MCOMD3HPC – High Performance Computing Assignment 1

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**Chosen domain: Stock Market Analysis**

# Task 1 – HPC?

High Performance Computing is used primarily by researchers and scientists for ‘computationally intensive tasks… it’s power comes from connecting multiple HPC nodes into a cluster’ (Intel, 2020). It is when multiple high-powered computers are connected together to be used for tasks that cannot be done using regular devices. HPC is becoming much more commonly used, with services like AWS and Azure allowing people to rent out HPC services, for purposes like server hosting, analytics and IoT.

The most commonly used HPC solution is cloud computing (CC), for example Google drive. This is an example of a centrally hosted service that can be accessed anywhere through the internet. Now, HPC is being used by everyday people more than ever before.

HPC is increasingly being used in a wider range of fields, such as analysing the stock market. CDW (2016) state that brokerage firms ‘rely on HPC systems to gather, parse, analyse and act on vast amounts of data.’. Pattern recognition is a key skill in being able to successfully play the stock market, being able to look at previous data and patterns as well as outside factors can give brokers an edge. Whilst HPC prediction is new, HPC has already had a huge impact on how stocks are traded. HPC also has been used by PayPal to improve security by ‘detect(ing) patterns and anomalies and take(ing) action upon those before the user experience is negatively impacted’ (Trader, 2014).

Services like AWS have given access to HPC analytical tools to a wider range of people than ever before.

In the future, HPC is set to become faster, with developments like edge networks and omnicloud. Edge networks are: ‘a distributed computing framework that brings enterprise applications closer to data sources’ IBM (2020). the lower bandwidth is beneficial to stock analysis as time sensitive calculations can be more viable.

There is a large overlap between using HPC for behavioural and stock market analysis. Prices can be affected by very human factors, progress in one area will benefit the other. An example of this is the work done by Landis and Cha (2020), they designed a system using machine learning to help calculate values:

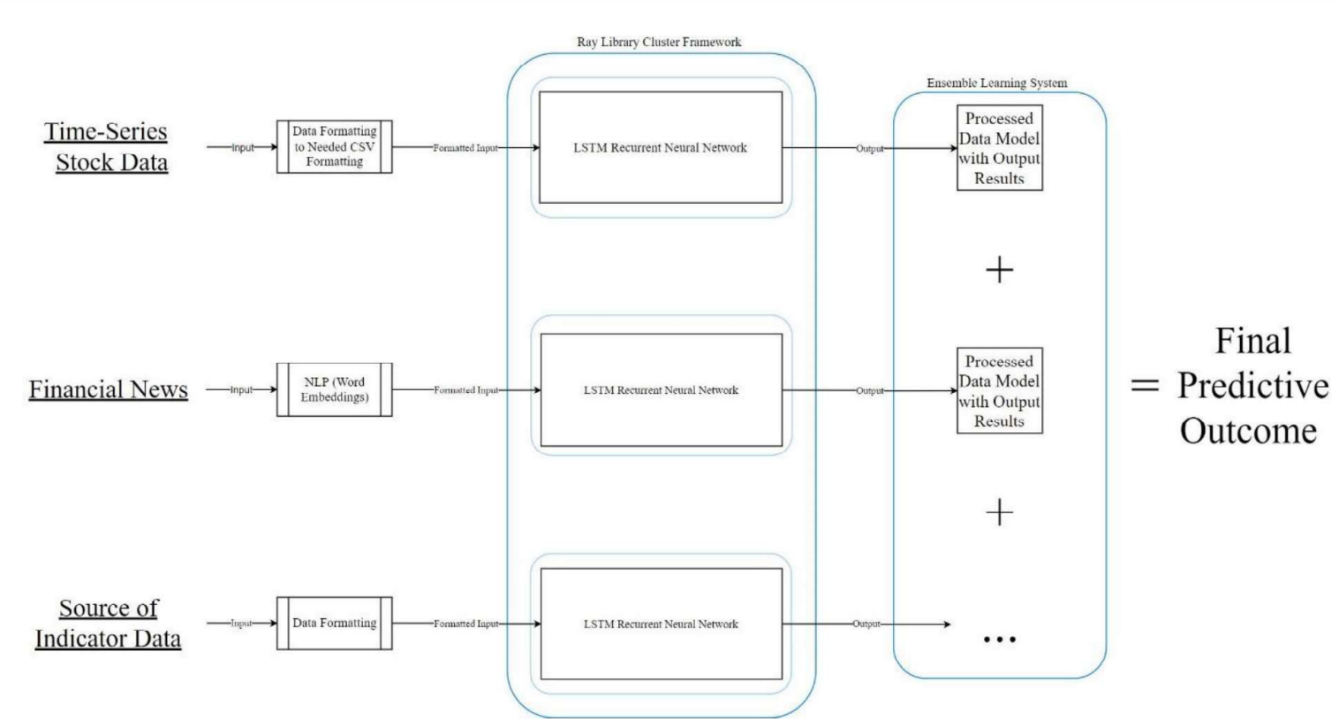


Figure 1- Hypothesized predictive system utilizing ensemble learning architecture[[1]](#footnote-1)

It takes into account financial news to handle outside factors. At time of publication, this method had not yet been tested and experimented on. If Harvard scientists have not yet been able to find a way to do this, it shows that this is a very new field which the company should take advantage of as soon as they can, before others do.

# Task 2 – R&D

Currently, there are two main solutions to allow a business to have access to HPC. The most common is Cloud Computing (CC) services. However traditionally, a business would build their own In-house Cluster (IHC).

## Cloud Computing (CC)

The simplest description of CC is ‘a virtual pool of shared resources offering compute, storage, database, and network services that can be rapidly deployed at scale’ (Huntington, 2019). There are 3 main cloud service models: Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS).

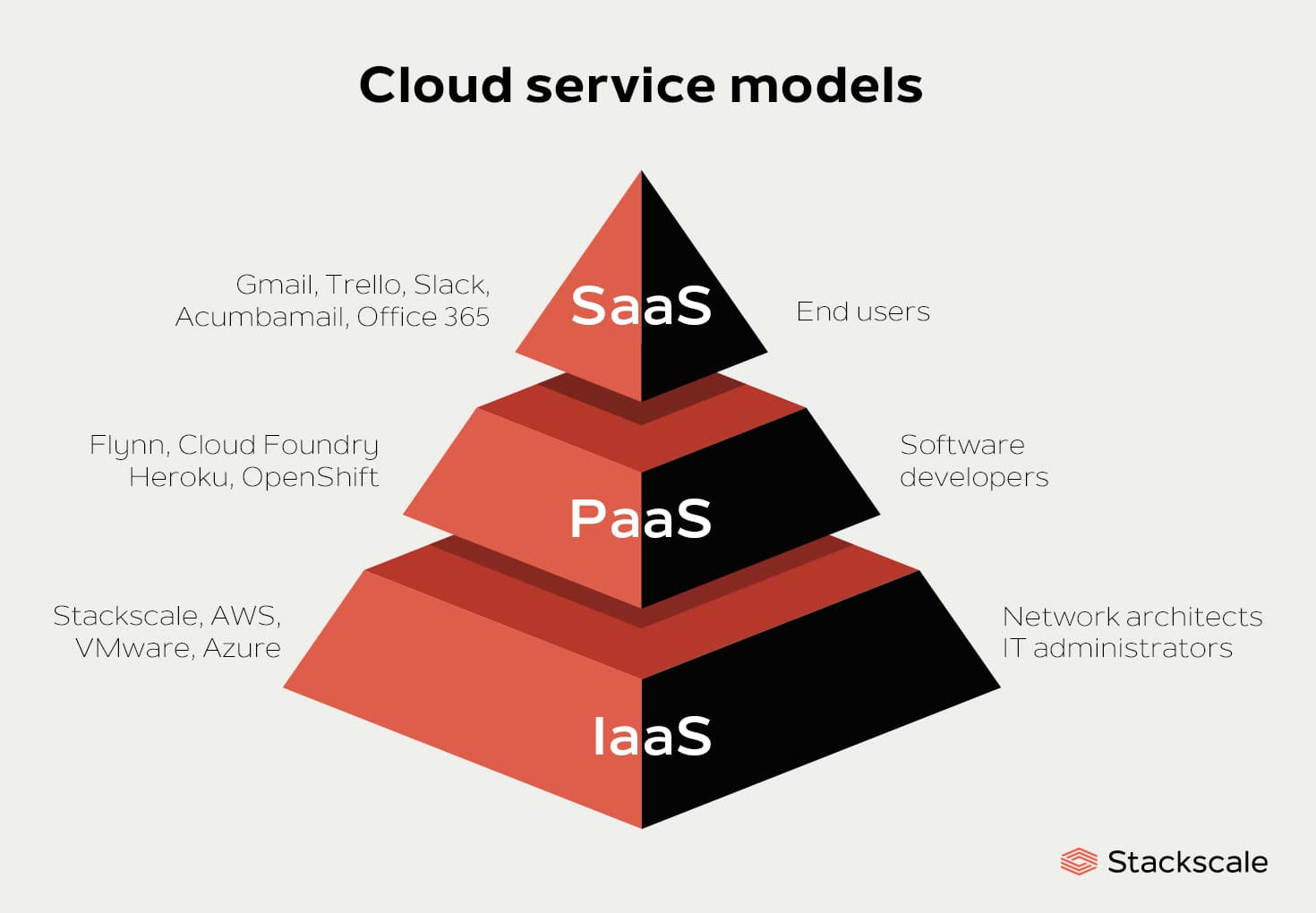


Figure 2- Description of cloud service models[[2]](#footnote-2)

PaaS works in a similar way to IaaS, except ‘the OS falls on the side of the provider. All you have to do is create the app, while the provider worries about updating the OS and keeping it secure.’ (Gracjar, 2017)

Outside of these three models is serverless. This is a newer development. The developer simply has to write the code, all of the security, scaling, and general server management are handled by the provider. This is closer to the ‘pay for what you use’ mantra for regular CC, as everything scales automatically as opposed to still having to pay for several resources, whether or not the project is at that time using all of them.

### Pros of CC

The key source of benefit to CC services is the ‘pay what you use’ idea. The developers pay only for the resources the project needs (pricing structures vary depending on the service model). Some of the main pros include:

|  |  |
| --- | --- |
| **Pro** | **Description** |
| Low infrastructure | Only infrastructure needed is a stable internet connection. Money is saved by not having to hire dedicated engineers and staff for IHC, energy consumption will also be lower. |
| Economic growth | CC is growing exponentially, and is projected to continue doing so, as displayed in Figure 2:  U.S. cloud computing market size, by service, 2018 - 2028 (USD Billion)  Figure 3- Graph showing growth and projected growth of US Cloud computing market[[3]](#footnote-3)  Growth in CC means more people in industry who are familiar with how it works, and competition between the giants who run the services (Amazon, Microsoft etc.) will keep costs lower. |
| Always available | Service should always be usable, even if scaling is taking place e.g. increasing memory needed, the CC will still be available to be used. |
| Keep data offshore | US authorities are able to access data in data centres. EU authorities are less strict, depending on what data is being used this could be a benefit, you can specify to store data in other countries. |
| Spin up time/ Immediacy | Getting set up and started is going to be much faster with CC since the hardware already exists, development work can begin sooner. |

### Cons of CC

There are however several downsides to CC:

|  |  |
| --- | --- |
| **Downside** | **Explanation** |
| Long term cost | Over time, the resources needed will increase and so the costs will scale. After a certain point, the cost benefit of using CC is lost as it may have been cheaper to invest in an IHC. |
| Geography and latency | ‘Without low-latency interconnects, cloud usage will be effectively impossible for massive MPI jobs typical of the most ambitious “grand challenge” research’ (Downing, 2018). If the connection is too slow then by the time data is processed the result could be outdated (particularly the case for up to the minute data like stock prices). If a data centre is far away, there will be higher latency. |
| Access to data | It is considered ‘very unwise to host that (sic) data in the US. Across the Pond, the US government has a lot more access to data than just about anywhere in Europe. Data centre pricing may be less expensive in the States, but it can also be riskier as well.’ (Carter, 2017). Since the company is in Silicon Valley, this is an important factor. |
| Reliance on big tech | Google, Microsoft and Amazon all run CC platforms, and have a poor track record with regards to handling customers data, despite promising security. Also, if one of the providers where to go down, (either going bust or data centre damage) the work would be lost, and the hardware needed will be unavailable. |

## In-House HPC Cluster (IHC)

Whilst it appears IHC solutions are extinct due to popularity of CC, much of the growth has been in SaaS. Consumers are using cloud products exponentially more than in the past. This growth is not as dramatic for IaaS and PaaS services, which are more commonly used by developers (see Figure 3- Graph showing growth and projected growth of US Cloud computing market).

Using an IHC would involve buying the components needed and building the cluster on site. The main parts needed according to Iowa State University (2020) are:

|  |  |
| --- | --- |
| **Part** | **Explanation** |
| Headnode or login node | Where users log in |
| Specialized data transfer node | (Self-explanatory) |
| Regular compute nodes | Where majority of computations is(sic) run |
| “Fat” compute nodes | Have at least 1TB of memory |
| GPU nodes | On these nodes computations can be run both on CPU cores and on a Graphical Processing Unit |
| InfiniBand switch | To connect all nodes |

They would be laid out like this:

![Diagram

Description automatically generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAYABgAAD/4RDgRXhpZgAATU0AKgAAAAgABAE7AAIAAAAHAAAISodpAAQAAAABAAAIUpydAAEAAAAOAAAQyuocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAGtyYWV2YQAAAAWQAwACAAAAFAAAEKCQBAACAAAAFAAAELSSkQACAAAAAzgwAACSkgACAAAAAzgwAADqHAAHAAAIDAAACJQAAAAAHOoAAAAIAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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Figure 4- Diagram of potential IHC layout[[4]](#footnote-4)

Aside from this, Gibson (2019) says ‘Ultra-dense servers call for more power, reinforced flooring and possibly liquid cooling.’. Whilst this is not the only way in which to structure and IHC, it is a good example of a typical one used for R&D purposes.

### Pros of in-house cluster

|  |  |
| --- | --- |
| **Pro** | **Description** |
| Low latency | Since the IHC is on site, there will be very low latency, meaning that time sensitive data can be easily used. This is especially important with regards to stocks, where values can change dramatically in seconds. |
| Investment in technology | By owning the hardware, you have control over what is used and can optimise it to your needs. When the project ends old hardware can be sold to recoup costs. |
| Data privacy | Only the company has access, not a big tech provider. |

### Cons of in-house cluster

The main root of the downsides to using an in-house cluster is the initial costs to set up the cluster

|  |  |
| --- | --- |
| **Con** | **Description** |
| Costs | Squashing Total Cost Rumors of In-House vs. Cloud Computing[[5]](#footnote-5)  Figure 5- Chart showing cost breakdown for IHC  As shown, there is a wider variety of costs for an IHC.  Hardware is currently very difficult to source.  Extra staff/engineers will be needed to manage and maintain the IHC |
| Power consumption | To ensure that the HPC cluster is always running, it will need to be powered, and the higher end the components are the more power will likely be needed. Also, there are potentially high infrastructure costs such as cooling and floor reinforcement. |
| Not easily scalable | Getting an in-house cluster to scale requires buying more hardware and potentially taking the cluster offline to update/maintain it. |
| High set up time/ Lack of immediacy | The cluster must be built before development starts. Longer wait = later time to deploy product = less money. |
| Lack of remote access | IHC is only going to be accessible at the company’s offices, not easily available for remote working like distributed services are. |
| Government access | AS the company is US based, the IHC will also be there. This means the US government have free reign to access the data stored. |

## Conclusion

In conclusion, there are numerous benefits and drawbacks to each solution, particularly regarding costs and geography. Ultimately, the best solution will be the result of what it is being used for and the type of computing that is happening. Whilst not investigated here, a different solution is Cloud Bursting. This is described by Open Telekom Cloud Editorial Team (2020) as ‘like the on-premise(sic) option. However, during peak loads, they also add compute nodes from a cloud provider.’

# Task 3 – Selection

## Brief

The problem being solved is predicting the price of a stock. Being able to predict a stock's price requires pattern recognition of how its price has changed in the past, as well as considering outside factors; these can be huge and varied, from an environmental disaster to a scandal involving a high-profile staff member. As HPC and AI evolve, they can be taught how to predict stock prices, which has traditionally been a very human skill.

What the team is trying to do is develop software that can predict a stocks future price accurately, software that can then be sold or licensed to others, as well as be used by the developers to hopefully make lots of money.

An important factor with this problem is latency. Since stock prices can change in an instant, having a high latency can mean that a prediction is useless and so large amounts of money can be lost.

## Selected technology

Cloud Computing Environment.

### Justification

|  |  |
| --- | --- |
| **Reason** | **Explanation** |
| Cost | Using a CC service such as AWS is simply much cheaper at the beginning as there is no hardware that needs to be bought and no additional staff that need to be hired. It is also a field that is growing exponentially economy-wise, and so using this platform lets developers deploy the product as SaaS when completed. |
| Geography | The company is located in Silicon Valley. There are many data centres here since it is the home of many ‘big tech’ companies, most notably Google and Apple. AWS also has data centres there:    Figure 6- Map showing AWS Data Centres in California, USA[[6]](#footnote-6)  Proximity to data centres means that high latency should not be an issue, provided the internet infrastructure is to standard. |
| Scalability | Much easier to scale when a provider already has more than enough computing power than what will be needed, scaling is instantaneous as more resources are required. |
| Accessibility | With CC, HPC access is not geographically constrained (provided internet is good). Therefore, developers can ‘work from home’ using low end devices. If the end product is deployed as SaaS, existing services can handle the hosting.  CC lets development commence straight away, no waiting for the cluster to be built. |

### Limitations

|  |  |
| --- | --- |
| **Reason** | **Explanation** |
| Government data access | Since the data centre will be in the US (to minimise latency), the US authorities will have the ability to access the data whenever they want. This should not be a serious issue if everything is above board, and no laws are broken. |
| ‘Big tech’ reliance | Using a CC environment relies on big tech e.g., Google, Microsoft or Amazon. Whilst having the resources to support the project, they have a poor reputation with regards to handling users' data. There is also always a chance the company could go bust or data centre could become compromised. |
| Longer term cost | If the problem takes a long time to solve, then CC platform costs will increase, and it may end up costing more in the end than investing in building an IHC. |
| Latency | No matter how good the internet connection is or how close the data centre is, the connection will always be slower when using CC than IHC. This will affect time sensitive stock decisions. |

## Conclusion

In conclusion, out of the two technologies Cloud Computing is the best choice for this situation. It is more immediate and has the benefits of scaling and due to where the company is located, latency is not too much of an issue. However, there are downsides like costing more over time and putting the data in the hands of the government and big tech.

A different approach that could be taken to solving this problem if circumstances were different would be to use an IHC, if the company was not located in Silicon Valley. Alternatively, a hybrid bursting cloud solution could be used. This could potentially work out cheapest, giving the immediacy and scalability of CC combined with the investment benefits and control of an IHC.

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# Image References

Figure 1: Landis, Warren and Cha, Sangwhan (2020) T*owards High Performance Stock Market Prediction Methods* Accessed at: <https://digitalcommons.harrisburgu.edu/cgi/viewcontent.cgi?article=1003&context=cisc_student-coursework> Accessed on 13.11.2021

Figure 2: Stackscale (2021) *Main cloud service models: IaaS, PaaS and SaaS* Accessed at: <https://www.stackscale.com/blog/cloud-service-models/> Accessed on 14.11.2021

Figure 3: Grand View Research (2021) *Cloud Computing Market Size, Share & Trends Analysis Report By Service (SaaS, IaaS), By Enterprise Size (Large Enterprises, SMEs), By End Use (BFSI, Manufacturing), By Deployment, And Segment Forecasts, 2021 – 2028* Accessed at: [https://www.grandviewresearch.com/industry-analysis/cloud-computing-industry Accessed on 9.11.2021](https://www.grandviewresearch.com/industry-analysis/cloud-computing-industry%20Accessed%20on%209.11.2021)

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