How Computers Work – 'Software'

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Topics of Discussion

What is Software?

▶Software is a set of instructions that tell computers what to do

▶Includes the entire set of programs, procedures, and routines associated with the operation of a computer system

▶The term 'Software' was given in order to differentiate instructions from hardware

▶The four types of software are system software, application software, programming software & driver software

Types of Software

▶System software helps the user, hardware, and application software to interact and function together. System software is designed to provide a platform for other software. An example would be an operating system like macOS

▶Application software is defined as any program designed for end-users. These types of software are productive programs that help you perform tasks. It is a broad term, but an example could be MS Excel

▶Programming software are programs that are used to write, develop, test, and debug other software. They are mainly only used by developers and an example would be Notepad++

▶Driver software translates commands of an Operating System for the Hardware or devices, assigning duties. Usually, the operating system comes built-in with drivers for mouse, keyboard, and printers by default. An example would be a Printer Driver.
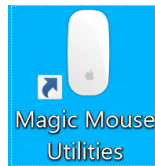
Spotify

▶ **Spotify** is a digital music, podcast, and video streaming service that gives you access to millions of songs and other content from artists all over the world

▶ **Spotify** is available across a range of devices, including computers, phones, tablets, speakers, TVs, and cars

▶ Spotify has **299 million users** (**Paying: 138 million**)

▶ Founders - **Daniel Ek** & **Martin Lorentzon**

▶ Launched - 7 October 2008 **12 years ago**

▶ Founded - 23 April 2006; **14 years ago**
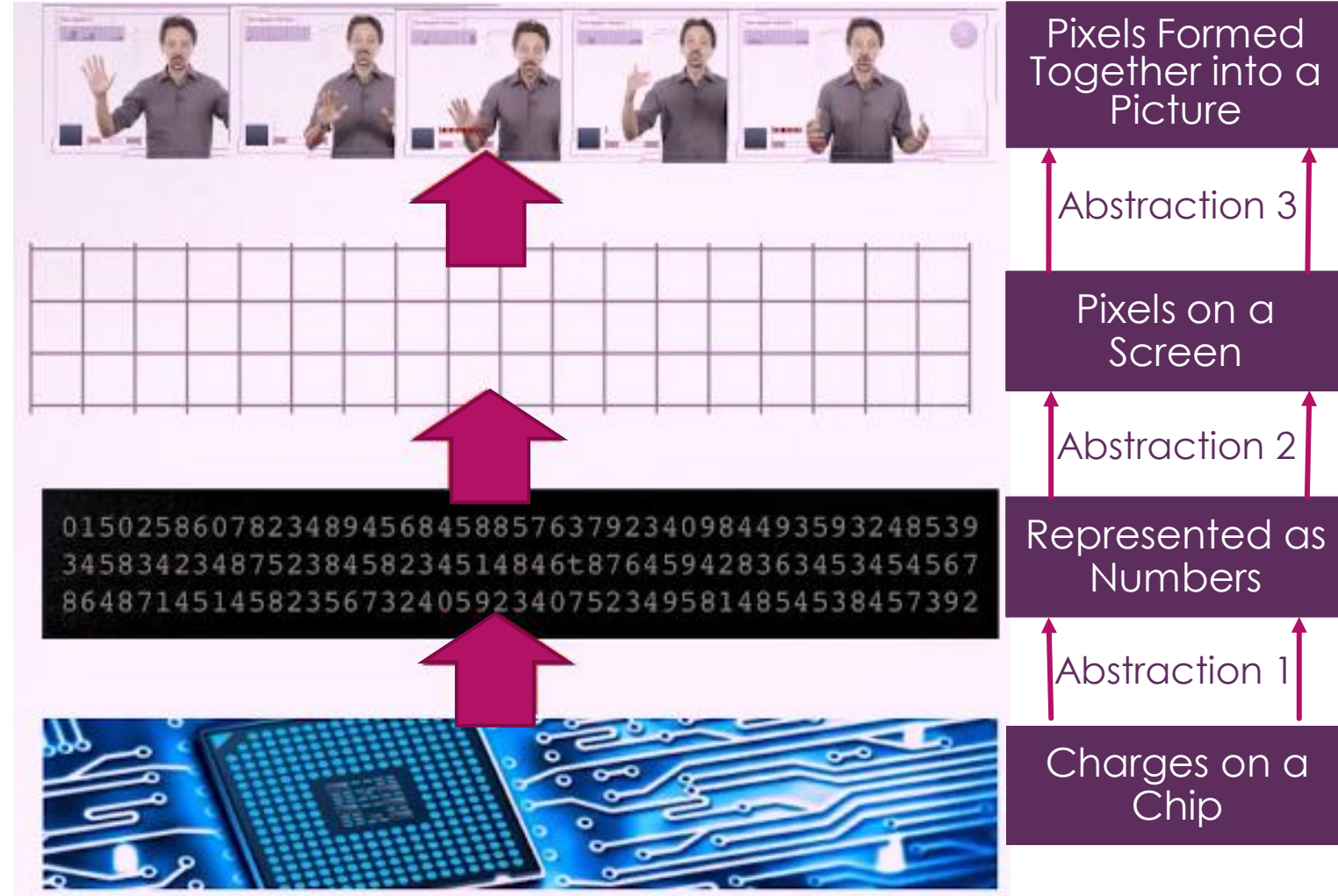
▶ Employees - **4,405** (2019)

▶ Headquarters - Operational: **Stockholm, Sweden** Corporate: **New York City, U.S**

▶ **https://www.spotify.com/uk/**

Abstraction

- Abstraction is a **simplified representation** or **way of thinking** about a piece of software that **emphasises the key details**

- The **most basic** abstraction is to represent things as **numbers** (almost any data can be represented this way)

- Abstraction is **key** to understanding how computers work

Pixels Formed Together into a Picture

Abstraction 3

Pixels on a Screen

Abstraction 2

Represented as Numbers

Abstraction 1

Charges on a Chip

Abstraction – Notional Machines

▶ Notional Machines is an abstraction of the **actions** the computer performs

▶ Notional machines are mostly to help you understand specific applications or pieces of software

▶ The **Spotify** Player, for example, streams an audio file which is delivered in small packets, so the data is buffered on your computer and played pretty much straight away.

▶ The player opens the packets and lays the data out on a timeline on the player. The Play Head identifies the position of the song being streamed

▶ A more complex would be understanding that when we use the pause and play button, all we're doing is automatically moving forward after every fragment of the data being streamed and then at the end we can pause and stop
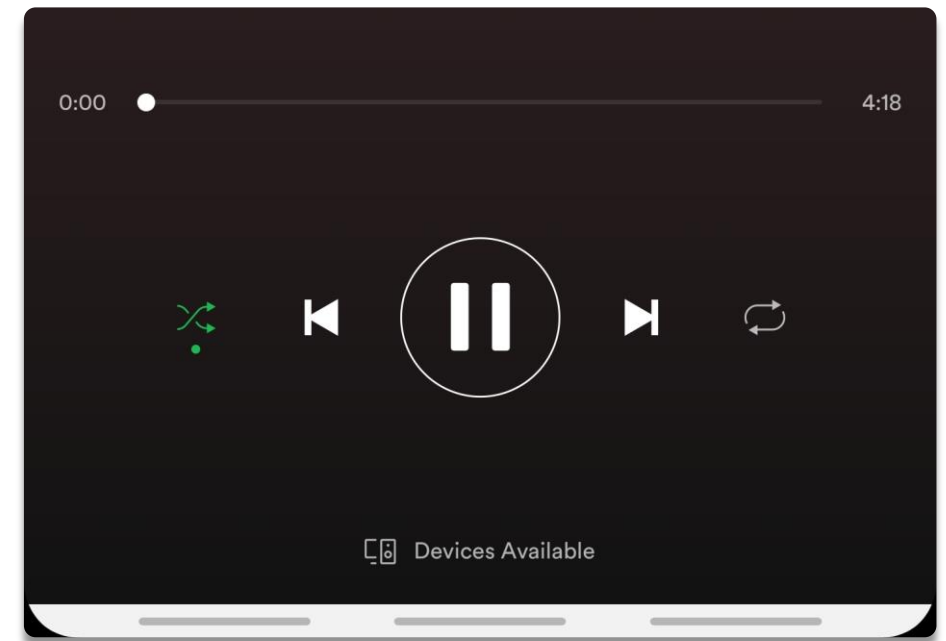
Abstraction in Spotify

- **Spotify** is a music streaming software

- Music streaming is a **complex infrastructure** of **hardware, software, networks, encoders, decoders,** and **other devices**

- Whenever an audio file is streamed, first it is **converted** into **small chunks of several data packets** using **encoders** which is then pushed to the **network** for transfer through the **internet**

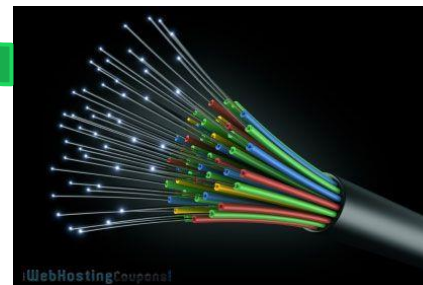## Example of Abstraction in Spotify
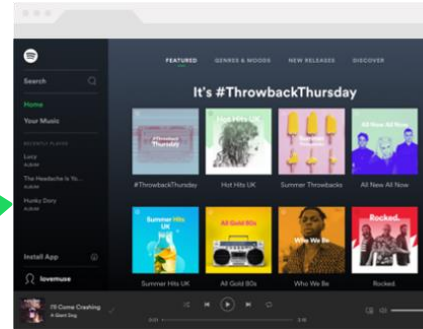
Data formed together and played on the menu of the **Spotify** software
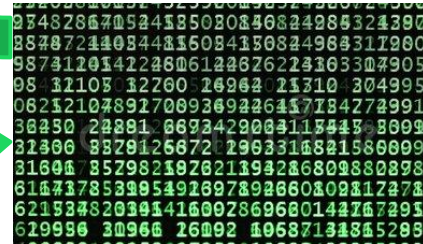
The data being streamed through the **Spotify** software can be represented as LOTS of numbers

Information from **Spotify** being processed through the electromagnet waves from the Wi-Fi signal to the device

Tiny Pulses of light in the optic fibers carrying the information from **Spotify** across the internet

Least Complex

Most Complex

States

State commonly refers to either the present condition of a system or entity

What does this Mean?

▶ There are examples of **'state'** all around

▶ Example: The computer is off/on

▶ These are two different states the computer can be in

Spotify States?

▶ The Spotify Player has two States

▶ Its first state is **Paused**, when the application is opened the player is paused meaning the music is not playing

▶ Its other state is **Playing**, this means the music is being played

▶ To move between the states, the user must tap the pause or play button

Tap **Play** Button

Music Plays

Music Stops

Tap **Pause** Button

0:00   4:18

Devices Available
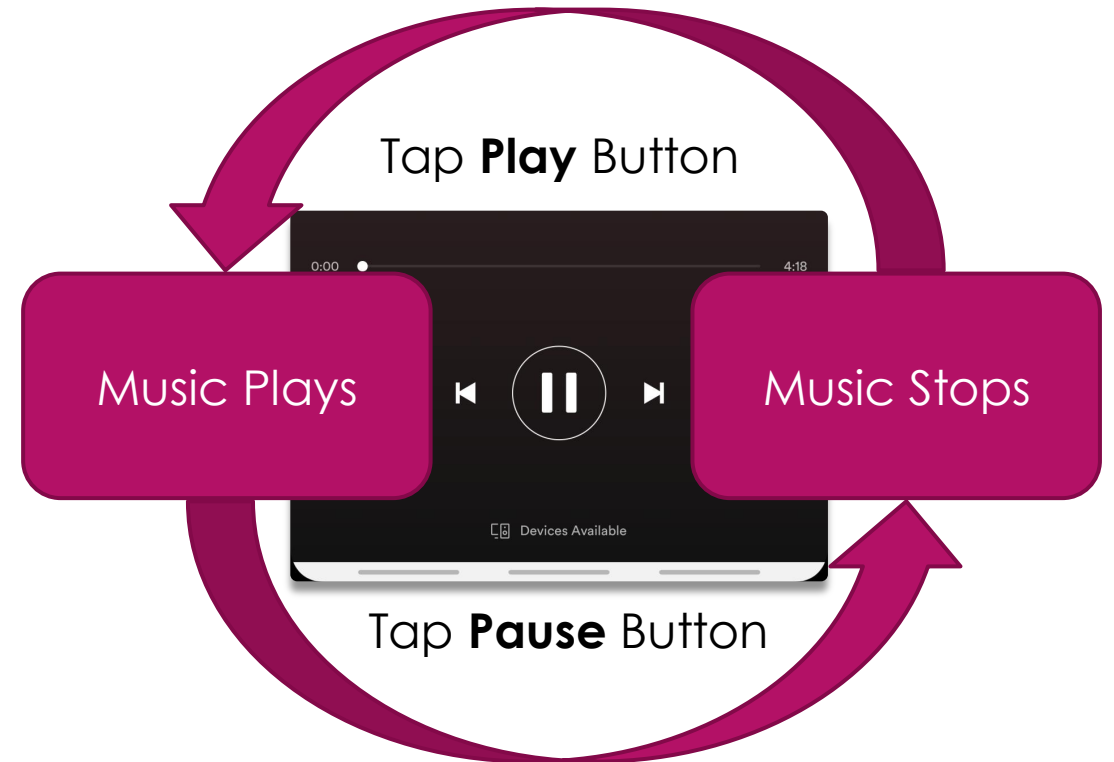
Changes of State in Spotify

Internal

▶ Playing the next song once a song has finished, suggested or selected

▶ Playing an Advert in between songs (if you don't have Spotify Premium)

▶ Music can Buffer if the Wi-Fi is too slow or the device does not have enough RAM to run in the background
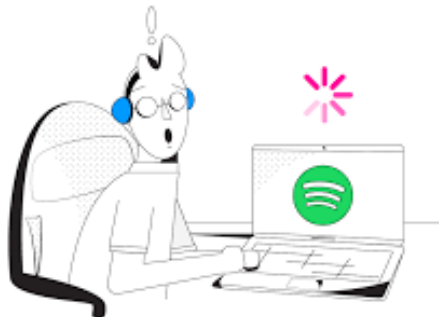
External

▶ Using the Pause/Play Button will pause or play the music

▶ Using the search bar to find a new song

▶ Adding a song to the current playlist or saving a song so that it is downloaded
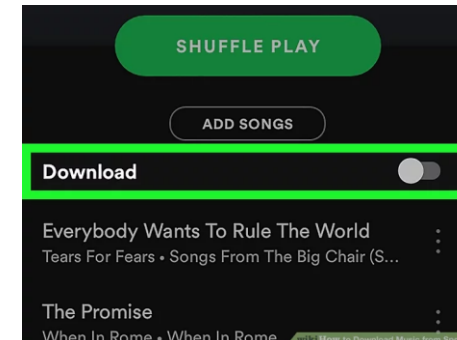
CPU & Memory

CPU

▶ The Central Processing Unit (CPU) is the chip that does all the calculations of a computer

▶ The CPU takes input from the computer's RAM, decodes and processes the instructions, before returning an output

Memory

▶ Also known as the Random-Access Memory (RAM)

▶ RAM stores the information your computer is actively using so that it can be accessed quickly

CPU & Memory Working Together

▶ The CPU chip retrieves data from the RAM. The chip takes those instructions and begins to move and process data through the motherboard in the correct order to its next designated location.

Data to Memory

Next Designated Position

Data from Memory

How Spotify uses CPU & Memory

If the Song is Downloaded/Saved:

▶ It is loaded from hard disc into memory.

▶ At regular intervals some of the data will be read from memory(most likely the Direct Memory Access) by the CPU

▶ Direct Memory Access (DMA) allows the audio data to be copied from memory to the sound card without going through the CPU

▶ This frees up the CPU for other things

If the Song is being Streamed:

▶ As the music is being streamed the performance is mainly down to the Bandwidth, however, RAM can mitigate poor WI-FI as RAM affects the storage available for buffering.

Task Manager
File Options View

| Processes | Performance | App history | Start-up | Users | Details | Services |

		4%	38%	1%	0%
Name	Status	CPU	Memory	Disk	Network
Apps (3)					
> ▦ Microsoft PowerPoint		0%	307.9 MB	0 MB/s	0 Mbps
> ● Spotify (6)		2.4%	266.7 MB	0 MB/s	0.1 Mbps
> ▦ Task Manager		0.1%	48.8 MB	0 MB/s	0 Mbps

Saved Music (Uses **more** CPU & RAM

Streaming Music (Uses **less** CPU & RAM)

Task Manager
File Options View

| Processes | Performance | App history | Start-up | Users | Details | Services |

		2%	40%	0%	0%
Name	Status	CPU	Memory	Disk	Network
Apps (4)					
> ● Google Chrome (15)		0%	991.9 MB	0.1 MB/s	0 Mbps
> ▦ Microsoft PowerPoint		0%	254.4 MB	0 MB/s	0 Mbps
> ● Spotify (6)		0%	76.1 MB	0 MB/s	0 Mbps

Modularity

▶ **Modularity** is about creating **systems** that are made up of simple **modules** that **interact** with one another

▶ **Modularity** isn't just for **hardware**; **software** is just as, if not **more important**

▶ Developers make use of existing elements from the **Operating System, Open-Source Software** or other **Developers Code**

▶ An **example** of **Modularity** would be **Driver Software**

▶ **Modularity** is **essential** for **developing code** and **understanding code**
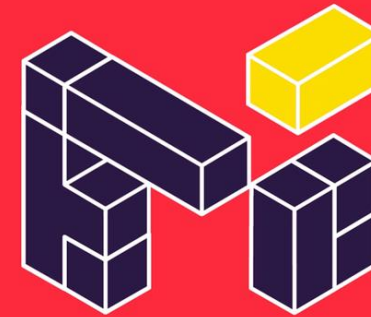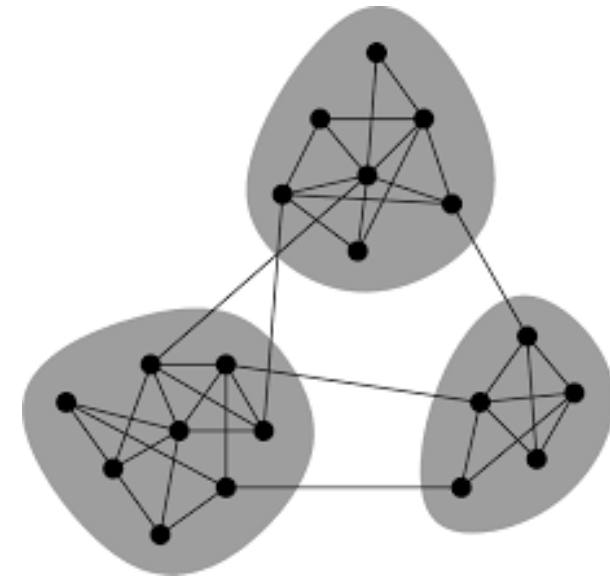
Modularity of Spotify

Spotify

The User

Spotify Developers would have had to write code specific to the user, such as creating a database for their users & making the site/application as simple to use as possible.
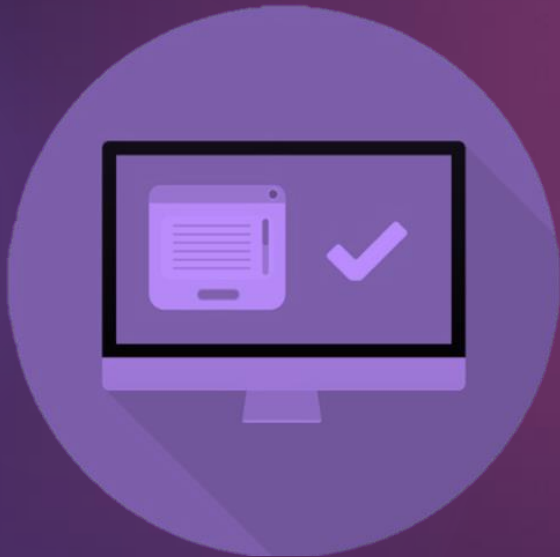
The Music Player

The Development Team would've split this into a module to efficiently design and build a unique and effective music player
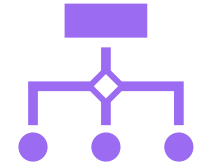
The Music Library

The Music Library would've been split into many modules as there would've been many aspects of code to make the music library perform all it's functions

Applications

An Application is a computer **program, or cluster of programs**, that are designed for an **end user**
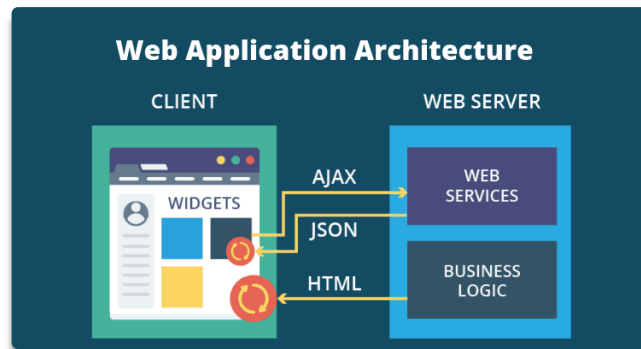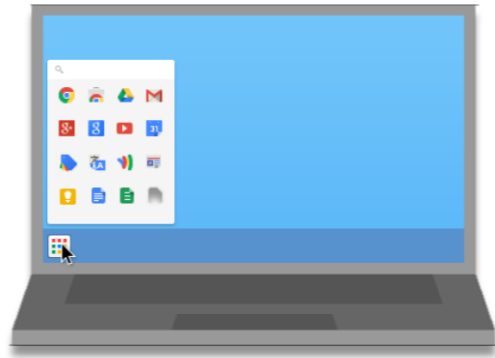
Conversely, **System software** consists of programs that run in the background, **enabling applications to run**.

The **Application Data** contains data created by programs. These application data files are normally called **resource files**.
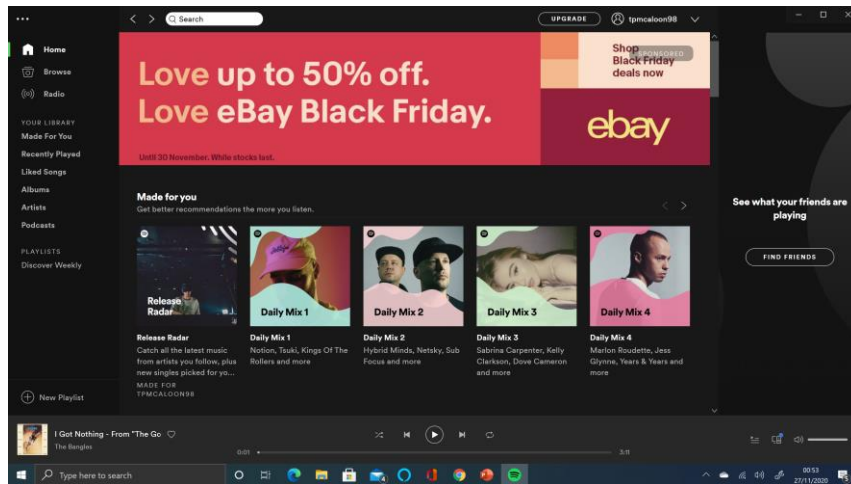
Application Software & Web Application

▶ **Desktop apps (Application Software**) are computer programs and don't need an internet connection in order to be used, they are downloaded to your Computer. Some examples of Application Software would be **Microsoft suite of products (Word & PowerPoint)** or **Internet browsers (Chrome & Safari)**

▶ **A Web Application** doesn't require any installation and runs on your web browser, it requires constant internet connection to run. Some examples of a web application would be **Facebook & Gmail**
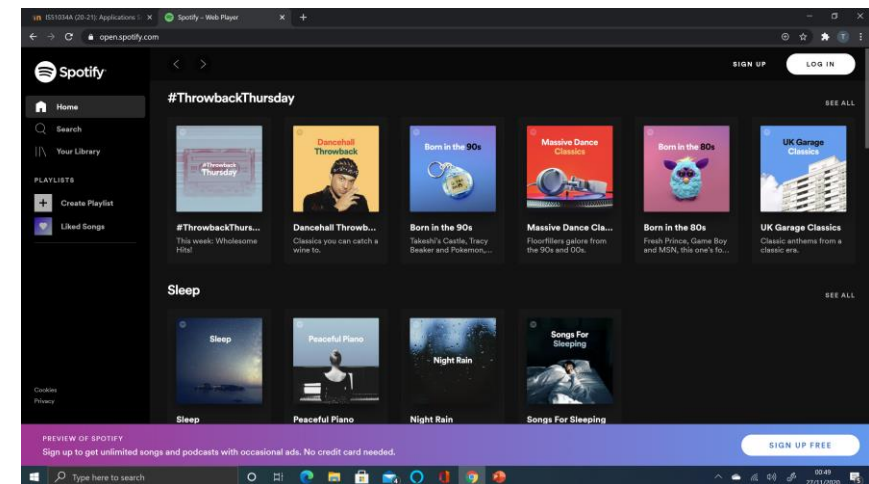
Web Application Architecture

CLIENT   WEB SERVER

WIDGETS

AJAX

JSON

HTML

WEB SERVICES

BUSINESS LOGIC

Spotify's Applications

Application Software

▶ Doesn't require WI-FI to work

▶ More Secure

▶ More customisable

Web Application

▶ Doesn't Require an Install/Updates

▶ Accessible from anywhere with WI-FI

▶ Should Work on any device that can access the web

How different technical choices or situations would affect the system ?

- There are elements outside the computer that can affect the system itself such as poor WI-FI/Network Outages

- This would prevent the computer communicating outside of it's LAN

- Therefore, the computer would not be able to use the Spotify web application & elements of the Spotify Desktop Application

- Spotify could release an update to Spotify's Desktop Application which could contain very large files

- This could make the application run slow depending on the hardware and could also be inconvenient for the user as they may not have sufficient storage

- If the User has multiple applications running at once, the applications will run slow and the entire system will run slow,

- However, this is dependant on the hardware of the system, particularly their RAM

- The more RAM they have, the less likely this will affect the PC

References

- https://goldsmiths.cloud.panopto.eu/Panopto/Pages/Sessions/List.aspx

- https://knowledgeplace4all.blogspot.com/

- https://www.goodcore.co.uk/

- https://www.spotify.com/uk/

- https://networkencyclopedia.com/web-application/

- https://www.howtogeek.com/177846/chrome-brings-apps-to-your-desktop-are-they-worth-using/

- https://www.pnas.org/content/103/23/8577

- https://www.edenspiekermann.com/insights/designing-for-modularity/