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HTML 5

Concepts, Architecture, Nutshell Examples, Outlook

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04.06.2020

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Abstract

This paper covers the development and history as well as the functionality of HTML5, the latest version of the wide spread and popular Markup language. The exiting history begins at CERN in 1989 with a researcher who becomes the founder of one of the most important technologies which dramatically changed how the world works and communicates. His name is Tim Berners Lee and he is the inventor of the World wide web as well as the inventor of the language used to implement this technology which is called HTML.
In this paper the latest specification of the Hypertext Markup language used to create and display websites will be described and explained with a general overview of the new features, nutshell examples and the concepts behind the language.

At the end of the paper a brief outlook of new ideas like the semantic web and the future development of the web in general is given.

1. Introduction

When opening Amazon.com, Facebook.com, Youtube.com or basically every other website there is something they all have in common. It's HTML or more specifically they are all based on a structure written in HTML. This enables the website to be displayed in any browser and creates an interface for us to see, read and interact with their data and information. It defines how we find information on websites and online encyclopedias like Wikipedia.com, how we select and watch movies on streaming services like Netflix.com or Disney Plus and how we order products online and interact with ecommerce big players like amazon.com or the web shop of our favorite local clothing store. Having access to webservices no matter if being at home surfing the web on your tablet, on the go on your phone or at work on your laptop changed the way we interact, create and communicate.

All of these significant changes and improvements have been enabled by the world wide web which was developed and invented by Sir Tim Berners Lee and is based on a method called packet switching.
However Sir Tim Berners Lee figured there needed to be some kind of hypertext language which would make it possible to display and structure the data send via the world wide web by interpreting it and transforming it into visual elements.
This language was then initially developed and proposed by Sir Tim Berners Lee in 1990 and it's called Hypertext Mark-up language or short HTML.

The early versions of HTML were closely linked to SGML, Standard Generalized Markup Language, which was a standard for documentation formats at CERN the European research organization Berners Lee worked for at the time. However in the coming years the world wide web would become increasingly popular and so did HTML as the main way of developing interfaces for internet based applications and services. And as more and more versatile applications started to arise and new ways of interactions, features and possibilities were created further improvement and additional development became necessary.

This resulted in four main versions and releases of HTML with the first official specification being HTML 2.0 in 1995 and followed by HTML 3, HTML 4 and most recently HTML 5 in 2014.(Raggett 1998, Chapter 2)

As HTML is such an important and crucial language not only historically but for the future evolution of the world wide web as well this paper deals with the history and development of HTML in general, how it works and which differences and requirements led to the various versions. As HTML 5 is the most recent and current implementation of the language the paper focuses on the concepts behind the release, the architecture and new features and shows how certain new functions work in brief nutshell examples.
As future development in web technologies are an interesting topic as well the concept of XHTML and the Semantic web will be briefly explained before a few critical thoughts and an outlook is given to round the paper up.

To fully understand what HTML 5 differentiates from previous versions and why it was a necessary development it's important to get a brief overview of what HTML is used for, how it's implemented and how it is structured. As well as comprehensive explanations of the so called tags which are used to describe the structure of the website and enable the web developer or the creator to deploy and insert elements like images, tables and paragraphs or connect the static HTML code to dynamic JavaScript, PHP and other application programming interfaces. This will be covered in the next chapter of the paper as well as a more detailed view on the thoughts and ideas which went into the initial development of HTML.

To start things off and to cover the basics of HTML let's start with the history and evolution the language has been going through.

2. What is HTML

HTML, Hypertext Markup language, is as the name already hints a Markup language. This means against some public assumptions that it is not a programming language as it doesn't have dynamic capabilities to perform and create functions. HTML can more be

compared, in a very loose way, to software tools like Microsoft Word or Power Point as it strictly is used to structure, organize and design documents, in this case the websites. For example to create a paragraph on a website you can use the tag my paragraph and this can then be displayed in the browser. We will go deeper into tags in the next paragraph but for now as a basic explanation these are the HTML elements used to structure and divide the website into sections or are used to display elements like images, links, etc. Domantas, G.(2019)

Other popular Markup languages are for example XML, extensible Markup language, and XHTML, extended Hypertext Markup language, which is described in chapter 3.4 as it's a very important new technology possible changing the way websites work and interact with users and browsers in general, called the semantic web. All Markup languages have in common that they are human readable and use tags to structure contents and elements. So in a general sense Markup languages are the building blocks of websites in the world wide web. Kyrnin, J. (2020)

Before discussing the history of HTML it is important to get an overview of what this language does and how it does it. Basically HTML consist out of a elements tree and text. Each element of the tree has a start tag which looks like this <html> and an end tag which looks like this </html>. Between these tags there can be other tags but every tag needs to be nested so for example when creating a webpage the document starts with <html> and then all the tags inserted after that display the content and they need to be closed before at the end of the document the </html> needs to be closed. This then creates a tree structure with all the nested elements which is also called the Document Object Tree or DOM Tree.

Here is some basic example code to showcase how the tree structure works in practice.

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <title>HTML 5</title>
  </head>
  <body>
    <h1>HTML 5</h1>
    <p>This page is just a demo.</p>
  </body>
</html>
```

This structure results in the following DOM tree:

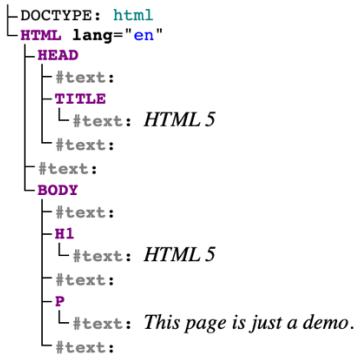

Figure 1: Example DOM Tree

And this is how it's displayed in the browser:

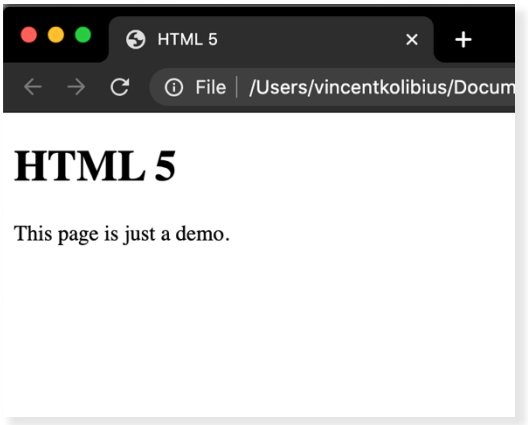

Figure 2: Browser view of example code

2.1 History of HTML

To fundamentally understand the need for a language like HTML and how it was developed and evolved throughout roughly the past 30 years we first need to have a look at the history of the world wide web.

The www as we know it today has a quite surprising point of origin considering its applications today.
It was developed in 1989 at CERN the European Laboratory for Particle Physics which is located in Geneva.
As it was and still is usual business for science institutes especially at this level to collaborate and share results and data with other institutes around the world Tim Berners Lee, an employee in the computer science section, had a vision to create a system which links the elements inside a document instead the document itself so for example when sharing research papers with texts referencing to other papers remote scientists wouldn't have to load the whole document but only the paragraphs referenced to. (Raggett 1998, Chapter 2)

Therefore a centralized repository of research papers or pool of information needed to be created.
However to be able to link the elements of a document and not the complete document at once the contents needed to be identified or marked up achieving that with a set of buttons one could navigate from one paper to another.

As Tim Berners Lee already had experience with developing word and text processing and already created a personal project called Enquire which was a hypertext system he used his capabilities to create the first browser which was released in 1990.
The release was perfectly timed as during that time technological advancements in communications systems were made and hypertext was being used increasingly on computers.
Another very crucial success factor was that through those developments the user base and the need for distributed information increased significantly. Another crucial development was the introduction of a new domain name system called distributed

name service DNS for the Internet which basically mapped IP-addresses to addresses in the format we know today starting with www. and ending with a top level domain like .com. This made the Internet increasingly accessible and easier to use for the average user. (Raggett 1998, Chapter 2)

The concept Tim Berners Lee used to create the world wide web and with it the Markup language is a technology called Hypertext.
This was already developed in the 1940s and later adapted by apple engineers which made it possible to jump between linked files. They called this application Hypercards and it became quite popular. However this was only possible with files on your local machine.
So by enabling this technology to work over the internet it was possible to jump to files on another machine possibly located at the other end of the world. (Raggett 1998, Chapter 2)

Even though there already existed various hypertext application at the time Tim Berners Lee decided to develop his own version of the technology due to significant reasons. Most of the available hypertext packages relied heavily on the computer system they were running on and therefore weren't able to interact with different systems like MacIntosh, Unix and Windows on a level necessary to successfully implement Lee's vision.
He then decided to develop his own package which was reasonably simple but also everything that was necessary at the time. To secure the correct transmission and interpretation of the files and elements he further created his own protocol used to send and receive the data. He called it the Hypertext Transfer Protocol or short HTTP, which is still used today and is part of the application layer. (Raggett 1998, Chapter 2)

HTML however wasn't completely developed from scratch by Tim Berners Lee but based to the most parts on SGML, Standard Generalized Markup Language, which defined elements like headings, paragraphs and lists. The following SGML tags were integrated in HTML p, h1 til h6, ol, ul and li. As the hypertext concept wasn't integrated in SGML some of the additional features added by Berners Lee were elements used to

implement references like the HREF attribute which takes an URL as input and links it for example with the <a> element as a clickable link. This was exactly the adaption needed to make HTML quite successful and stable as it is based on an already recognized and proven framework. (Raggett 1998, Chapter 2)

Additionally as Tim Berners Lee is a researcher and a natural process within that domain is sharing and discussing findings within the community. From the beginning on HTML was openly presented and ideas as well as possible improvements were shared and exchanged via an email list first implemented in 1991.
With this possibility experts as well as enthusiast could collaborate and further develop the world wide web and with that HTML.

One major event during the time following the initial release was when Dave Raggett, who worked for HP at that time used Berners Lee's version and created a richer more versatile HTML which he called HTML+. To secure new features were useful and reasonable he looked at magazines and other media to define which elements would become necessary when these media types would be digitized and made public online.

In the years following commercial projects and new collaborations led to various interesting developments with new browsers being developed and HTML getting an increasingly bigger audience.
With the bigger audience more people and organizations realized how big of an evolution this technology was and wanted their share of it. One of the first teams getting into was from the National Center for Supercomputing Applications NCSA. They developed a browser called Mosaik. (Raggett 1998, Chapter 2)

It played an important role when the img tag was proposed to be implemented and after various discussions taking place through the www-talk the team of the Mosaik browser and more specifically Marc Andreessen managed to claim his solution as the one being implemented and therefore his version of the img tag which enabled the integration of images is still a crucial part of the most current release of HTML 5. However what needs to be mentioned here is that not all members of the group at that time were happy

with how the <img> worked and if it even should be implemented. (Raggett 1998, Chapter 2)

In 1993 the mosaic browser was finally released and simultaneously Dave Raggett worked on his own browser project which was called Arena. However even though being an employee at HP he didn't get funding for the project as especially bigger cooperations were quite restricted and acted carefully with respect to the new technology.

One year later the first HTML forum was held in Geneva and HTML+ was shown using the Arena browser.
In that same year some of the projects were made available commercially and the whole HTML topic developed a new dynamic. New collaborations and groups were formed like a HTML task group related to the Internet Engineering Task Force IETF, and later the World Wide Web Consortium. The W3 Consortium which was led by Tim Berners Lee himself recruited some of the internationally most important players of the History of the web which were at that time Dave Raggett, Arnaud le Hors, Dan Connolly, Henryk Frystyk Nielsen, Hakon Lie, Bert Bos, Jim Miller and Chris Lilley. The goal of the W3 Consortium was to develop standards and regulate the development of web technologies. It is linked to the Massachusetts Institute of Technology and sponsored by various big companies (HP, IBM, Microsoft, etc.) which as a result profited from the consortium's work. (Raggett 1998, Chapter 2)

Additionally the first official release of HTML was conducted with a specification called HTML 2.
1995 further attributes and tags were introduced to the feature catalog of HTML which also included some styling options.
Some of the core developers however were skeptical if these should be integrated in the Markup language as one characteristic of this kind of language is that it's used solely for structuring and sectioning documents. However they were still released.

HTML 2 introduced important tags like <form>, <head>, <html>, <DOCTYPE>, <meta>, <table>, <tr> and quite important as well the <body> tag which is basically used in every website.

In March of 1995 the third specification of HTML was published, first as a draft, as due to expansive new features and the possibility to reference to style sheets the approval of the community was quite hard get.
And even more problematic was the loose integration of browser providers.
Various browsers only picked some but not all functionalities of the new version and still claimed using the HTML 3 standard which apparently wasn't the goal of applying a standard.

The third version which was also called HTML 3.2 introduced the following new tags: <basefont>, <big>, , , <font>, <s>, <script>, <small>, <style>, <sub> and <sup> with most of them being deprecated in later HTML versions. However the then introduced tag is still one of the most used tags.

Later that year after various internal discussions of the HTML working group which led to difficulties commercial players started to play a bigger role in the development of the standard.
One example was the implementation of the Cascading Style Sheets, CSS, where Microsoft played a role in the deployment as they managed to integrate CSS in it's at that time brand new Internet Explorer.
The slow decision making process of the HTML working group which made it impossible to keep up with the fast developing dynamic of the standard led to its dissolution. (Raggett 1998, Chapter 2)

With the participation of corporate companies especially the academic community which was involved in HTML was increasingly concerned as of course enterprises like Microsoft and other browser makers introduced their own tags which meant that the open source project was slowly becoming more proprietary. Another big company influencing the further development of the language quite significantly was Netscape, a

browser maker, who also played a big role when the HTML scripting support for JavaScript was introduced as Dave Raggett's solution for the W3 Consortium was in parts based on the initial concepts of the Netscape team.
However the general opinion of the core HTML community changed over time as especially Microsoft made clear that an open standard is still the goal. (Raggett 1998, Chapter 2)

During the following years 1996 and 1997 various updates on the third specification were released and the teams started working on a new version of HTML which was called "Cougar" as a working title.
This version was far away from simple features and a clear overview of possibilities however this was necessary at this point in time as the web has grown to an important communication technology and already shaped the way people live with various expansive new applications which also needed a way to be created and deployed.
This specification eventually became what we know as HTML 4 the fourth iteration of the language which was then used as a new standard across all browsers and secured this position for a long time. (Raggett 1998, Chapter 2)

2.2 Issues with HTML 4

Before diving deeper into the specification's shortcomings from today's perspective and the need for a new version after HTML 4 the new features introduced with that iteration of the language need to be discussed first.
Generally there are integrated improvements for various aspects like referencing and using stylesheets, performing scripting tasks inside HTML and embedding elements as well as various new supported attributes and objects like different text formats and new possibilities with tables.
Additionally with forms there was an upgrade introduced with made it more accessible for people with disabilities.
Another very important improvement considering the broad availability of the world wide web was the support of various languages across the globe. This was mostly done by integrating the ISO/IEC:10646 standard which is the most inclusive character set for international text support.

To diversify and increase quality as well as efficiency the W3 Consortium recommends to split the structure of a document and the styling with the improved functionality of the connection between HTML documents and CSS documents.
Furthermore the tables feature got a rich update of new attributes leading to new possibilities like captions and column groups.
Additionally tables can now be displayed with its content loading dynamically which means an iterative loading so not all the contents need be loaded at once before the table is shown but are displayed incrementally.
(w3.org, 2018)
Further newly added tags are the <button> tag, which is used within the <form> tag and makes it easier to reference styling attributes to the element, the tag which can be used to color a part of a text, the <abbr> tag which labels an abbreviation and has a similar functionality as the introduced <acronym> tag.
The introduced <object> tag provides one more option to include assets like images on the website as well as for example other html files or even videos. It can be defined as a container which embeds media in the website.
(w3schools.com, n.d.)

With quite a similar functionality one of the major and very popular tags introduced was the <iframe> tag.
This enabled to create and display an inline frame which means that inside one HTML document another HTML document can be displayed simultaneously but with no direct connection between the two documents other than the URL to access the inline framed document.
This could for example be another website or any kind of media taken from another source like displaying a YouTube video in one's own HTML document without having to integrate the video itself as an asset inside the HTML structure.
Or you can use it to apply a different design or color scheme to highlight or focus a certain part of the document as it's treated as an unrelated HTML file and therefore the connected stylesheet can be adapted as well. This feature is quite important in regards to HTML 5, the current version because this is one of the functions that is used quite often to embed videos as we will learn in a later paragraph. However this feature can also

offer an attack surface for hackers as the content of the iframe needs to be trustworthy enough so third party sources don't integrate malware or other harmful activities which enable for example cross site attacks.
Apart from security iframes also create usability issues as for example the browser's back button will not be working properly, the content of iframes often isn't displayed right or looks odd and apart from that they also increase memory usage and lead to a lower website performance in general.
Smirnov, A.(2019)

Even though the developers created quite an expansive new feature catalogue and provided a lot of new solutions to create and structure web content with the huge increase in popularity new issues and limitations were identified.
HTML 4 was broadly accepted and supported by basically all browser in the recent years but especially with the rise of mobile based users many shortcomings were uncovered and as no newly updated version of the language existed a lot of issues were solved with workarounds and additional plug ins.

Looking at the statistics this development becomes quite clear as back in 2010 mobile internet usage was just 3.81 % via Russell, J. (2012) which is significantly lower than the 52.2 % in 2018. Clement, J.(2019)
As space on mobile devises is critically lower than on regular desktop machines especially developers had problems creating the pages with a good user experience in mind as they needed ways to dynamically adjust the page to fit various screen sizes.

Another issue with HTML 4 was that there weren't a lot of control mechanisms provided to manage website performance and data handling which also became increasingly difficult with more advanced services and requirements. This meant that web developers needed to find workarounds and other browser extensions to for example manage server side applications.

Most websites are designed with some sort of navigation bar, a header area and a footer section however with HTML 4 all of these elements were for example structured using the tag.
This makes the HTML code harder to find mistakes or get an overview in general as most websites will be made out of multiple tags embedded in each other.
Another problem for web developers occurred when custom data attributes were used. As these could prevent the website from loading and displaying only some parts.

Even more major however is the problem that in order to store data locally there is only one possible approach in the fourth specification of HTML and that is cookies. Cookies are essentially http packets containing data which is supposed to be stored locally on your computer so for example when you log in to a page the website theoretically can remember you and the preferences you made on the website. However as cookies only provide a relatively small storage space and are often disabled from users there is no stable way to store data from the web application locally. Arsenault, C.(2017)

The biggest and probably most prominent issue considering HTML 4 was the Adobe Flash Player problematic which isn't necessarily all HTML 4's fault as the issue occurred first as Apple introduced the iPhone and with it removed support for Adobe Flash applications on its mobile devices but the missing functionality to integrate dynamic content like videos, online games and other interactive web applications within the original HTML structure made this a crucial vulnerability of the fourth specification. Users needed to have Adobe Flash Player installed to be able to interact with and view these animations and creators used for example the Flash Professional, later Adobe Flash, to design and produce these rich contents.

Apple founder Steve Jobs once said in an open letter that "Flash was created during the PC era--for PCs and mice,". Therefore he refused to integrate flash support on the iPhone as he had the opinion that this is not the future and new technologies will be provided which suit the requirements in a more appropriate way. Shankland, S.(2010)

As we know now in 2020 he was right and Adobe Flash Player will finally deprecated this year with support of Adobe being removed at the end of the year. This also means that the current and newest specification of HTML called HTML 5 finally replaced the older inefficient technologies and is now broadly accepted as the best practice for creating basic web interfaces as well as rich, dynamic and interactive web applications like it's never been possible before.
So after almost 17 years between HTML 4 and HTML 5 at October the 28th in 2014 the W3 Consortium released the official specification.
In the next chapter the new version will be discussed and explained in more detail and the interesting concepts and ideas will be presented as well as how most of the issues with the fourth specification are improved and how the foundation for a new era of the web was built.

3. HTML 5

After the release of HTML 4 a few years passed by and with new concepts coming up like the integration of an xml based version which would allow a new way of creating web content.
These ideas led to the reconsideration of the W3 Consortium to restart the development and improvement of the popular language. This initially came up at a workshop of the group held in 2004.
As not only the Consortium had interest in further evolving HTML but also big companies like in this case Apple and the browser firms Mozilla and Opera a new joint venue was created under the name WHATWG.
Before starting work on the new specification there were a few rules set which in particular should include backward compatibility and ensuring there is no reverse engineering of implementations necessary when specifications are too loosely formulated.
In 2006 then after previously not collaborating on the development of the new version the W3 Consortium decided to step in and requested participation in the project.
As the other parties approved the involvement of the group they formed a task force in 2007 and started working.

One condition however was that the W3 Consortium is allowed to own the full copyright of the specification with the other three parties also receiving a reduced version of the copyright on HTML 5.
After continuing working together for several years there were noticeable differences in both parties' opinions with Apple, Mozilla and Opera as WHATWG group on the one side having the goal to create a so called "living standard" for the HTML specification which would mean that there will be continuous work in progress and there will not be one official release but consecutive updates and improvements so the development team can react better on potential bugs or missing features. On the other side however there was the W3 Consortium with the opinion to create one finalized product which will then be the standard to go for even if it meant releasing a specification with errors or missing features. All this happened around 2011 but for now they kept working together. It took eight years to finally come to an agreement with the WHATWG group which declared that both parties will work together at one single version of the firth specification.
This agreement defined that HTML 5 will be a continuous work in progress and therefore a living standard. WHATWG(2020)

At https://html.spec.whatwg.org/ the standard's documentation can be found and it's constantly updated with the last time during the writing of this paper being May the 29th of 2020.

An important second language which is important for the fifth specification of HTML was developed by the W3 Consortium after the release of HTML 4 and is an adaption based on the XML specification which is called XHTML.
XML is different from HTML in a sense that it was designed to transfer and carry data whereas HTML was created to display data.
Another important characteristic is that XML tags are not predefined so you can customize them individually in contrast to the fixed structures of the Hypertext Markup Language.
In a later chapter the integration of XHTML in the new specification of HTML will be discussed as this is a very significant process for the evolution of the web.

Before that it's important to understand the concept behind the new version and a brief overview of the newly added functions, attributes and tags which include for example the <video> tag, the <audio> tag, the <header> and the <footer> tag.

3.1 Concept

So after almost a decade HTML 5 was finally released in 2014 but why was it necessary and what was changed in contrast to the previous standard. To explain this the best way is to look at some of the most significant issues which existed with the fourth version. Some of the minor issues where related to missing structure elements as websites have typical layout elements like navigation bars, headers and footers and these couldn't be defined previously and therefore the HTML files where harder to maintain and read as all these layout elements where usually defined as tags.
To address this issue new tags were introduced to significantly ease the creation of these layout options which are the <header> tag, the <footer> tag and the <nav> tag.

Furthermore until now there existed only one way to locally store data and that was with the help of HTTP Cookies. However as they are limited in storage space and often are deleted by the user they weren't a very stable or secure way for web developers to store data locally. This was also addressed in the new version and will be explained in more detail in a later chapter. Generally speaking there is now an additional way to store data locally which makes it much easier to implement applications which require this feature. Arsenault, C.(2017)

Updates were also made to styling attributes and especially for the type category which leads to an increased amount of options like new supported fonts, shadows, colors and more effects.
Motion effects now can also be natively achieved in HTML 5 which is limited but still supports basic functions for cursor actions and movable objects. Arsenault, C.(2017)

Another addition is the introduction of a 3D application using WebGL, a JavaScipt API which enables rendering of interactive 2D and 3D objects using the computer's graphic

processor and works on any browser without the need for any plugins. Arsenault, C.(2017)
One of the most significant improvements with the introduction of HTML 5 is the general support of various new formats, interactive applications and APIs natively without the need of any sort of plugins or add-ons on any browser. Arsenault, C.(2017)

The major example for this is, as already mentioned in an previous chapter, the depreciation of Adobe Flash based applications. The Adobe Flash Player was probably one of the most commonly used plugins in the past decade before the release of the fifth specification and became irrelevant with it to the extend of Adobe removing support for the application later in 2020.
This step was very important considering the mobile internet usage as Apple decided to completely remove Flash Player support for any iOS device back in 2010 and as Apple was involved in the development of HTML 5 this step makes sense.

Some more arguments related to the issues with the Adobe Flash Format expressed by Steve Jobs in a public letter where he stated that when

"**letting a third-party layer of software come between the platform and the developer ultimately results in substandard apps, and hinders the enhancement and progress of the platform."** Jobs (2010).

And this would have the consequences that if

"**developers grow dependent on third party development libraries and tools, they can only take advantage of platform enhancements if and when the third party chooses to adopt the new features."** Jobs (2010)

Apart from that he criticized that Adobe Flash wasn't an open software but completely proprietary which might sound surprising from the founder of a company with basically selling nothing other than proprietary products and software but in his opinion web standards are supposed to be open and accessible for everyone.

Regarding this he stated the following which also clarifies the involvement of Apple in the evolution of the HTML 5 standard.

Figure 3: Steve Jobs https://www.confidentspeak.com/wp-content/uploads/2013/08/stevejobs-845x684.jpg

"we strongly believe that all standards pertaining to the web should be open. Rather than use Flash, Apple has adopted HTML5, CSS and JavaScript – all open standards. Apple's mobile devices all ship with high performance, low power implementations of these open standards. HTML5, the new web standard that has been adopted by Apple, Google and many others, lets web developers create advanced graphics, typography, animations and transitions without relying on third party browser plug-ins (like Flash). HTML5 is completely open and controlled by a standards committee, of which Apple is a member." Jobs (2010)

As one of the most wide spread uses of the Adobe Flash Player however was the implementation of video streaming services how is this supposed to work instead now with the new version and without any plugins making sure various formats are supported and a general accessibility across multiple platforms is secured. This was one of the strengths of Flash as it was widely supported not being restricted to any platform except for as mentioned iOS and as video streaming services are now responsible for a major part of all generated web traffic and videos are basically embedded everywhere a secure and robust solution to this issue is extremely important for the web community. Video traffic already made up more than half of all generated internet traffic, in numbers 57.7 % in 2018. Clement, J.(2019)

With HTML 5 now, a new tag was introduced which solved all these problems.
It's called the <video> tag and as video material isn't the only media which is streamed via the web there was introduced a new <audio> tag too which simplifies embedding audio files in web based applications.
This tag has also quite a significant importance as well as video streaming the amount of audio streaming also saw a major increase in the past years. Perez (2018)

These two important tags will be further explained in the next chapter as well as some of the other most significant tags released in HTML 5.

3.1.1 The Video Tag

Now, there exists a new tag for embedding video files and sources inside the HTML code with the simple <video> tag. But how does it work? How is it implemented? And which requirements need to be met in regards to size, format and data type?
The functionality of the <video> tag is best described as a possibility to embed video content like video clips or video streams inside a HTML document.
As attributes it can handle one or more video sources for example one video in various formats and the browser automatically chooses and displays the first source it supports. This means that the compatibility across multiple platforms and browser environments can be secured. (w3schools.com, n.d.)

In case only one source is added which cannot be displayed by the browser or multiple unsupported sources the text entered between the start and end tag will be shown. However for example the mp4 format which is commonly used is supported by all of the major browser writers like Chrome, Safari, Firefox, Edge and Opera.
Apart from that there are a few more attributes which can be added to further customize and adapt the displayed video. (w3schools.com, n.d.)

Autoplay:
First there is autoplay which as the name suggests can be activated to automatically start the video once it's loaded.

Loop:
With the loop attribute you can also play the video as a loop.

Height, width and muted

Then there are basic attributes like height and width and an option to mute the video with muted.

Controls

The controls for the video can also be switched on or off via the controls attribute.

Poster

In case the web developer wishes to display a thumbnail before and during the video is loading this can be done via the poster attribute which takes an URL as a input.

Preload

With the preload attribute the web developer can control if the video should load when opening the website or not and how it's supposed to be loaded.

(w3schools.com, n.d.)

In chapter 3.3 Example Code there can be seen how the video tag is implemented in practice with various attributes integrated and how this changes the content displayed in the browser window.

Related to the video tag and quite similar in appearance is the <audio> tag which will be described in the next paragraph.

3.1.2. The Audio Tag

The <audio> is another new feature of the new standard and the functionality of it is quite similar to the <video> tag as described previously.
It too takes one or multiple sources in various formats and depending on the browser's support the first source which is compatible is chosen to be played.
Similar to mp4 one of the most common audio formats is mp3 and this is also supported by all major browsers.

WAV, another format allowed in the HTML specification, however is also quite commonly used but is for example not compatible with Edge and the Internet Explorer. In this case for example the behavior of the browser would be the same as with the video tag not finding a compatible format which means there will be the text displayed which can be entered between the start and end tag.
As with the video tag so does the audio tag come with various options in the form of attributes.
However the audio is created a little bit easier as there are not as many attributes which can be added.
Basically autoplay, controls, loop, muted and preload have the same functionality as previously described for the video tag however these are all attributes which can be adjusted and added to the <audio> tag.
In chapter 3.3. some example code is provided to better understand how it's implemented in an actual HTML document. (w3schools.com, n.d.)

3.1.3. Additional Improvements

Apart from the two new tags related to embedding media assets there are several more new tags introduced with HTML 5.
This chapter provides an overview over what was added, what it's used for and how it works.
To begin with the list some of the most useful new implementations are as already mentioned before the new layout tags <header>, <footer> and <nav>.
So here is a little overview how these work.

<header>

This tag is basically a container which is usually integrated in the beginning of the website as it's usually the top area of a website and contains for example banners and headings introducing the content of the page.
It can include for example <p>, <h1-h6> and other tags however not a second header tag.

With the help of CSS it can be personalized to pretty much every layout design a web developer wishes to implement. (w3schools.com, n.d.)

<footer>

The footer area is usually the section at the bottom of a webpage and contains for example links to the impressum and other administrative subpages as well as the contact information and similar elements. As well as the header tag it can be used multiple times in one document and can be customized with CSS stylesheets. (w3schools.com, n.d.)

<nav>

On mobile devices often hid behind a hamburger icon you can find a navigation bar on every website which is used to navigate through the various subpages and links them together. However not every reference to a subpage needs an own navigation tag and this tag is more intended to be used for actual sections of links and can also be styled using CSS.
As basic inputs the link within a HREF attribute and the displayed name need to be entered for a navigation entry. (w3schools.com, n.d.)

Additionally there are some more new tags like <canvas> which creates a space for JavaScript applications to be embedded.
Then there is <article> which for example defines the main content of a webpage and <figure> which can be used to define an image linked to an article.
The <section> can be used instead of to divide the webpage into segments and also helps clarifying the structure of documents.
Then there is the <aside> tag which enables web developers to create for example a sidebar used for additional information or other content. Kyrnin, J. (2019)

As at the date of writing the latest version of HTML 5 is 5.2 there some more changes which were added since the release of HTML 5.0 which also need to be covered to provide a comprehensive overview. IONOS (2020)

Introduced with HTML 5.1 there is now officially a <picture> tag as well as advanced functionalities for the input element.

<picture>

The picture tag makes it more efficient and flexible to integrate images in documents with multiple image sources.
Therefore, web developers can link multiple images and for example improve the responsibility of the website by uploading various different sizes which can be optimized to fit different screen sizes.
This is automatically done by the browser through identifying the current screen size and looking for the matching media query. And additionally a regular <img> element needs to be included. IONOS (2020)

<input>

The input tag which is used to handle user inputs for example in forms has gotten more functionality with the release of version 5.1 to support the input types e-mail, number, url, time and date. Therefore users can now enter days, months, times and even calendar weeks. IONOS (2020)

After version 5.1 the next update HTML 5.2 was released in 2017 and brought some additional improvements.
New features introduced are various security methods to reduce the risk of cross-site-scripting, a new API for online payments to simplify the e-commerce process, new rich content features to improve accessibility for disabled users and an update to the <main> tag which now supports responsive design layouts.

To the time of this writing there is only a draft available of the next version of HTML 5.3 which will be described in chapter 4 regarding an outlook of the technology.
The next chapter will give an overview over the general architecture of HTML5.

3.2 Architecture

In this chapter the architecture of modern web applications implementing HTML 5 is explained and discussed.
Understanding the various components used in the development of web applications is the first step to explain the functionality.
In general there are two main categories which need to be considered.
There is the client side Code and the server side Code.
Swapnil, B.(2020)

Client Side Code:

This is where HTML 5 comes to play as this is the layer which can be seen by the user and offers the interaction layer in the form of HTML5 websites with CSS style sheets and some JavaScript or similar scripting language.
This Side is also often referred to as the Front end and development of this layer is usually called Front End development.

Server Side Code:

On the other side there is the Server Side Code which as it cannot be seen by the user is called the Backend. Here basically every scripting language can be used which can respond to HTTP requests as this is the only way of communication between the two sides. Examples for this are PHP, Python , Java, JavaSript, C#, Ruby and more.
The Backend handles all server related requests and basically adds the functionality to most websites as for example e-commerce platforms, streaming services and basically every other website needs a webserver to be deployed on and usually any sort of database which manages and stores content and other data.
Swapnil, B.(2020)

These two sides are the structural components of every web application and additionally there are the UI/UX components which are individual elements and features implemented at the Front End and are basically interface elements.

The client component is as already mentioned before built with HTML, CSS and JavaScript whereas the Server component is managed and consist of usually two parts a logical layer which controls the data and a database which actually stores the data and is developed in one or more scripting languages like php, python, java, NodeJS and more. Swapnil, B.(2020)

Now to actually connect these components and create the application there are various options and **models**.

Single webserver, single database:

The simplest implantation would be using one server and one database which is easy to deploy however has the downside of being dependent on the one server to work. As soon as the server is down the website is down as well.

Multiple webservers, single database:

Another approach is to use various web servers and one external manged database which reduces the risk of downtimes as if one web server fails there are still one or more other servers to handle the requests. This configuration is called stateless architecture.

Multiple webservers, multiple databases:

In this model there are multiple webservers and multiple databases which reduce the risk of downtimes to a minimum and therefore this makes it the most efficient model. The data can either be stored with exact duplicates in each database or it can be distributed on all databases depending on the requirements and concepts the web developer has in mind.

Swapnil, B.(2020)

In terms of **architectures** there also are various different approaches to develop a web application.

Single Page Applications (SPAs)

First there are SPAs which basically eliminate the need for the application to reload the website every time a user takes action and use AJAX to dynamically deliver the updates to the webpage.

This technology enables applications which are similar to desktop tools as a continuous workflow is possible due to no interruptions occurring during the process.

Microservices

Microservices execute are single action and therefore are small and easy to deploy.

As web developers can implement more than one microservice in an application and these do not need to be dependent on each other they can be written in different languages and therefore can speed up the development process.

Serverless Architecture

When web developers are setting up a web application but don't want or can develop and maintain the infrastructure components and therefore use a cloud service for outsourcing the architecture of the application is called serverless architecture.

Swapnil, B.(2020)

3.3. Example Code

In this chapter some of the previously described concepts and elements are visualized with actual code examples to create a better understanding of how this technology is implemented in real world applications.

Let's start the overview with the **<video>** tag:

```
<video width="640" height="320" controls>
<source src="space_x.mp4" type="video/mp4">
Your browser does not support the video format.
</video>
```

Figure 4: video tag - code

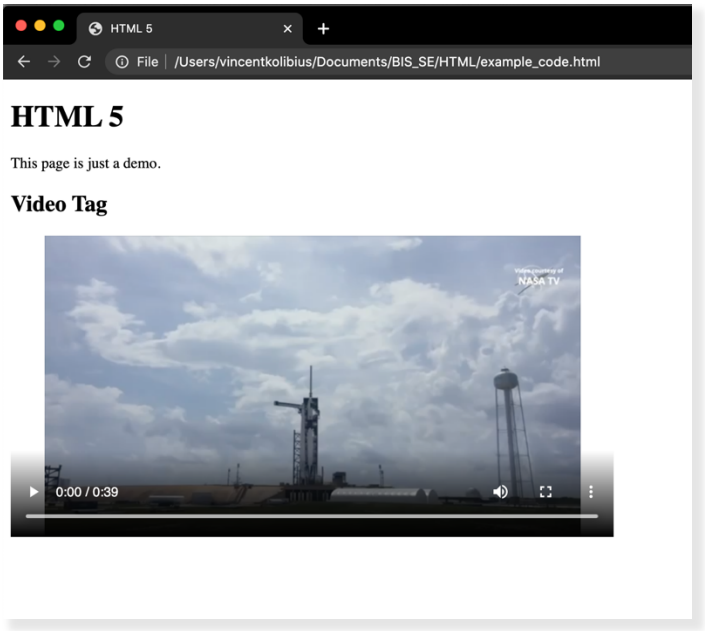

Figure 5: video tag - browser view

Next up the **<audio>** tag

```
<audio controls>
  <source src="dogs_audio.mp3" type="audio/mp3">
  Your browser does not support the audio format.
</audio>
```

Figure 6: audio tag - code

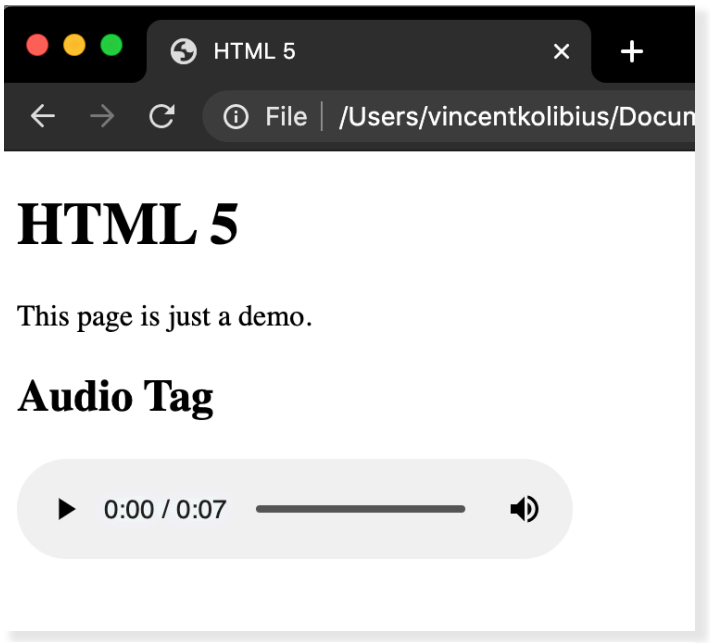

Figure 7: audio tag - browser view

The **<header>** tag with some inline CSS:

```
<header style="background-color: navy";>
  <h1 style="color: white";>Welcome to the demo</h1>
  <p style="color: white";>The latest HTML5 news</p>
</header>
```

Figure 8: header tag - code

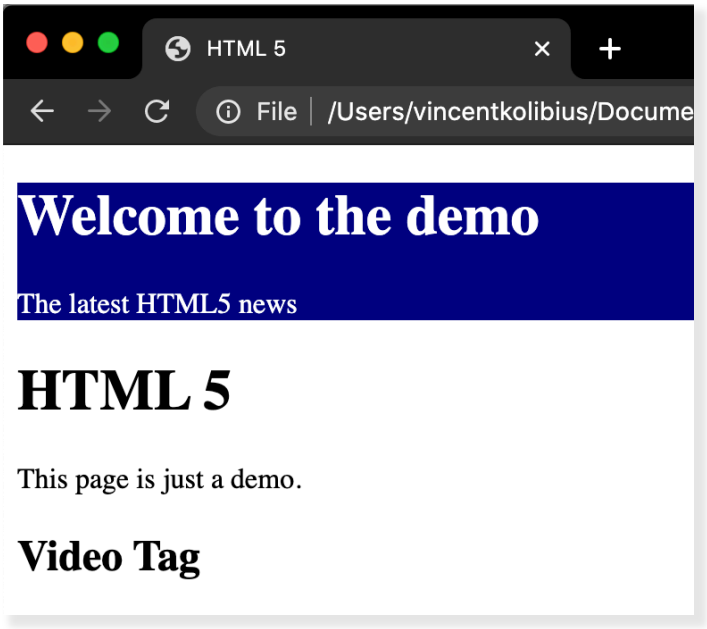

Figure 9: header tag - browser view

3.4. XHTML & Semantic Web

Apart from HTML there exists another very interesting technology which is also developed by the W3 Consortium and is basically a combination of HTML and XML. It's called XHTML and was developed to extend the functionality of HTML as well as the compatibility of various different document types.

As HTML is based on the SGML as described in the beginning of the paper the rules are quite strict and XML however was in various ways more simplified and easy to use. So to make the web development process more efficient and easier to implement.

As another issue with HTML at the time was that many browser tended to not being very strict with errors in HTML code and still displayed the website with errors XHTML got a more restrictive error handling system to gain more control.
XHTML is based on the XML syntax and the hopes were that with the combination of the two Markup languages there would be more compatibility between various data and document types and popular XML tools could also be used for XHTML adaptions. Wikipedia (n.d.)

Due to being quite similar to HTML 4 the first version of XHTML was broadly accepted by various browser writers and therefore some web developers transformed and transited to the new language.
And by offering tips on how to develop XHTML websites close to the structure of HTML websites even browser not supporting that language were able to display the website. Wikipedia (n.d.)

One of the major benefits of XHTML was the ability to be parsed by basic XML parsers rather than specialized HTML parsers which were necessary for the regular Hypertext Markup Language.
However with the Internet Explorer denying support and the benefits of XHTML being questioned Tim Berners Lee had to announce in 2006 that the effort of the W3 Consortium to change web content to be written in a XML based language didn't work and soon after the support for XHTML was dropped.

There were two major versions. XHTML 1 released in 1998 as a working draft and became a recommendation in 2002.
The second version which was even more criticized was developed between 2002 and 2006.

After admitting that the attempt to transfer web development to XHTML failed the W3 Consortium decided to shift its focus towards the new version of HTML.
This fifth version implemented some of the initial ideas and advantages from the XHTML concept and even is available in either a HTML serialization or in a XML

serialization and therefore the community settled on the fact that this is going to be the web development language of the future. Wikipedia (n.d.)

Another Concept is the so called Semantic Web.
As well as most other technologies in this paper is developed and researched by the W3 Consortium and with that from the inventor of the web Tim Berners Lee.

The current web we know is one of documents. So text embedded in websites is basically only a string for the computer. So for example a city name like Vienna is just a string and when searching for Vienna the web only looks for this particular string. The idea of the Semantic web is to create a web of data which refers to the concept of the W3 Consortium to develop a web of linked data.
This means that for example the browser would recognize the string Vienna not only as a simple string but as for example a city. Therefore the web can become a richer environment and especially automated tasks can be more efficient than ever.
This can be reached with so called ontologies, one of the popular new languages being the Web Ontology Language OWL, which basically create vocabularies which as the example with Vienna adds more meaning to data. w3.org (n.d.)

3.5. Critics

With the release of HTML 5 there were some critical voices especially considering the potential implementation of the digital rights management system called Encrypted Media Extensions EME.
This was mainly pushed by big companies and enterprises like Apple, Google, Microsoft and BBC as it can be used to protect digital media like video streaming services.
However there was even a petition started in 2013 against the implementation and it took until 2014 for all major browser makers to support the digital rights management solution with Firefox being the last one to implement it.
The W3 Consortium therefore wasn't sure at that point if it will be integrated in HTML 5 however now it is a recommendation of the Consortium and broadly accepted.

4. Outlook

After the release of the second update to the HTML 5 specification in 2017 the W3 Consortium as well as the WHATWG Group immediately started working on what will become the next recommendation of the Consortium with the release of the third update HTML 5.3 which is yet to be finalized.
The current working draft can be found on the W3 Consortium's website and the WHATWG group has set up a Github page where the community can openly contribute and exchange ideas and issues which to further improve the web as we know it today and integrate the wishes from the whole community.
This makes the process very transparent and increases the openness of the groups work. Therefore, decisions can be comprehended and the motivations and reasons are communicated openly.
So it will be interesting how the web will evolve in the next years especially considering new concepts like the semantic web and the new possibilities created by HTML 5.

5. Conclusion

After learning about the exciting beginnings of the internet and the various groups involved with their in parts different aspirations it is incredible that this kind of technology evolved to the point it is today and generated so many new possibilities and opportunities as well as completely changing the way most things are done today.
HTML started as a small personal project of researchers at CERN to exchange information with other institutes around the world and evolved into a language used to create millions and millions of websites and applications from users and web developers from all over the world.
Even though there were some obstacles to overcome and some groups had to compromise on their opinions the overall outcome and development of the language worked quite seamlessly until the release from the fourth version of HTML.

After that there existed two main approaches which on the one side was the further development of HTML by the WHATWG Group which was in parts led by companies like Apple and Mozilla and on the other side the efforts of the W3 Consortium and with that the efforts of the inventor of the www Tim Berners Lee to create a XML based version of HTML called XHTML. After a few years however the WHATWG group was able to take the lead and the two groups started collaborating on the newest version of HTML. HTML5

This version introduced many new features and replaced missing or weak functionalities with new frameworks and possibilities.
It also integrated some of the major advantages which an XML based version would have had so the best of both worlds is combined with the new release.
Some of the major new features are the new tags <video> and <audio> which remove the need for plugins to stream and display video/audio files as well as new layout tags like <header>, <footer> and <nav>.
Additionally new APIs were created which support the rendering of 3D objects with the local resources of the computer as well as new components for payment APIs to improve the processes of e-commerce platforms.

HTML 5 clearly can be considered as the future of the web and it will be exciting to see how it will evolve in the next few years and which new opportunities will be enabled by this technology.

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