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Creating Website as a Service using Web Components

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Abstract – *In today's fast pace world, technology is changing rapidly and we are working on technologies that seems to be impossible a decade ago. Web applications and web technologies are changing the world rapidly. Web applications has become the most important feature of any business specially to showcase what they are offering and tools to use their products. To meet current business needs, web applications have become quite complex to develop, the number of files has increased and as the application grows it becomes difficult for the developer to maintain the application and as well as test the application. At the same time, we have web applications that are used as a service by various enterprises, these applications are modified according to the need of the customers, which sometime results in building the application again and modifying the app according to the customer needs, this process sometimes leads to regression which increases the delivery time as developers have to find out the root cause of the issue. To solve this issue what if we divide the whole application into components that are capable of functioning independently, we can add or remove the functionality according to our needs and it would be easier for developers to build the application even from scratch. Now, since the application is divided into components we can maintain and test these components independently allowing developers to reduce the time taken in a release cycle. In this paper my aim is to automate the process of creating a website that can be modified according to the user need without making change on the code level and also to automate the whole process using Web Components.*

***Key Words*: Web application, Web omponent, Code maintainability, Dynamic website generation**

1. INTRODUCTION

With the invention of WWW or World Wide Web [8] in 1989 by Tim Berners Lee bring about the revolution needed in the technology space. WWW is the platform which we use to share and interact with web around the globe. Websites make our day to day life easier like we have email clients which seamlessly provide us a way to view emails, create a new and send them. There are institutes showing all the related information to them on their website and has become the bulletin board for every student. Currently there are 3,424,971,237+ active internet users.

The internet isn't owned by any government and is free to everyone around the globe, you just have to pay your Internet Service Provider. There are only two important parts of internet that is Domain Name System[9] and Internet Protocol Address are designed and maintained by Internet Corporation for Assigned Names and Numbers (ICANN)[9]. The Internet Engineering Task Force (IETF)[9] is responsible for creating and standardizing the new protocol for internet.

Hypertext Transfer Protocol or HTTP[10] is the basic protocol that we use for interacting with World Wide Web. We have HTML documents which contains the contain content which is to be shown when a user visits a website, these documents also have links to other resources that a user can use to easily access. HTTP makes streaming of media possible.

With the recent development major fields have adopted the internet and is widely being used by everyone. We have a government website which is for the general public acting as the first-hand information source and providing service to the people and eradicating queues to avail service, black money and bribes. E-Commerce is also the big next gift of internet allowing user to access internet and buy the products online by not going to the shops, and receive the products at your doorstep. Online payment gateway are the foundation of e-commerce and major part of the internet, it facilitates the payment online and allowing user to avail paid services from their home, you don't have to go to bank to pay for a product, now you can do it online with the help of the gateways. Gaming industry is what provide gaming experience to everyone on the online platform, although the games are not as powerful as the native ones are but yes, they are entertaining. Media streaming has recently been the most popular service and has successfully reduced piracy of the content. It provides us the show at a very low cost and give us very high quality of content. In all of this we have education arm of the internet, learning anything was never so easy, sit and relax and learn everything with online classroom, coding playground has facilitated more and more user to use the online services. In all of this we have institutional websites which provide us with the news course and everything related to institute online. The websites should be user friendly as it will be the first thing any parent or student will visit to know about

the institute. It should be updated every day so that it will be able to provide news to the user every time, whenever there is an update and thus, they don't have to wait for the news to arrive at their doorstep.
The web applications are getting complex especially the web apps which serve as a service and are used by different organization according to their business needs, now sometimes to satisfy business needs the web app are modified on code level which generally leads to regression this results in increased time needed for delivery of the product, testing of the product. The main idea here is to break the whole application into different components which we call as custom web components. These web components are independent from each other and can work independently. If we were to create a custom website according to the customer needs then we can just bring these components together to create our web app.

1.1 Basic Concept

HTML or Hypertext Markup Language[11] is a markup language based on SGML which allow users to create web pages which are then interpreted by the browser and displayed. There is not error mechanism in HTML like we have in different languages. The web is changing rapidly, and its requirement to keep up with the changing world we need to keep ourselves updated and update the technology we use. With that been said with every version bump HTML is made more and more powerful. Hypertext Markup Language (HTML)[11] is considered to be the standard language for developing and authoring web applications. Cascading Style Sheet and JavaScript are used in union with HTML to create what we call an interactive webpage. CSS styles the page and JS makes it dynamic and change the content when a certain action is performed. With HTML 5[12] there were many new tags launched some of the most widely used are <audio />, <video />, <svg />. With HTML 5 we also introduced the concept of semantic HTML, semantic HTML allowed developer to create webpages with meaning instead of just using any random tag everywhere. With the recent development we have started generating HTML using JS and sometimes compiling JSX acronym for JavaScript XHTML. JSX mainly use all the rules of HTML except that it always require a closing tag whereas in HTML we can skip for some elements. HTML is interpreted and not compiles so we do not get any errors.

Cascading Style Sheets, fondly referred to as CSS[13], is an easy beautifying language used to make web pages presentable. CSS is responsible for styling the webpages in a way that they look catchy when we show it to user. CSS has been widely used ranging from adding text style like font size, color and also allowing us to specify the line spacing of the text, it can be used for styling a layout by allowing us to specify the background image of our page or component, it can also allow us to create animation on web, add transition which allow us to smooth a particular action. CSS has been designed in a such a way that it can be easily understood and learning CSS is also very easy as compared to other language. CSS is basically used to beautify the rendered content of the HTML. HTML and CSS generally go hand in hand.

a) Inline - by using the style attribute in HTML elements.
b) Embedded- by using a <style> element in the <head> section.
c) External - by using an external CSS file

It's called Cascading because the styles are applied in top to bottom. Inline is given preference over embedded and external.

JavaScript or JS[14] is the programming language for the WEB. Over the time JS has grown so much that it now can be found everywhere from client side to server side, powering small to big devices. JS is based on ECMAScript and is the most powerful skillset for any web developer. The latest version of ECMAScript is ES6. The 4 leading web browser companies that is Google, Microsoft, Mozilla and Apple developed their own JavaScript engine for their browser. Google use V8 JS engine to power its Chrome web browser, Microsoft uses Chakra Core to power its Edge browser, Mozilla uses SpiderMonkey to power it's Firefox browser and Apple uses squirrelfish to power its Safari browser. The rendering of HTML page which contains JS highly depends on these engines. This is what drives JS in your browser.

ES6 introduced many new features, some of them are: -

1. Allowing uses of classes natively.
2. Arrow functions.
3. Modules.
4. Spread operator, and many more…

For complete list you can visit official documentation available at Mozilla Developer Network.
Like CSS, JS can be also used in 3 ways with HTML

a) Inline: by using any event attribute like onclick, onhover in HTML elements.
b) Embedded: By writing the JS in <script> tag, either at the top or bottom of the page.

c) External: By writing JS in a separate file.

Web Components[15] are a set of standards that are currently being developed and maintained by W3C. These standards allow a developer to create highly reusable web components or widgets. These reusable components can be used across world wide web. W3C has been working actively on them to introduce CBSE to World Wide Web. They also allow us to encapsulate the components. It is an approach to create a custom HTML tag which can consist their own HTML, CSS and JavaScript making them truly independent in nature and making them reusable to a great extent. Web components can help us to simplify the process of building complex web applications, apps are built out of components that hide underlying complexity. They promote the principles of reuse you build a component once, and then, you reuse it in many other places. Lastly, they provide the important capability of encapsulation, which prevent the Script and CSS of components from affecting each other.
Following standards are critical for development of a web component:

a) HTML Template: The HTML Template tag gives us a way of taking a bunch of HTML mark up and indicating to the browser that it shouldn't be used for anything until our code is ready to make use of the template contents.
b) HTML Imports: This is the most important feature of all the components, it allows us to create a reusable code and allow us to use it somewhere else. It also allows us to separate the code of component in separate files allowing and then using it in a primary file.
c) Custom Elements: This defines how you can build new tags that work just the same as the tags that are natively built into the browser. We can also extend their properties.
d) Shadow DOM: When you create web component you want to make sure that it doesn't interfere with any of the existing JavaScript or CSS you have written for your webpage. You also want to bundle anything that's related to your component into a single entity. Shadow DOM prevents those problems from happening by providing a way to encapsulate all of the related component pieces, so that they are isolated from other components and any global styles or scripts that you're using in your apps.

Document Object Model or DOM is a concept model which allow us to understand the way our HTML page is getting rendered and allow us to interact with the document. Document in DOM means the pages that is getting rendered on the browser. DOM is a very helpful concept for the developers as they can use the developer's tool to see and inspect the document. We can even use the DOM to manipulate our website. DOM dislays all the element in a tree structure starting from the html parent node.

2. Literature Review

Fei Yui-Ku and Wang Zhi-Jian et. al.[1] proposed the main and theoretical concept of web components. In their paper they discussed about how the web has shifted different source of information to different source of service which are distributed in nature. They introduce a new paradigm in web technology web component. In their paper they have also discussed about various aspects of said technique. Web components have been characterized as something which is autonomous, robust, introspect and social ability. They also proposed an architecture of the same, architecture consists of ontology which interweaves as way to communicate with Humans, interface description which tells us about what services are provided by the web component. Then the service model was introduced which was responsible for handling all the services that were being used by the component. Now since we have everything in our component the only thing which is left is how to communicate with the service for this service grounding was introduced these will be typically a network related services. They also gave an implementation of tailoring service under the parameterized contracts.

Chouki Tibermacine and Mohamed Lamine Kerdoudi et. al.[2] proposed how we can build web components using J2EE libraries like struts or JSF. They also discussed about how difficult it is for a developer build a web component based application but it has its own advantage as these components are independent in nature so they can be distributed with other developers either as commercial off the store or by deploying them as a free to use component. They also tell us that how these components can be used again and again in different projects and how they separate their business logic from each other. In their paper they explained that converting a web component to a web service is a 6 step process starting from Operation Extraction, Input and Output Message identification, Operation Filtering, Operation Distribution, Composite Web Services and Web Service Choreography Creation. The technology used in developing the web services are JAVA EE EAR which contains some Web and EJB modules. JSF framework is used to develop these modules which then binds the input values got from the HTML forms to JavaBeans. These technology was used to create a BMI calculator which was capable of giving dietary advice and email the user. The EJB modules connect to a database via JPA to get the stored information.

J. L. Herrero, F. Lucio and P. Carmona et. al.[3] proposed a web service-based framework according to component software engineering (CBSE), with the aim of developing efficient and reusable web applications. They also explain as to how a software application based on SaaS model changed delivery and access method also how they are delivered and update on the user

machine over the internet. In this paper they explain the benefits of SaaS which are delivery, license as the user doesn't have to buy one, maintenance and support. They have used different components which constitutes a single web application the components are SaaS technology, web services, web application and components are built according to the component based model and RIA mechanism to increase the efficiency of the web application. They have also classified the web components into client web component, hybrid web component, server web component and framework web component. Different layers were also given by them which are Definition Layer, Interface Layer, Functional Layer. Different steps which will be taken by the application are also discussed.

Andrea Gallidabino And Cesare Pautasso et. al.[4] In today's time a single person has different heterogenous devices which are of different form factors ranging from small screen to a laptop and even tablet. They proposed a way to create a web application that is built using liquid.js for polymer. This provides the user ability to continue his work on different machines or devices. This also focuses on creating web applications that are responsive in nature which means that they can run on different devices and can change their orientation according to screen size. They also explained what Polymer is, Polymer is basically framework used to develop web components and it helps us to reduce the complexity of the application. Liquid.js has 3 components liquid component, liquid frame and liquid variable. They have also discussed the sharing policy that can be defined and different storage states the app can use. This is in accordance to what we call hand off feature which allow user to work on different machines and allow us to continue from where we left. They also have created a storage model which would help app to function in a more robust manner, now these are based on the following policy sharing policy this defines how many components a variable is shared with, component scope defines whether the variable are shared among instances if the same component type or among instances of any type, persistence policy defines for how long a variable should be stored. In this strategy they have also added a scope for security and latency.

Jaewon Oh, Woo Hyun Ahn and Taegong Kim et. al.[5] proposed a way to create an independent component which can be enclosed from the parent app using Shadow Document Object Model and template standard. Each website has several parts into it like there is a menu, sidebar, footer now to have a new page client sends a request to the server and then we load the same again by fetching the same style and same menu the only thing changes is the content. There are 2 types of web apps Multi-page web application and Single-page web application. In multi-page web application, we fetch a new page and the whole document reloads to load that page whereas in SPA only partial content changes and all other remains same. SPA also reduces redundancy because only the code that has to be shown will be fetched rest of it will remain same. The authors proposed a way to restructure a MPAs with common widgets into SPAs, such that page specific widgets are encapsulated and they did by using Shadow DOM, template and 2 standards of W3C Web component standards. They explained how a DOM works and also explained how to implement a widget. They divided their application into widgets and those widgets can be universal or page specific. Now shadow dom is similar to DOM but the difference is that the widgets style and code is encapsulated to a specific dom and is not available to parent dom. They compared the performance of the app with widgets and without widgets and how they improve the performance.

Michael Krug and Martin Gaedke et. al.[6] proposes a way to create smart components which are build using W3C web component standards. These standards are natively supported by all browser. They also explain this approach with the help of two examples. They explain as to why they picked up this approach by explaining all the issues that arises with the web app as to how they lack simple reuse of the code which is used multiple times in the same app. They also explain how we can use other platform like apache rave and open ajax hub and how they require different environment to run not just a simple HTML. They also propose that component we create should be responsive because the app that run on web can run on multiple devices with different screen size. Their idea is to create a web component that can run on multiple device and then the same component can be interacted from other devices like a power point controller the slideshow is running on bigger screen but it is being controlled by the controller that is running on your mobile device. The above concept was made possible by using event based web components and these events were used to control the app, the server was implemented using web sockets which is asynchronous service so once the remote presses next ws server will see an event change and that change then will be reflected on other device. They also used the concept of Shadow DOM to encapsulate their web component.

Maxim Bakaev and Vladimir Khvorostov et. al.[7] suggested that with the recent innovation in web engineering technology component based engineering has been at the top. Engineers relying heavenly on frameworks to generate component for their application. If we want to replicate a certain component or website it is very difficult and sometimes impossible due to the licence restrictions imposed on them and sometimes the technology limits us. The authors have suggested a process that can create web user interface from a specific solution or parameter. They also try to optimise the similarity between a design generated by the tool and the high-quality solution that they have used to generate in the first place. In their paper they have also described the process of implementation of their tool that are used. First one is the miner that is responsible for collecting website data, second one is the analyser that analyses screenshot which is then transformed into semantic representation in JSON format. They have also specified the algorithm which is responsible for optimisation.

3. Comparison and Analysis

Papers	Objective	Technique Used	Advantages	Disadvantages
Fei Yui-Ku et. al. [1]	To discuss and present various dimensions of web components and also give a conceptual model of the same.	It gives us a concept model as to what is web component. Paramaterized contracts used to explain its functioning	They give an important understanding which will bring the component-based engineering into the web application world and allow the developers to create the independent component which then can be used in separate projects or applications	Even being an independent component would require various files and it would live in various doc. This is high level and conceptual
Chouki Tibermacine et. al.[2]	To propose a solution which can allow existing component-based application can be migrated to web services and then can be deploy on a web service provider. Which in turn helps the backend developers to create web services which are intended for remote code execution.	Java related Technologies like Java EE EAR JSF, JPA, Javax.Mail And HTML	This will allow developers to create component which will have access to all the JAVA API. This was a great option to create components as the JAVA was in boom that time	This would make it as a monolithic design. Where server is the same as the client and also rendering of component is taking place. Web have evolved much since then and we have much powerful JavaScript libraries at our disposal.
J. L. Herrero et. al.[3]	To present a web services-based framework which is derived from CBSE. The main aim will be developed maintainable and reusable web services.	Various technologies have been used to prove the concept, like WSDL, AJAX, UDDI and SOAP	Software as a Service has its benefits by allowing developers to has not to worry to install it on the user machine, User doesn't have to worry about License, software can be easily updated through internet	Since it will be a rich internet application and with the growing complexity of RIA it will require that the RIA applications to be downloaded before they can be used. Lack of reusability.
Andrea Gallidabino et. al.[4]	Creating liquid components which are based on the concept of Web components and by liquid in nature they mean these can run on any device with any screen resolution. They are presenting this for Polymer framework.	JavaScript, HTML, Liquid.JS, Polymer, CSS	This framework would allow developers to create responsive web component which would be able to run on all screen factors and at the same time that application will have concurrent functionality that means the app is on page on 1 device it will be on same page on other device.	Internet connectivity is important for the application to continue. There might be latency due to difference in internet speed on different devices. It requires additional library to work.
Jaewon Oh et. al. [5]	To present a way which will allow the web application to stay encapsulated,	Shadow DOM, Template, HTML, CSS, JS, W3C web component standard	Using shadow dom would allow developers to encapsulate their component from the parent dom and hence	Manipulating shadow dom is not easy as compared to manipulating dom. Not all mobile browser currently support shadow dom.

	allowing independent development of the component.		there won't be any conflict in styles	Shadow dom is still maturing.
Michael Krug et. al. [6]	To introduce enhanced web components which are based on the web component standard. These components can run on multiple devices and remain in sync with the use of a backend service.	W3C Web Component Standards, Web Socket Standards, HTML, CSS and JS	This application provides seamless connectivity between app running on one device and app running on another device. They are using web components which would allow different applications to use their feature	Internet connectivity is required as long as application is running. They rely on backend web socket server which can have multiple user if not configured correctly the server would not work as expected. Latency can also be there.
Maxim Bakaev et. al. [7]	Present a way to generate WUI from a solution and then further optimise the similarity using evolutionary optimisation algorithm. The generated components are store in semantic JSON.	Drupal, OpenCV, Web Intelligence, HTML, CSS	This would allow users to create component just by looking at the webpage. They will be optimised	Sometimes component generated may not be what is expected. The generation of component and their optimisation greatly depends on the algorithm.

4. CONCLUSION

Web component has gained moment recently and not has been widely adopted. W3C Web Component standards are here to solve the most significant issue that we face in the web world i.e. code reusability. Web Component allow us to create custom HTML tags which contains all their JS, CSS and HTML code inside them instead of being a separate entity now it can be one. These components can be used in n no. of projects. With web component it is truly possible to break our application into separate element and then these elements can develop independently and even these elements can be published as an NPM module which then can be used by different developers. With the advancement in JSP we also tried to create a true web component but there was a flaw that we had to run two servers if we want to meet higher expectation but this in end would result in using higher resources. There was an alternative solution but that solution also used web socket protocol to keep its component updated which in return would result in outage and the app won't update which would lead to downtime, to solve these issue Web components is introduced which can increase productivity and also automate the generation of Web Application which serves to different organization according to their needs making truly Website as a Service. We don't even have to rely on any other 3rd part libraries. This could also help organizations in deploying their application easily and efficiently and no need to worry to write their whole app again and again.

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