JavaScriptEngine

Node.js uses the Google V8engine to execute JavaScrip tcode. Unlike other JavaScript interpreters,the V8 engi ne converts JavaScript code into machine language. Int hisway,JavaScriptcoderunsfaster andmoreefficiently ,ensuringthattheruntimeenvironmentsupportsthe p resentation of the web server used [1].

OffbeatI/OOperations

Node.js further plays out all I/O tasks non concurrently through a solitary strung occasion circle. The high level techniquemakestheNode.jsapplicationtoperformI/O activities by sending non concurrent undertaking to an occasion circle close by a get back to work. Subsequent to sending the async assignment to the occasion circle, the application keeps executing the excess code. In the wake of finishing the asynchronous operation, theevent loop returns to the task, and executes the get backtowork.Notwithstandingconsuminglessmemory, the feature enables Node.js to handle a tremendous numberofconcurrentaffiliationsgainfully.The

engineers can use the runtime environment toperformtypical taskslikearchivesystem orassociation affiliations, examining or staying in contact with the informational collection.

ComplementsReal-TimeandMulti-UseRequirements

In addition to using responsive webdesign, the developersthesedaysneedtofabricateongoingand multi-client web applications. Node.js empowers software engineers to make complex gaming, chatting and communication applications without investing any additional time and effort. The engineers can utilize websocket conventions tomake ongoing web applications. Websockets can make the internet based server push information to the client in an extremely quicker and more productive way without increasing the overhead of HTTP. Atanequivalenttime,thedesignerscanmake multi-client applications by exploiting the occasion circle element of Node.js [7].

Popularityof JavaScript

JavaScript has been available in browsers since the early daysoftheWWW.DespitetheemergenceofAJAX,JavaS cript is still important. Despite some criticism, this made
JavaScript popular with developers. Although a server- sidescriptinglanguageisused,JavaScriptispreferredfor clientsidescripting.KnowledgeofJavaScriptandcompati bility with Node's JavaScript code, as well as server-sidecodingcapabilityandmanyotherfeatures,allowdev elopers to adoptNode.js. Leveraging the bestof Java Scri pt as a languageand building a strong community, Node has become a popular platform and foundation, and ado ptioncontinuestogrow.
Fig-4:JavaScriptend-to-end

Whatreasonarethebiggestcompaniesusing Node.js for?

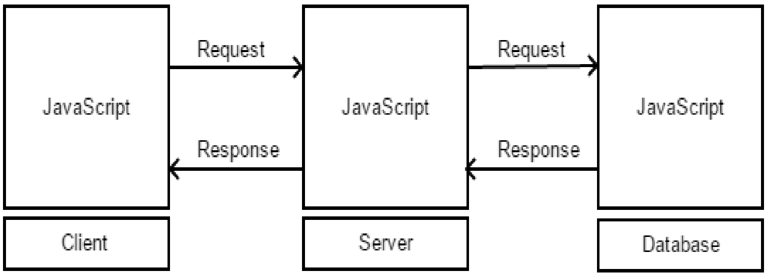
PayPal

PayPal is one among the most significant and most notable overall frameworks for Web installments. The stage empowers its clients to execute with each other online rapidly and basically in extra than 100 monetary standards.
AsperPayPal,thehelphasmorethan184million

dynamic client accounts (starting around 2015). The Organization has been usingNode.js to create the purchaser confronting side of its web applications.
For whatreason did they pick Node.js? Ranking executive 'Jeff Harrel' of Installments Items and Designing at PayPal says: "Node.js helps us solve boundary between the browserandserverbyempoweringboththeprogramand server applications to be coded in JavaScript. Itunites our structurespecialtiesintoonegatheringwhichgrantsusto be aware and answer our clients' requirements at any level inside the innovation stack" Results: TheNode.js application was built twice as snappywith less people, in 33% less lines of code and 40% fewerfiles (in connection with past Java-based application)[3].

LinkedIn

Linke LinkedIn is a business-arranged one individual to another correspondence organization found in 2002 in Mountain View,California. LinkedIn grants clients towel come anybody (regardless of whether a site client or not) to turn into an affiliation.
Itisaccessiblein24dialectsandasofnowhasinexcess



of 400 million people in excess of 200 countries and regions. LinkedIn utilizes Node.js to engage the server side of its portable application.

Yahoo

Yippee is an American overall innovation association; basing and all on saw for its online interface, web crawler, and related administrations. Accordingto Hurray, administration attracts more than 500 million consumers in more than 30 dialects consistently. Why did they pick Node.js? Eric Ferraiuolo, Head Computer programmer at Yahoo clarifies: "It can be scalable, and every property that we've advanced toward the Node.js stack has seen an extension in execution" Results: Node.js has changedandboundtogetherthefrontendoriginator culture at Hurray, it at this point controls various regions [3].

Netflix

Netflix is the world's greatest worldwide supplier of video streaming including movies and TV series, accessible in more than 190 nations. As of April 2016, Netflix detailed more than 81 million patron around the world, with in excess of 46 million in the U.Sitself. At Netflix , the entire UI is worked with Node. The innovation demonstrated so viable, that the organization needs to utilize it likewise in different layers of the stack. For what reason did theypickNode.js?ThegroupchosetoutilizeNode.js to accomplish lightweight, modular and fast application. Therefore, the start-up time of theirnew application has been diminished by 70% [3].

PotentialapplicationareasofNode.js

- Media
- Paymentgateways
- Ecommerce
- Socialmedia
- Enterprisewebapps
- Backend/APIformobileapps

According to Stack Overflow survey 2019 the Node.js is themostcommonlyusedandmostwantedtechnology

[4]GivealookinFig-5andFig-6.

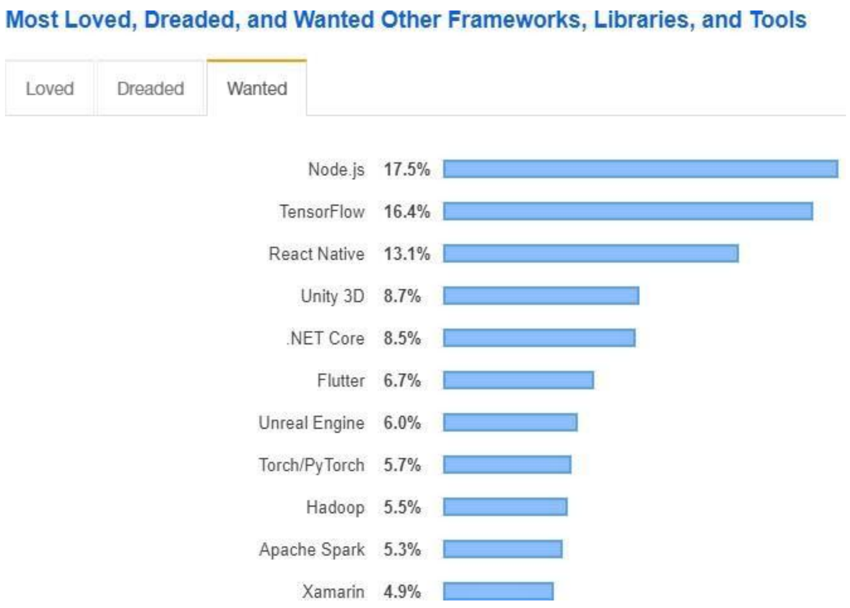


Fig-5:StackOverflowSurvey-2019

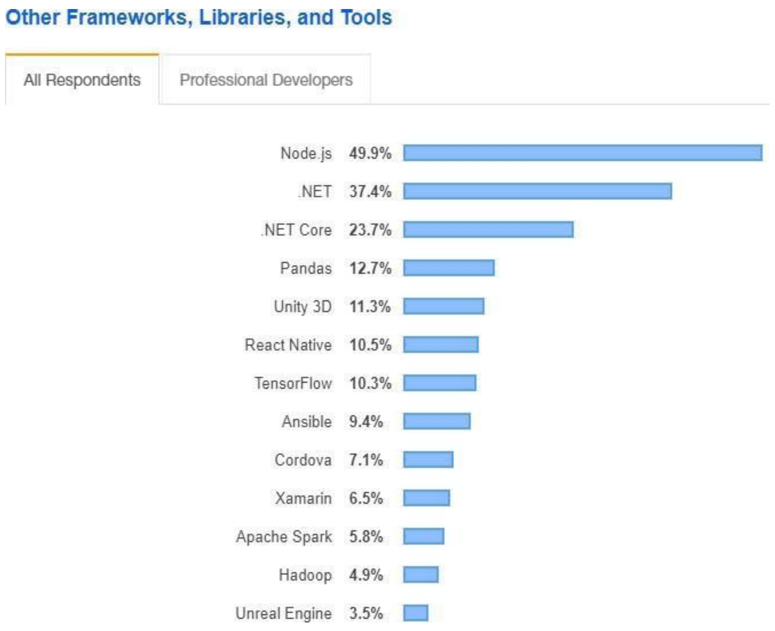


Fig-6:StackOverflowSurvey-2019

CONCLUSION :

NodereplacestheJavaScriptimplementation,making Node a complete programming language. Node provi des a runtime environment, a library of free and usef ul templates thatcan be usedtoruna builtintool call edNPM,frombrowsertoserver-sideandscripting outsidethebrowser.Node.jsusesevent-drivenI/O, non-blockingasynchronousprogrammingtobe lightweight and be efficient. Essentially, any business utilizingNodecan:utilizefewerservers,utilizeless engineers and abatement page load times.

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