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Discussion of the triple bottom line benefits of server refurbishment

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Abstract. With a growing legislative push towards circularity and benefits in terms of staff attraction and retention, investment and turnover to companies who can display good sustainability credentials, more and more companies in the data centre sector are interested in adopting circular economy practices. This paper outlines the benefits of this on the triple bottom line of social, environmental and cost impacts. It also identifies the best use cases for refurbished components and remanufactured machines.

1 Introduction

The data centre industry (DCI) is crucial to the contemporary global economy and sectoral growth is rapid and on-going. Data Centres house millions of servers, which process and store data. The DCI is set to grow by 500% globally by mid-century. 120 M new servers will come online in the period 2019-2023 alone, according to Gartner. The average use phase rate is three years; their functional life fa r exceeds this. Extending mainstream use phase with in-house refurbishment, component level upgrades, sale to and purchase from the secondary market, will have positive impacts on society, the environment and economic development. This triple bottom line analysis from a lifecycle cost (LCC) perspective is part of the Interreg NW funded Circular Economy in the Data Centre Industry (CEDaCI) project of which Techbuyer is a partner.

1.1. The policy landscape

The EU has published policies and directives on the circular economy and taken practical steps to facilitate repair and reuse. The Ecodesign Directive [1], which came into effect in all member states in March 2020, has a specific section (Lot 9) on servers. It stipulates parts and firmware be available for servers from 2-8 years after the release date, paving the way for increased reuse, repair and remanufacture.

The EU Circular Economy Action Plan includes specific ambitions relating to electronic goods and ICT, including targets to extend product lifetimes [2]. While in the past, data centre professionals would have been concerned about this due to the huge

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efficiency gains with every successive generation of servers, recent evidence suggests that the slowdown in Moore's Law means that product lifetimes can be extended without a negative effect on energy efficiency. This will be discussed in detail below.

The UK published a Circular Economy Package policy statement in July 2020 [3], which outlined identifying towards an ambitious and credible long-term path for waste management and recycling. This was followed in September by the more sector-relevant Greening government: ICT and digital services strategy 2020-2025, which included commitments towards zero-to-landfill on electronic waste and a percentage increase in refurbished or remanufactured goods in the public sector IT estate [4]. The UK Government has also made a commitment towards Right to Repair legislation for consumer goods. If adopted, this paves the way for business related legislation more in line with the EU Ecodesign Directive.

1.2 Industry attitudes towards Circular Economy and product life extension

The European Data Centre sector has made advances towards more circularity with initiatives like the Climate Neutral Data Centre Pact. This consortium of data centre operators and trade associations has a commitment to the reuse and repair of servers as one of its five pillars [5].

Hyperscale data centres like Google, Amazon Web Services and Microsoft are also publicising models for successful circular economy practice through refurbishment and remanufacture of servers, sales to the secondary hardware market increasing focus on scope 3 emissions as part of carbon neutrality. This sector-level awareness of circular practice means there is increasing demand on smaller organisations to follow suit.

Indeed, manufacturers have been running remanufacturing departments for a number of years: Cisco has "Cisco Refresh"; Dell has "Dell Refurbished"; HP has "HP Renew". They are beginning to expand this remanufacturing capability, working with the public and private sector to reduce waste by directing products into refurbishment and recycling centres for reprocessing. Much of this relies on partnerships with refurbishment specialists, which is helping to bring the practice into the mainstream and increase public awareness.

2 The triple bottom line impact of product life extension

The triple bottom line outlines the three pillars against which a sustainable business should aim to create value: social, environmental, and economic [6]. With this in mind, the costs, and benefits of refurbished equipment are worth outlining.

2.1 The Social Benefits

Manufacturers in the electronics sector have been aware of potential human risks in the supply chain for some time. Many carry out due diligence on their supply chain using frameworks like the Responsible Business Alliance. However, obtaining an accurate picture of working conditions in the supply chain is extremely challenging given the complexity and geographical spread involved.

Server manufacturers work as server assemblers because many of the component parts such as CPUs and memory are made by a limited number of specialist suppliers in China. The supply chain is complex with numerous vendors fulfilling bulk component orders in fluctuating numbers. This means it is difficult to understand which item came from which original company.

In contrast, remanufacturing and recycling are relatively high-value job propositions and growth sectors, particularly in the European Union (EU). Health and Safety regulations mean that environmental pollution is eliminated when processing the material, meaning no risk to employees.

Further down the supply chain, some of the raw materials come from conflict zones in the developing world. The EU has a policy of conflict minerals [7], but accessing the mines and auditing conditions is difficult, especially as component factories and mines fall outside of the jurisdiction that governs the manufacturers, meaning there is no legal requirement to report. However, there are outstanding legal challenges lodged against the mining practices and societal impact in the supply chains of large Information Communication Technology (ICT) manufacturers [8].

There are similar challenges in managing risk at end-of-life. There are no accurate data on the amount of electronic waste that is recycled because tracking is difficult. Much of it ends up in the developing world, where risks to human health are high because rudimentary technology is used. Extending the use phase on electronics has benefits both on preventing this short term and buying time for better processes to be developed globally.

Increased use of refurbished and remanufactured equipment also has benefits for high-value job creation. The refurbishment process is clean, safe and requires a high level of knowledge and skill. According to a 2019 Deloitte report, ICT aftermarkets were worth at least $46 billion USD in Europe and employed more than 220,000 people in 2015 [9], and this number is set to grow.

2.2 The environmental benefits of extending lifecycles

“Towards Zero Carbon” announcements have been highly publicised within the sector over recent years. Product life extension contributes by reducing emissions associated with mining, transport, manufacturing, and destruction at end-of-life. It also impacts on other important issues such as material shortages and destruction of the natural ecosystem. Of the 30 “Critical Raw Materials” (CRM) identified by the EU as a combination of “raw materials of high importance to the EU economy and of high risk associated with their supply” [10], 23 exist in data centre IT hardware. Stores of these materials are extremely stressed; some are predicted to run out within decades unless alternative sources are found. The seabed has been suggested as one such alternative [11], but this comes with significant implications on subsea biodiversity.

End-of-life material recovery reduces the need to mine and process new materials. However, in 2015 Joint Research Council informed policy makers that current recycling technologies are unable to recover 100% of the materials within the servers and that CRMs are amongst the most difficult to retrieve [12]. Many recycling technologies rely on shredding and melting (which have their own energy and emissions costs). Although new techniques are in development such as bioleaching and pyrolysis, these are in their nascent stages. Finally, material recovery leads to a manufacturing process also involving energy usage and emissions, which means that reuse, refurbishment, and repair are higher up the value chain in terms of environmentally friendly practice [13].

A 2018 report by the Rochester Institute of Technology found that remanufacturing and comprehensive refurbishment delivered a range of environmental benefits [14].

Compared to brand-new options, it can reduce greenhouse gas emissions by 79-99%, cut raw-material requirements by 82-99%, and result in 69%-85% less energy use.

2.3 The economic benefits of extending lifecycles

2.3.1 Purchase costs

The costs of refurbished and remanufactured servers are considerably lower than their brand-new counterparts [new currently being Generation (Gen) 10 for HPE and 15 for Dell]. While basic configurations can be closer in price, any configured variants will be considerably more expensive. For example, the latest generation with a single CPU and low-GB RAM will have a smaller gap in pricing between new and refurbished versions.

However, increasing the power with additional CPUs and RAM will be significantly more expensive with new components than refurbished.

Based on Techbuyer’s industry experience, the cost of new equipment for servers is often as high as 50-80% more than the refurbished condition even after three years. When a generation moves to end-of-life, or a newer generation comes out, the remaining OEM stock will be sold at reduced prices but still for more than refurbished equivalents.

It is worth noting that when a new generation is released there may not be available supply of refurbished for around 12-18 months as businesses will generally hold the asset longer than 12 months before updating or refreshing.

2.3.2 Performance differences and energy costs

Ground-breaking research by Bashroush et al. found no significant difference in performance between refurbished and new models of servers or components, despite the significant price differentials [15]. Moreover, it also shows how the slowdown of increased efficiencies affects server trends. In broad terms, CPUs are no longer doubling in performance every two years. Energy efficiency is tailing off at maximum usage and degrading at idle, where they spend a significant amount of time in real life situations.

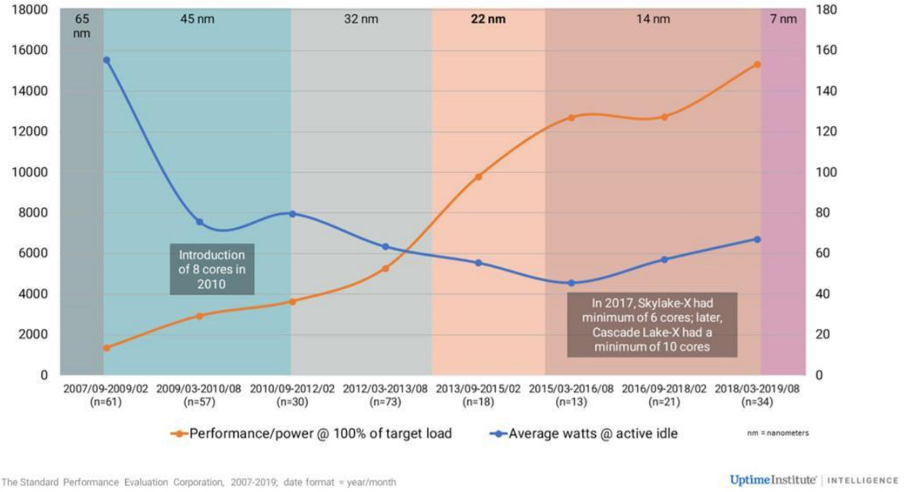

Fig. 1. Impact of CPU lithography on performance and idle power (n = number of servers/time frame)

Figure 1 shows this, with the orange line tracking performance divided by power at maximum usage over time and the blue line showing the trend for CPUs in low power mode.

Prior to 2015, each successive generation of server was more energy efficient, so cost savings on energy bills were significant. With this no longer being the case, the operational cost benefit of new versus refurbished has decreased. It now makes financial sense to consider refurbished and remanufactured machines as part of an upgrade process especially in use cases, which do not push the CPU to maximum capacity.

Reliability is also comparable between the two options, as the refurbishment process removes the parts that are most susceptible to failure, such as power supplies, fans and hard drives. This reliability can be further backed up by offering a three-year warranty on refurbished goods, to match the manufacturers' original warranty.

2.3.3 Lifecycle costs

With the above information, Bashroush et al. have identified the payback point of replacing different older generations with new equipment and the immediate past generation. They find it makes sense to replace six-year-old servers with newer refurbished equipment (delivering a return on investment within four years) but not with new (which would take 5-8 years). This gives data centres the option of buying the refurbished previous generation, which in the case of the LCC analysis is a Gen9 HPE server.

At the time of writing, prices for a refurbished previous-generation server at a higher specification are roughly half those of a refurbished current-generation option with a base specification. For example, a dual-CPU 64GB RAM Gen9 server can produce roughly 2.5x the performance of a Gen10 low-specification equivalent and at half the price

2.3.4 Buying decisions and product life extension

The main buying decisions come down to rack density, available space, and utilisation rate of the hardware. Looking at the CPU trends in figure 1, choice of generation depends on the level of utilisation of the servers. If the utilisation rate is below 60% then previous-generation refurbished equipment usually offers the best cost-benefit balance. Servers with component-level upgrades are also a good option. Where utilisation or CPU demands are higher than normal, current-generation servers will be best. In each case, refurbished options will have the best return on investment in a cost-for-performance model.

The business case for brand new mainly applies to cases where top-end performance is required but refurbished options are unavailable. This is relatively rare, yet the predominant purchasing approach is to favour new equipment from the manufacturer without considering the cost related to operational energy and purchase price. Given the evidence above, it seems sensible both environmentally and economically for this approach to change, and for data centres to examine their buying choices more closely and consider extending the life of their current assets.

2.3.5 End-of-life cost recovery

Suppliers of new and refurbished equipment offer a three-year warranty. However, this is an economic lifecycle rather than a technical one as performance does not degrade. Selling the equipment to a refurbishment specialist or IT Asset Disposition Company (ITAD) will generate higher returns than selling for scrap or destruction. This is because prices for scrap are based on weight and most of the value lies in the CPU and system board.

According to Techbuyer analysis, the value of a fully populated Gen10 server will be around £24 and around £26 for the fully populated Gen9 (interestingly, the variability in price is due to a heavier system board in the previous generations). At time of writing, selling to an ITAD would generate more than £100 for the Gen10 and £50 for the Gen9, including the secure data sanitisation of the assets.

3 Conclusion

Sustainability is becoming a core business concern for an increasing number of organisations wishing to attract investment, supply the public sector and attract both new recruits and customers. Choice on the use of refurbished IT hardware in the data centre has noticeable social, environmental, and cost benefits. Whereas data-centre managers would previously have had to balance this against reduced energy consumption achieved with regular refreshes with new hardware, the slowdown in Moore's Law means this is no longer the case. With the correct analysis and understanding, IT procurement that includes refurbished hardware and sale to recyclers and refurbishment specialists neatly satisfies the triple bottom line.

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