Cloud Computing & E-waste

Presented by:
Owen Bedford, Amir Hadzic, Mohammed Masudul Islam

Presentation Outline

- Introduction to Cloud Computing & E-waste
- 3 Issues Related to E-waste & Cloud Computing
- E-Waste Prevention Strategy
  - Proposed Solutions/Plan for Implementation of Strategy
  - Solution Evaluation
- Impact of Plan to Businesses

What is Cloud Computing?

- Cloud computing is the delivery of services through the use of the internet
- Cloud computing involves the use of data centers and servers in order to achieve this
- Key examples of cloud computing include:

Image references:
https://aws.amazon.com/
https://zoom.us/
https://drive.google.com/drive/u/0/my-drive
https://www.techrepublic.com/article/microsoft-onedrive-a-cheat-sheet/

What is E-waste?

- E-waste is a term used to refer to electronic waste
- E-waste often consists of products which are at the end of their life, or are now redundant that have been discarded
- Examples of e-waste within the industry of cloud computing include
  - Hard Drives
  - Circuit boards
  - Fans
- It is estimated that only 20% of e-waste was recycled in 2016 (Hoyle, 2019)

https://www.thebalancesmb.com/introduction-to-electronics-e-waste-recycling-4049386
https://www.wsj.com/amp/articles/scrap-metal-market-targets-the-cloud-as-its-next-recycling-project-11564401605

Image references:
https://www.istockphoto.com/vector/e-waste-recycle-bin-filled-with-old-computer-gm532118811-55621852?irgwc=1&esource=AFF_IS_IR_Eezy%2C%20LLC_38919_&asid=Eezy%2C%20LLC&cid=IS&utm_medium=affiliate&utm_source=Eezy%2C%20LLC&utm_content=38919&clickid=2mjynRxmRxyOTg%3AwUx0Mo3EWUkE2Rm3Vm0cMT40&utm_term=www.vecteezy.com

Relationship of E-waste & Cloud Computing

- The cloud is becoming vital to our lives as a society, with many services we use on a daily basis in some form incorporating the cloud into it
- The large scale uptake of cloud computing results in vast amounts of hardware which in turn could create large amounts of e-waste
- As a society we need to be conscious of the negative impacts cloud computing brings, particularly in terms of e-waste
- The following three issues will be covered in this presentation
    - Lifespan of servers
    - Issues with recyclability
    - Increased waste by redundancy of old equipment

Image references:
https://www.vecteezy.com/vector-art/82984-vector-cloud-computing-concept

Issue 1: Lifespan of servers

- A server is hardware which is needed for the cloud to function in a data center
- Servers are vital to the operations of cloud computing
- The lifespan of servers, is estimated to be around three years due to the extensive workload (Hoyle, 2019)
- The limited lifespan of servers means that servers frequently need to be replaced
- This contributes to the vast amount of electronic waste
- As new cloud technology develops old technology quickly comes out of date further contributing to the problem

https://www.wsj.com/amp/articles/scrap-metal-market-targets-the-cloud-as-its-next-recycling-project-11564401605

Issue 2: Issues with recyclability

- Many cloud data centers may hold sensitive data this presents additional challenges with recycling of hardware, such as hard drives (Rundle, 2019)
- Not all hardware found that is used for the cloud, such as servers contain components which are recyclable
- This results in large amounts of hardware just ending up as e-waste

https://www.wsj.com/articles/sec-queries-investment-advisers-about-cloud-data-security-11559035802

Image references:
https://www.freepik.com/premium-vector/e-waste-recycle-bin-with-old-electronic-equipment_7058552.htm#page=1&query=ewaste&position=28

Issue 3: Increased waste by redundancy of old equipment

- The clear benefits cloud computing brings over on-site servers means that there is increased incentive for organisations to move from onsite to cloud
- For example due to security and data protection reasons the public sector has focused on private or community clouds but with better development of guidelines to deliver e-government services there is an imminent need to switch to the public cloud (Abraham, 2020)
- This results in old hardware becoming redundant and ending up as e-waste

https://graz.pure.elsevier.com/en/publications/e-government-in-the-public-cloud-requirements-and-opportunities

E-Waste Prevention Strategy

Our proposed e-waste prevention strategy:

Optimal equipment replacement policy

Optimal equipment replacement policy (solution)

What it does: This solution considers the life span of servers (optimum life span for performance is 3 years) and how they can be refurbished in order to reduce e-waste. Overall, servers will improve in quality, cost less to make, and produce significantly less e-waste. The solution will follow a plan that will repeat itself every 5 years.

https://ieeexplore.ieee.org/document/9177554

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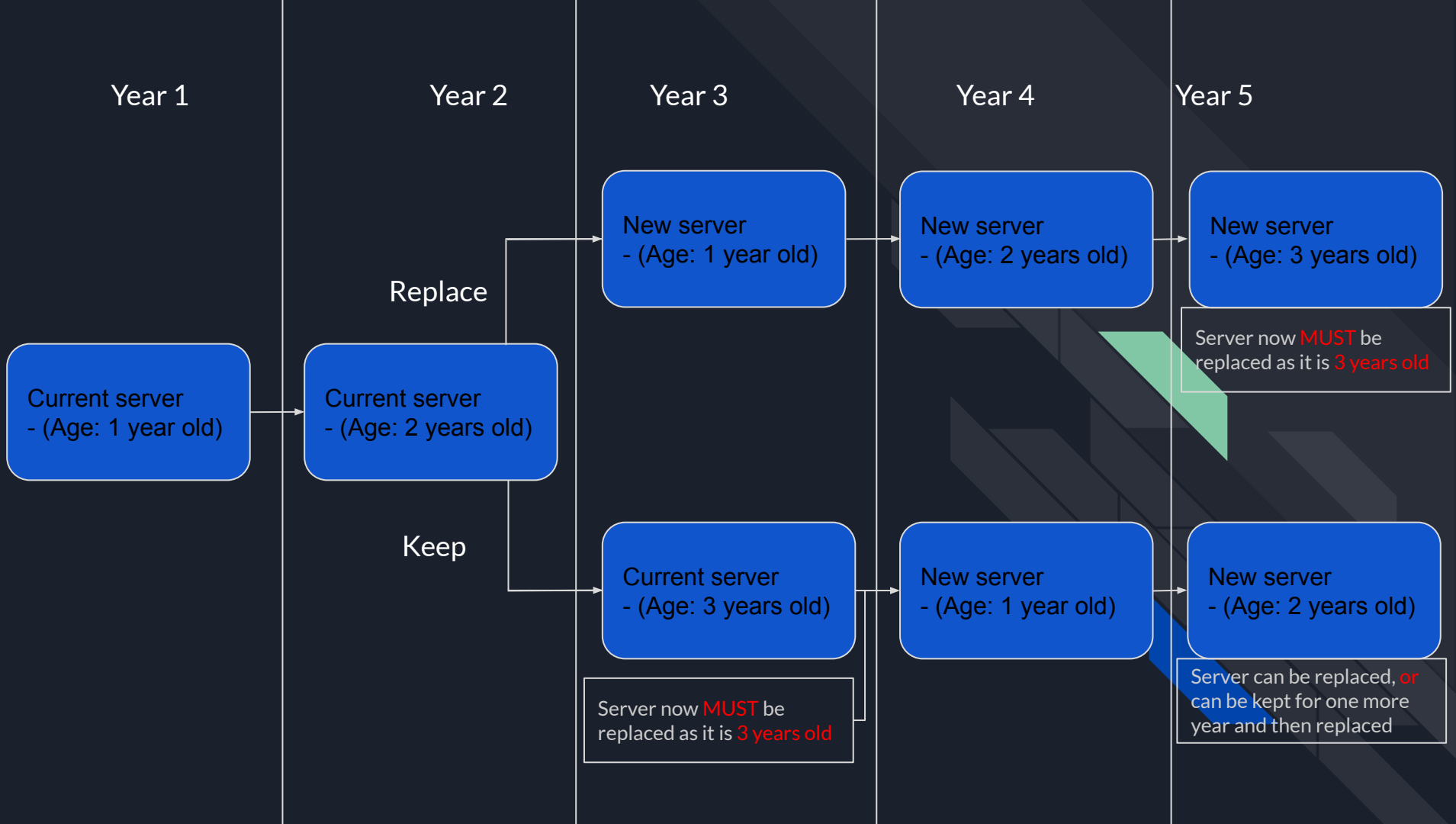
Implementation: Evaluation of the servers is taken into account by the management team and they decide whether they wish to replace it once it reaches the age of 2 years. This brings about two paths to tackle the problem:

1. If they decide to replace it, the new server will have to run for at least 3 years. After the 3 years, the server must be replaced by the old server which has been refurbished with fresh new components.

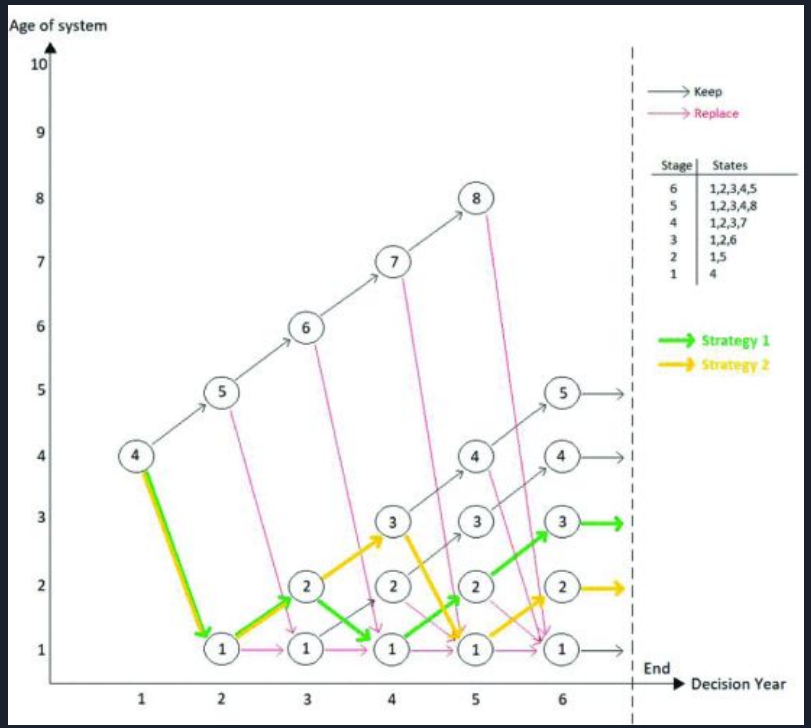
2. If they decide to keep it, the server should only run for one more year and then be replaced using the same exact process. However, if option 2 is selected, it means the management team has the option to replace the server after 2 or 3 years as it still has good performance.

Both paths follow the 5 year life cycle and come at the same cost (Esra Çakır et al., 2020).

https://ieeexplore.ieee.org/document/9177554


Year 1
Year 2
Year 3
Year 4
Year 5
Current server
- (Age: 1 year old)
Replace
Current server
- (Age: 2 years old)
New server
- (Age: 1 year old)
New server
- (Age: 2 years old)
New server
- (Age: 3 years old)
Server now MUST be replaced as it is 3 years old
Keep
Current server
- (Age: 3 years old)
New server
- (Age: 1 year old)
New server
- (Age: 2 years old)
Server now MUST be replaced as it is 3 years old
Server can be replaced, or can be kept for one more year and then replaced

Summarised solution/plan



https://ieeexplore.ieee.org/document/9177554

This is another illustration for the optimal routes for which a server should take. As you can see, servers should never be used if they are 4-5 years old, this is because server performance will decrease drastically. “Optimal replacement strategy is either R-K-R-K-K/ R-K-K-R-K” (Esra Çakır et al., 2020).

This strategy will:

- Reduce the cost of making servers as perfectly good condition components are reused.

- Reduce e-waste produced from servers that are used all around the world

- Improve server performance drastically as they receive much more maintenance, and so greater performance means increased attraction towards the general public and companies for use of cloud computing

Evaluation of the solution

- Asus' green optical drive can be encouraged to be used wherever possible in order to make servers more eco-friendly (environmental benefit) (Biswajit Debnath et al., 2016)
- Hire specialist staff to carry out any repairs and replacements for the servers (social benefit)
- Increase the number of e-recycle centres as they will increase in demand due to the strategy, this in turn will create more jobs (economic cost, environmental benefit, social benefit)
- Research and invest into more durable components and materials in order to increase life span of servers and materials (economic cost, environmental benefit)
- Overall, there are huge social and environmental benefits with a slight economic cost, however this economic cost is reduced due to the money saved from using refurbished and recycled components rather than brand new ones.

https://www.sciencedirect.com/science/article/pii/S1878029616301529#:~:text=E%2DWaste%20Management%20%E2%80%93%20A%20Potential%20Route%20to%20Green%20Computing%E2%98%86&text=Different%20approaches%20have%20been%20established,etc%20are%20a%20few%20approaches.
Image references:
https://www.racksolutions.com/news/blog/what-is-a-server/
https://community.connection.com/buy-new-vs-upgrading-existing-servers-when-does-it-make-sense/
https://www.datacenterdynamics.com/en/opinions/pros-and-cons-of-physical-servers/

What does this mean for businesses?

Economic impact on businesses

Businesses can reduce the cost of buying new servers and therefore reduce the amount of servers wasted (save up to £10,000 per server)

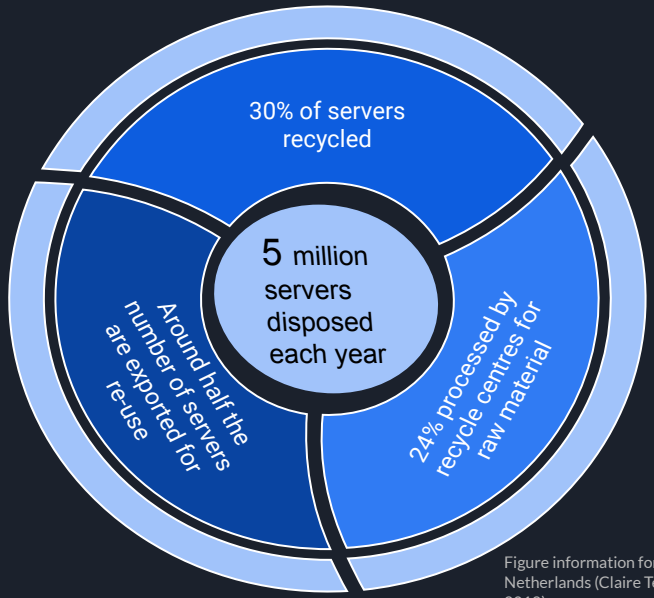


Figure information for Netherlands (Claire Teurlings., 2018)

Economic impact on businesses

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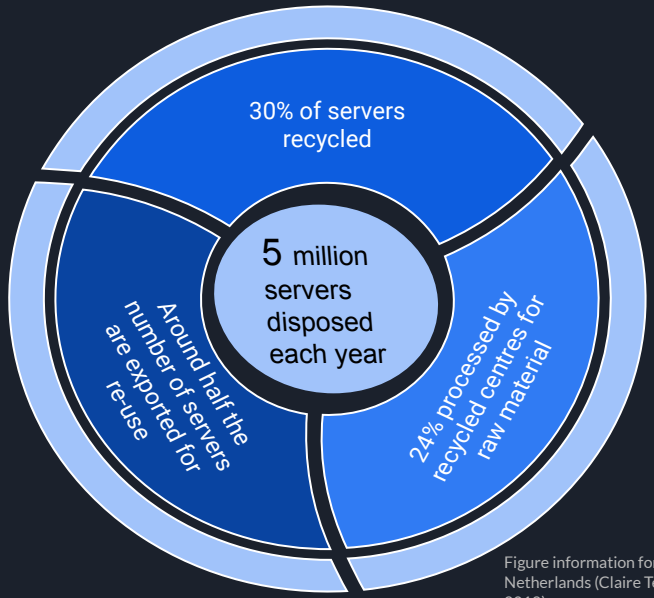
Using recycled components reduces carbon footprint



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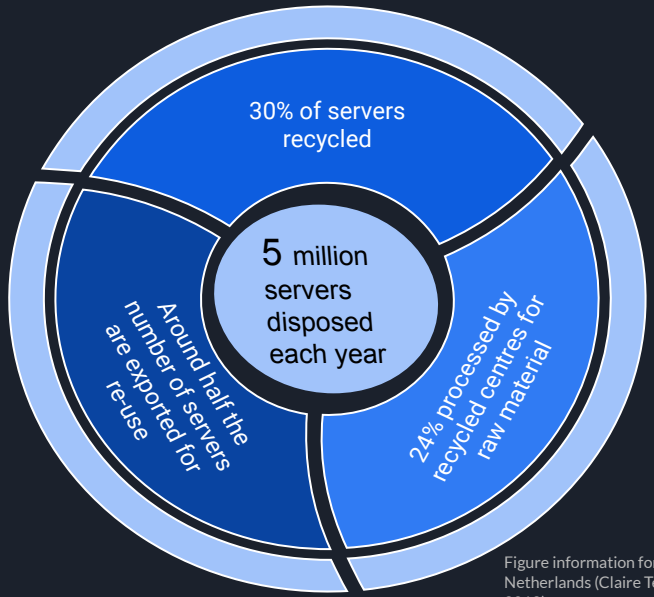

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Costs to employ specialists can be reduced through partnerships

Impact on customers and stakeholders

- Customers are affirmed that their experience with using the business is not leading to increased e-waste and their own digital footprints are reduced

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Impact on customers and stakeholders

- Customers are affirmed that their experience with using the business is not leading to increased e-waste and their own digital footprints are reduced
- The public as a whole are encouraged to recycle old components to be used more efficiently elsewhere, such as recycling hard drives that can be re-used in data centres for cloud servers
- Cloud providers should have incentives and schemes that encourage businesses to reduce e-waste

Conclusion
Future development of Cloud Computing

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- Increased use of cloud computing has led to more emphasis on reducing e-waste
- Data-centres counter large power consumptions by switching to operate on 100% renewable energy
- Reducing the consumption of raw materials by using greener and more efficient components in servers has great social and environmental implications

Conclusion
Future development of Cloud Computing

- With all parties from engineers, cloud providers, businesses and recyclers discussing the lifespan of a server from its making to its disposal, the whole cycle of reuse will bring economic profits for businesses and a positive environmental impact with more jobs created for society

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Team Contribution Statement

Assignment Number: 2
Group Number: 14.6

Write the name of each of your group members in a separate column. For each person, indicate the extent to which you agree with the statement on the left, using a scale of 1-4 (1=strongly disagree; 2=disagree; 3=agree; 4=strongly agree). Total the numbers in each column. **Include a completed and signed Team Contribution Statement in your group submission file.**

Evaluation Criteria	Mohammed Masudul Islam	Amir Hadzic	Owen Bedford	Ka Lau (Not present at all)		
Attends group meetings regularly and arrives on time.	4	4	4	1		
Contributes meaningfully to group discussions.	4	4	4	1		
Completes group assignments on time.	4	4	4	1		
Prepares work in a quality manner.	4	4	4	1		
Demonstrates a cooperative and supportive attitude.	4	4	4	1		
Contributes significantly to the success of the project.	4	4	4	1		
TOTALS	24	24	24	6		

Feedback on team dynamics:

1. How effectively did your group work?

Work was divided equally and completed efficiently. Everyone completed their individual tasks and helped ach other out.

2. Were the behaviors of any of the team members particularly valuable or detrimental to the team? Explain.

Everyone's contribution was equally beneficial and we worked well together

3. What did you learn about working in a group from this project that you will carry into your next group experience?

Improved communication skills and time management. Organisation as a whole will improve amongst all individuals in the group.

Team Names and signatures

1. Amir Hadzic

2. Owen Bedford

3. Mohammed Masudul Islam

4.Ka Lau

We the team members have discussed and agreed the ratings and comments given above.