THE FUTURE OF FRONTEND TECHNOLOGIES

Abstract

Today, in the digital world, all the manual processes have become digitalized. Since it attracts more users, the look and feel and performance of the applications which the user access, should really appealing. This dynamic web page is composed of Frontend (client side) which is the user interface and Backend (server-side) where the data is fetched from the database and sent to frontend through APIs (application programming interfaces). The front-end technologies play a key role right from the user interface, responsiveness, performance, security etc., This article will provide insight about front-end technologies and their future trends.

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Table of Contents

Good webpage: Characteristics

Today, industries are digitalizing many of their business requirements and making it easier for the end user to access it from the comfort of sitting at home. For example, previously if the customer wants to deposit or withdraw money from the bank, then he needs to go to the bank personally and stand in the long queue, fill the forms and then follow another process. But digitalization has made money transactions very easy through net banking and mobile apps. A good website helps both the business and the customer. Below are the points to be noted for the informative website,

• The website content should be very precise and effective, and the page design should be in such a way that the end user can access it smoothly without any hassle.

• Websites should be developed in a way that protects the user data from being hijacked by third-party websites and ads

• It should have the capability to optimize the search engine traffic

• Analyze website statistics and prioritize the interesting areas based on the no. of users visited the page and time spent in that. This analysis will help the business to plan their marketing strategies.

Frontend – An Overview

To predict the future trends of frontend technologies, one should know the history of evolution of the frontend webpage (Figure 1). Initially websites were used only for static content, mostly for advertisements or information portals. The increase in user interest has resulted in the creation of more dynamic websites which was the triggering point for the introduction of JavaScript.
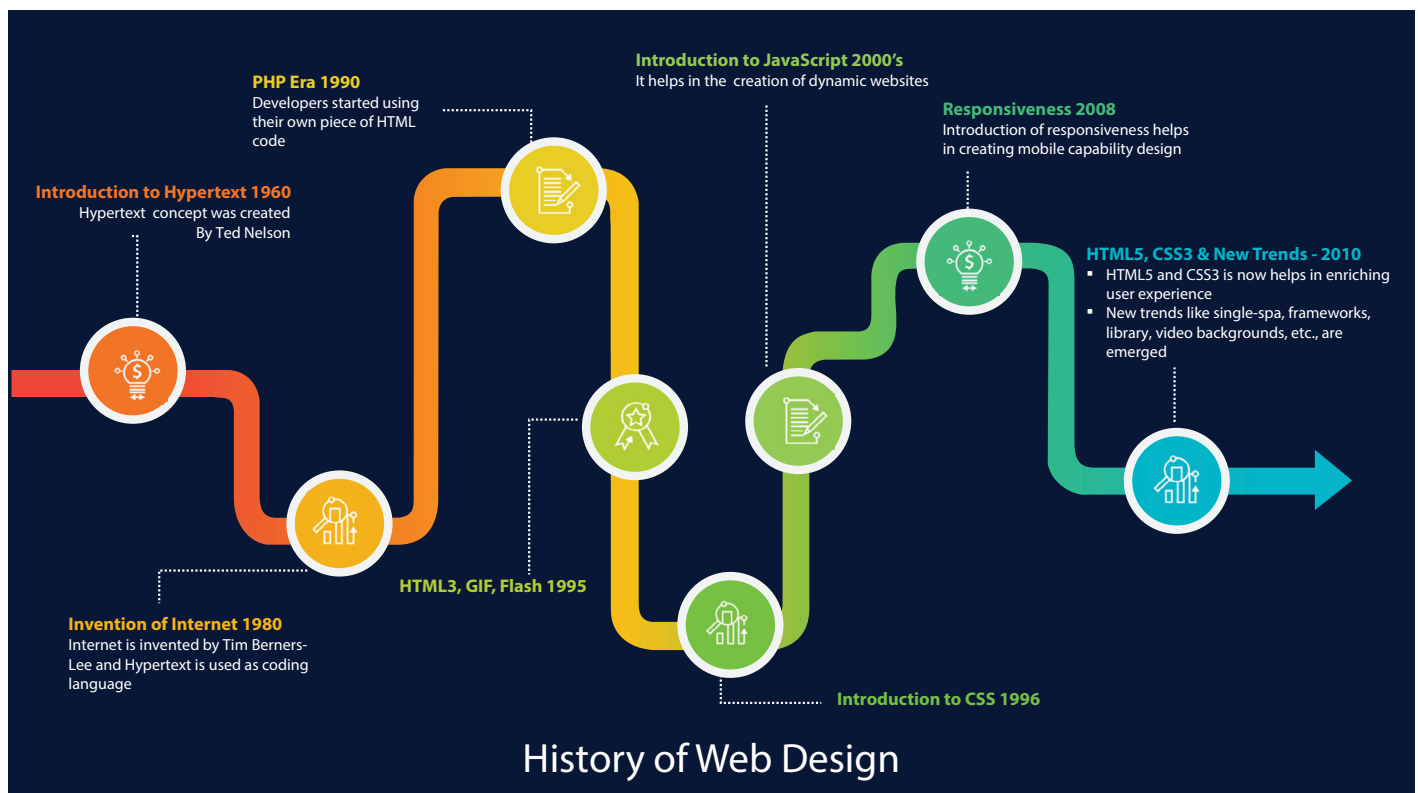

Figure 1: History of web design

Progression of JavaScript

JavaScript plays a vital role in the dynamic webpages. JavaScript is not only used for frontend script but also as a server-side script **(NodeJS)**, packaging **(NPM)**, transpiling **(Babel)**, package and optimize application **(Bundling)**. A quick glimpse of how it is evolved over a period of time is depicted in Figure 2.
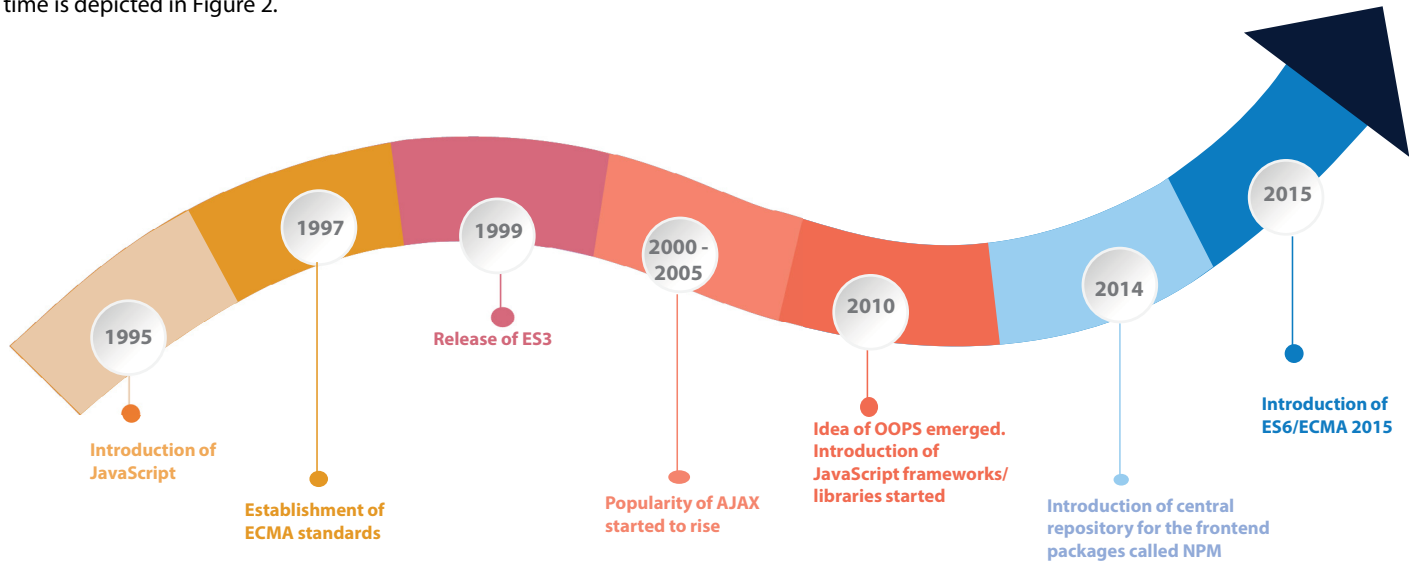

Figure 2: Progression of JavaScript

Evolution of the WWW

In the current world, when the internet is developing rapidly, let us take a step back and see how the web (World Wide Web) has evolved over time. In this section a comparison of Web 1.0, Web 2.0 and Web 3.0 are explained in detail in Figure 3. Web 4.0 is still an underground idea about symbiotic web. The thought process behind the symbiotic web is interaction between humans and machines in symbiosis. In future it will be possible to build an interface which will be controlled based on the human mind.

Web 1.0	Web 2.0	Web 3.0	Web 4.0
1996 – 2004	2004 - 2016	From 2016 till date	Web 4.0 is still an underground idea about symbiotic web which is in progress and there is no exact definition of how it would be.
Hypertext web	Social web	Semantic web	
Read only	Read and write Web	Executable Web	
One Directional	Bi- Directional	Multiuser virtual environment	
Echo system	Participation and interaction	Understanding self	
Contents are published by the organizations	Contents are published by the people	Application creation, content published and interaction all by the people	
Personal websites	Blogs and Social media pages	SemiBlog	
Static content	Dynamic content	AI and 3D inclusion	

Figure 3: Comparison table for Web
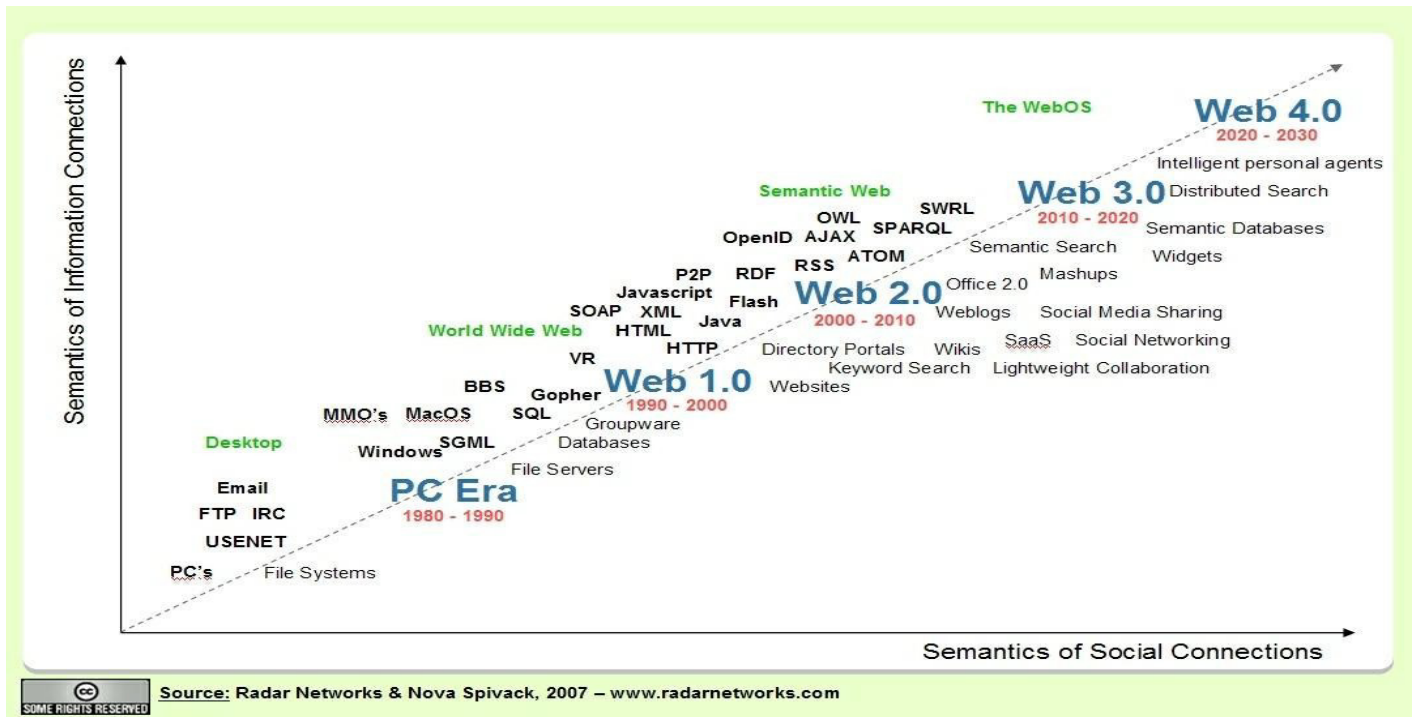
Figure 4: Evolution of WWW
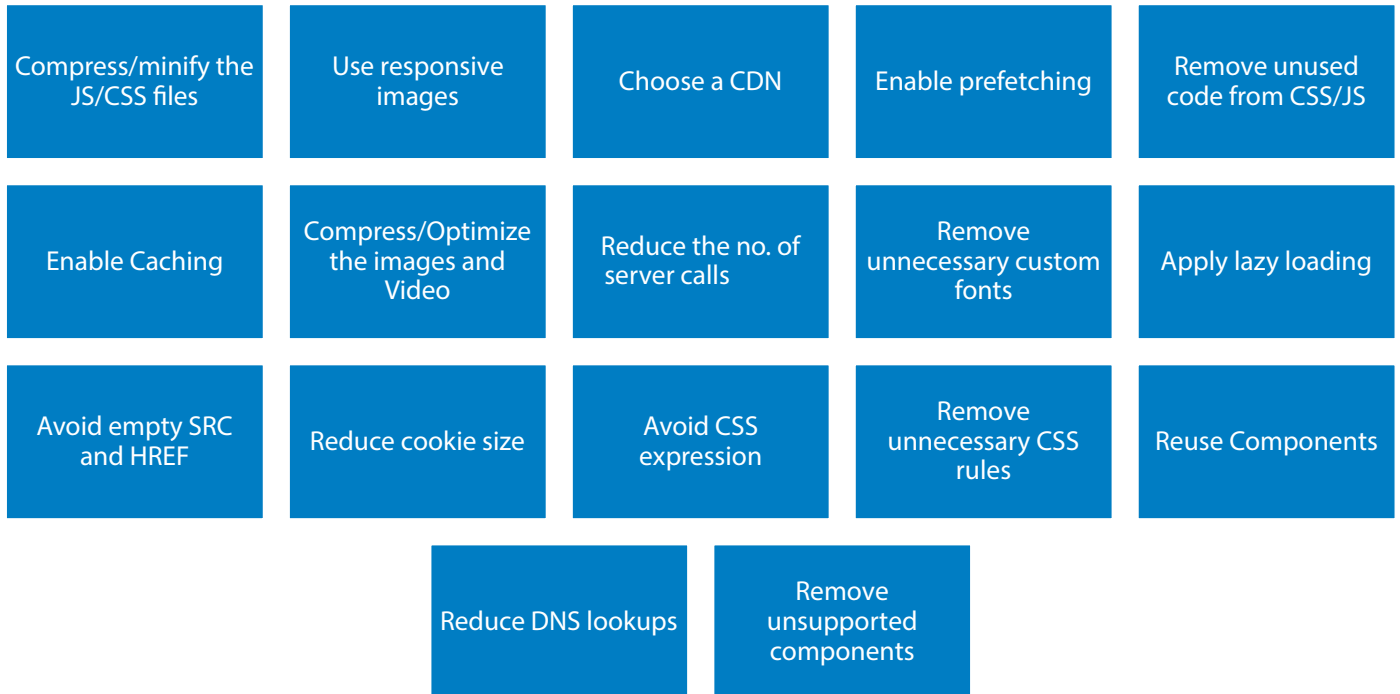
Frontend: Vital components

In the rapidly moving world, everyone wants the web application to be super-fast and user friendly. There are a few vital components which make the web pages more user friendly and act as the decision makers to decide on the future trends of the Frontend technologies.
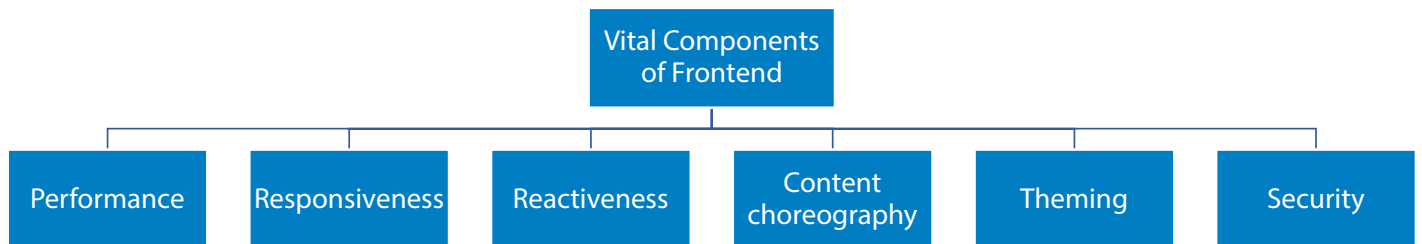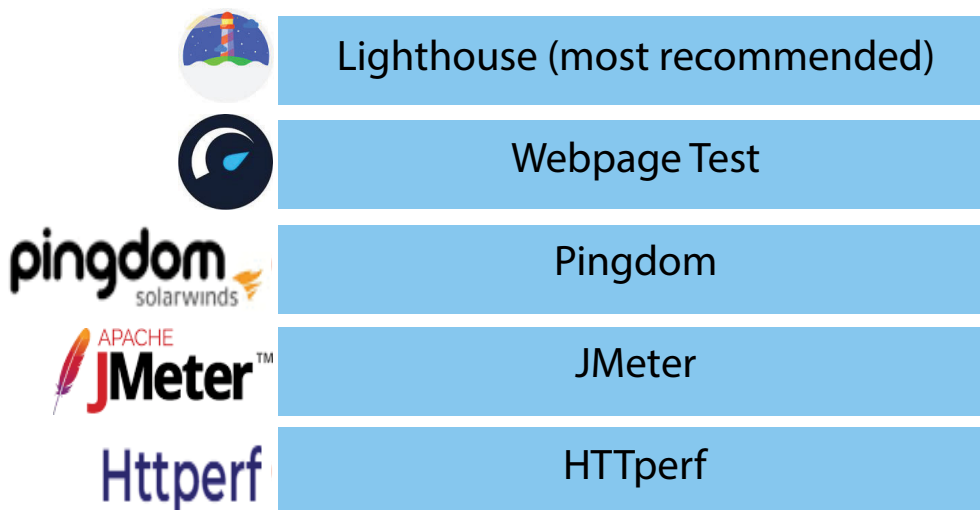
Performance

With millions of users accessing the websites in a day the application initial load time is more. The user loses interest and leaves the page assuming there is something wrong with that website. The goal of front-end performance is to give the users the ability to get what they want from a website or an application in an extremely limited time and ensure that they have a smooth experience while interacting with it.

To improve the performance of the front-end application there should be some optimization techniques that need to be followed. Below are a few optimization methods,

Compress/minify the JS/CSS files	Use responsive images	Choose a CDN	Enable prefetching	Remove unused code from CSS/JS
Enable Caching	Compress/Optimize the images and Video	Reduce the no. of server calls	Remove unnecessary custom fonts	Apply lazy loading
Avoid empty SRC and HREF	Reduce cookie size	Avoid CSS expression	Remove unnecessary CSS rules	Reuse Components
	Reduce DNS lookups	Remove unsupported components		

Tools to analyze the performance of the website:

Lighthouse (most recommended)

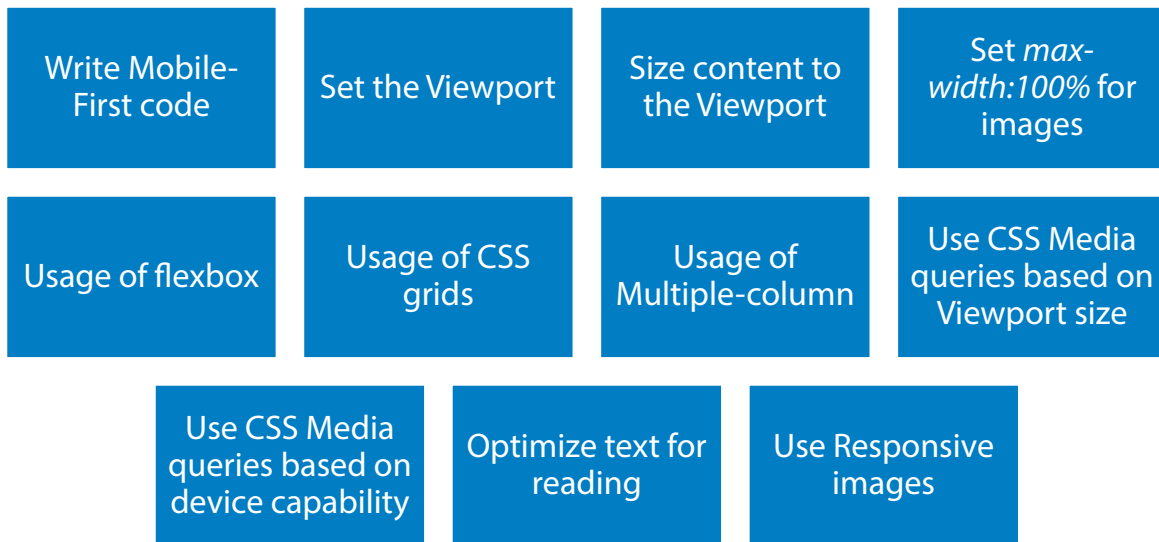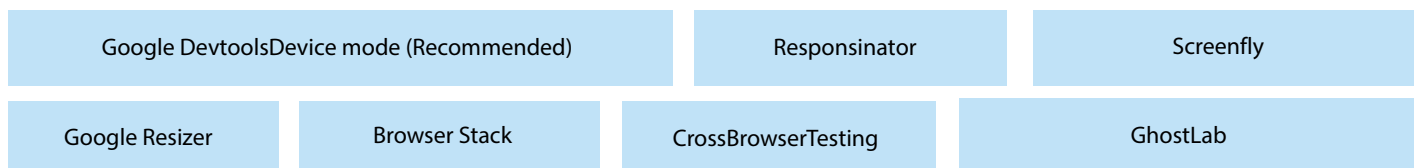Webpage Test

Pingdom

JMeter

HTTperf

Responsiveness

As technology develops, the usage of mobile phones increases drastically. Maintaining different version of webpages for different size of devices will be time consuming and need a lot of effort and it will affect the performance of the application, since it needs to choose which version to put in. To resolve this issue, the Responsive web design responds to the user based on the device they are using. The layout of the application changes based on the size and capabilities of the device.

For e.g., in the mobile, the content would be displayed in a single column due to the size restriction and the same content will be displayed as 2 columns for tablet and 4 columns in laptop/Desktop view.

The website developer should consider the items below to experience a better responsive experience.

Write Mobile-First code	Set the Viewport	Size content to the Viewport	Set *max-width:100%* for images
Usage of flexbox	Usage of CSS grids	Usage of Multiple-column	Use CSS Media queries based on Viewport size
Use CSS Media queries based on device capability	Optimize text for reading	Use Responsive images	

Tools to test the responsiveness of the website:

Google DevtoolsDevice mode (Recommended)	Responsinator	Screenfly

Google Resizer	Browser Stack	CrossBrowserTesting	GhostLab

Reactiveness

Users accessing a webpage will show interest only when the application is reactive. It means, the user should feel that the interaction to the webpage should be fast regardless of the network speed. If there is a delay in the response, then the user will think that there is some issue on the website, and he will try to refresh the page multiple times and eventually leave the page. The reactive web application should immediately render the content if there are any changes detected in the server.

Things to be noted in the case of Reactive Websites are,

- If there is a failure, then it should not affect other portions of the page
- Rapid response time
- Should have proper error handling
- Proper loader needs to be added in case of server calls
- Usage of skeleton loader
- Optimize the JS code and server side code to get the faster response
- Lazy load content

Content Choreography

Content choreography is nothing but re-arranging the same content in the different devices relatively. There should be a relationship between the layout which is designed for the laptop/desktop and mobile. The responsive design is generally achieved wither by Flexbox or Bootstrap grids. Typically, when the application screen size is resized from Laptop to Tablet and then to mobile, sue to the size the column size will reduced by 1. Approach to be taken for proper choreographed content is

Stack up the columns one after another	Restrict the usage of container class
Make sure clickable areas are sufficient	Action buttons should be noticeable and accessible

Theming

Generally theming refers to the branding of the organization who owns the website. But this theming should be in certain way that it should attract the user to access the web page. Theming also includes the font selection of the web page. Choosing the right theme is a vital factor in web development. Before finalizing a theme for a website, a few key points need to be noted.

Restrict the selection of brighter colors	Avoid fancy font family	Text size should be readable
Try to use dark mode	Avoid more distracting colors and images	

Security

Due to digital modernization, everyone is accessing everything by the comfort of sitting at their house. Parallelly cyber security is also increasing day by day by misusing the loopholes of the technology. Many are concentrating on the security only on the backend side and ignoring the frontend security which leads to many cyber-attacks. To prevent the web application from cyber security threats, a few important points need to be followed.

Sanitize all the inputs to prevent XSS Attack	Configure firewall and routers to prevent DDoS Attack	Implement a token-based authorization to avoid CSRF attack
Use vulnerability management tool to find Vulnarability in CSS to prevent CSS injection attack	Scan all the third party libraries we are using	Set up Feature-Policy header to stop unauthorized policy request.

Way Forward- What Next?

The future trends of front-end technologies are as follows

JavaScript (JS) frameworks

Whatever the latest trend comes, the JavaScript framework will always hold a position in that list. JavaScript is not only used for frontend script but also as a server-side script (NodeJS), packaging (NPM), transpiling (Babel), package and optimize application (Bundling). When it comes to JavaScript framework, SPA (Single Page Apps) is inevitable. Single Page Application or SPA refers to JavaScript based web application that renders a single HTML page with dynamic content, updating automatically without refreshing the page. It simplifies the user navigation on the website. Few SPA frameworks are **Angular, ReactJS, VueJS** etc.,

Upsides:

- Cost effective

- Easy maintenance

- Easy debugging

- Improves performance.

Why will it trend in the future?

Even though multiple JavaScript frameworks are available in the market only a few frameworks/libraries continue to work to provide the proper support. Such frameworks/libraries will always take a fixed place in future web development.

- React

- Angular

- Vue.js

- NodeJS

- NextJS

LCNC (Low Code No Code)

LCNC (Low Code No Code) platforms are software development environments that enable the developer with little to no coding experience to build the applications. It will provide visual editor where the user can drag and drop and create the application. These platforms help business users to quickly deliver the business requirement in a short span of time. Few LCNC platforms are **OutSystems, Mendix, Unquork, Quick base, Zoho Creator,** etc.,

Upsides:

- Less Coding

- Increased Productivity and speed

- Easy to understand

- Short release cycles

Why will it trend in the future?

With its faster deliverability and scalability, the Low Code No Code model will be a complete game changer for business. Other important reasons are listed below

- LCNC makes the team more productive by speeding up the end-to-end process right from development to building applications.

- Easily adaptable

- Applications can be easily created even by non-technical users.

- Build applications faster without writing more code

Micro frontend- What about it?

Micro frontend is an architecture which is like Microservices and is specifically designed for the frontend. When digital modernization increases, the business produces many feature-rich components in web applications. But with the existing traditional monolithic approach, the maintenance of the code will be difficult. If there is a change in one feature module, then the entire application needs to be rebuilt. With the help of this architecture, different micro frontends can be managed by different teams and can be built and deployed independently. There are so many frameworks such as **Single-Spa, Module Federation, SystemJs, Bit, Piral, Qiankun**, etc., available in the market which helps to achieve the micro frontend architecture.

Upsides:

- Better code maintenance and code isolation

- Have ability to independently build and deploy

- Adding new features in one micro frontend is easy

- Continuous Deployment

- Less regression testing

- Scalability

Why will it trend in the future?

Micro frontend Architecture provides the feasibility to maintain the code easily. If there is a change in the existing feature or adding a new feature in the application will be quick and it can be independently built and deployed. In future, with the growing demand the application size will be increased if the business does not go with Micro frontend. This may be optional today, but it will be a necessity for tomorrow.

Progressive web apps (PWA)

Progressive web apps (PWA) are the web pages that behave like a mobile application. It will use the features of native mobile devices and the user does not need to visit the app store and install the separate installable software. It is very quick to create PWA rather than creating a native mobile app. Nowadays we can convert almost any website to PWA.

Upsides:

- It can use both the features of the browser and device capability

- Offline use

- No installation/updating required

- Supports SEO

- Visible as an App icon

Why will it trend in the future?

PWA is the faster way to create a mobile app like application. It becomes more popular because the application will load in a short span of time and provide an excellent mobile experience for the user. Hence business is adapting to PWA more in recent days and it is believed that this trend will continue to grow.

Multi-experience

Multi experience refers to the digital experiences in different devices and touch points. Due to technology advancement, human and machine interaction increases which is not only restricted to typing, touching, and chatting but also with voice, gestures in 3D or virtual environment.

Assume if the user is in the shopping mall and has a big queue in the billing counter. If the user uses the mobile device to pay the bill to avoid the queue and in the last minute the mobile device is switched off, then the user can use his smart watch to finish the payment without any hassle provided that the service provider is availing the multi experience. Currently Multi experience is focusing more on immersive experience that uses AR (Augmented Reality)/ VR (Virtual Reality), mixed reality and sensing technologies. Few examples of MXDPs (Multiexperience Development Platform) (Multiexperience Development Platform) (Multiexperience Development Platform) are **Alexa, Smart TV, Smart watch, Voice assistance** etc.,

Upsides:

- Greater control over user's digital experience when they use MXDP (Multiexperience Development Platform)

- Reduces the release to market time

- Digitalize process

- Increase operational efficiency

- Improve security

- Helps to stay ahead of the trend

- Flawless user experience across devices and touch points.

Why will it trend in the future?

Since industries need to be always ahead on their market offerings and evaluate the chances of new development options, multi-experience apps must keep up with these trends to meet industry requirements in the near future.

Metaverse- Trend of Future Web

Metaverse is the next generation of the internet where the users will be able to navigate through a virtual space. It is called the next generation of internet because it uses the Web 3.0 concept and is a blockchain based public platform. It uses a decentralized open-source ecosystem to enable users to create applications. Currently users view the content in the web, but in Metaverse the users will be immersed in the content because of the usage of VR, AR, AI/ML. Based on the trend it currently goes, this will not totally remove the existing traditional websites rather it will end up coexisting with Metaverse. A few frontend technologies which are used in metaverse are Three.js, A-frame, etc.,

Upsides:

- Providing the virtual experience to the User

- Sell and showcase products

- Innovative advertisements

- Helps in remote work challenges

Why will it trend in the future?

As the metaverse concept is starting to incorporate Web3.0 technology enabled through blockchain technology, the future metaverse would be something remarkably like our real world in many aspects and even replace some real-world activities. Due to a sudden pandemic situation the world has faced some challenges in remote support and communication with others. Metaverse will become a platform for solving those challenges and will become the platform for innovative branding and selling products. The usage of NFT (Non-Fungible tokens) is already used in some metaverse games. Clothing and footwear industries are planning to have their venture in the metaverse and use NFT for the transaction.

AI (Artificial Intelligence) based chat systems

Artificial Intelligence chatbots are trained to have a human like conversation using a process called Natural language processing (NLP). Using this chatbot will help the business in providing 24/7 support to the customer and get good customer satisfaction. Some of the AI based chat systems available in market are, Zoho Sales IQ, FreshChat, ChatBot, LandBot, etc.,

Upsides:

- Facilitates seamless live communication

- Save time and money

- Eliminate Tedious time-consuming tasks

- Make customer support 24/7

- Able to gain insights on customer behavior and use it as the product delivery strategy

- Can offer personalized experience

- Better security

- Greater transparency

Why will it trend in the future?

As customers' attention spans decrease and demand faster methods of consuming information, companies are increasingly turning to voice search and text-based messaging platforms to connect with their target audiences. Chatbots are constantly evolving and becoming more widely used to offer the best possible customer service. By interacting with customers in real-time, customer service chatbots can provide a different level of experience to them. As per the current market trends, these chatbots helped the business gain market share and be a significant investment in customer service experience. Hence this will surely hold a unique place in the future too.

WebAssembly

WebAssembly or Wasm is a powerful technology that aims to solve performance-related issues of web applications. It is a new language that can run in the browser along with JavaScript. It has a binary code format hence it can execute any code with faster performance, irrespective of its programming language. It is a portable compilation target for programming languages and enables deployment on the web for client and server applications.

Upsides:

- Run code in native speed

- Supports multiple programming languages

- It can run in any web browser hence can be accessed by any device

- Faster, Efficient and Portable

- Provide excellence performance especially for Computing intensive apps

Why will it trend in the future?

As previously mentioned, one of the Vital components for the front end is performance. Considering the amount of requirement business have the bundle created by JavaScript is still more and it will increase the load time. WebAssembly can work along with any programming language and has the ability to debug easily. It helps in compiling the code and optimizing it and improves the performance of the application. Hence this will be one of the trends in the future.

BFF (Backend for Frontend)

BFF (Backend for Frontend) is one of the variants of API (application programming interfaces) gateway patterns. It will provide an additional layer between the client and the microservices. This pattern will provide multiple-entry point of API gateway, instead of bombarding everything from one place. Even though this pattern is mainly used in the API gateway and not directly related to the frontend, it is specified in this section mainly because it helps in improving the performance of the frontend application when the application uses this pattern.

Summary and key takeaways

There will always be change and advancement in any field/technology. Business should always be alert about the trends in technology development and analyze whether the application which is being currently used will continue to be used or become redundant.

- Industry should be updated with the latest trends in the market and understand the utilization of their products

- Analyzing the necessity before adapting

- Choose the right technology which matches the business requirements.

- While migrating/modernizing the application, the industry should keep both the vital components and characteristics of the webpages in mind.

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