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Appendix A: Terms of Reference

Terms of Reference

1. In exercise of its duty under section 33(1) of the Enterprise Act 2002 (the **Act**) the Competition and Markets Authority (**CMA**) believes that it is or may be the case that:

    (a) arrangements are in progress or in contemplation which, if carried into effect, will result in the creation of a relevant merger situation, in that:

    (i) enterprises carried on by Broadcom Inc. will cease to be distinct from enterprises carried on by VMware, Inc.; and

    (ii) the condition specified in section 23(1)(b) of the Act is satisfied; and

    (b) the creation of that situation may be expected to result in a substantial lessening of competition within a market or markets in the United Kingdom for goods or services, including for the supply of:

    (i) Ethernet network-interface cards;

    (ii) fibre channel host-bus-adapters;

    (iii) storage adapters; and

    (iv) fibre channel switches.

2. Therefore, in exercise of its duty under section 33(1) of the Act, the CMA hereby makes a reference to its panel chair for the constitution of a group under Schedule 4 to the Enterprise and Regulatory Reform Act 2013 in order that the group may investigate and report, within a period ending on 12 September 2023, on the following questions in accordance with section 36(1) of the Act:

    (a) whether arrangements are in progress or in contemplation which, if carried into effect, will result in the creation of a relevant merger situation; and

    (b) if so, whether the creation of that situation may be expected to result in a substantial lessening of competition within any market or markets in the United Kingdom for goods or services.

David Stewart
Executive Director, Markets and Mergers
Competition and Markets Authority

29 March 2023

Appendix B: Conduct of the Inquiry

Conduct of the Inquiry

1. We published the biographies of the members of the Inquiry Group conducting the phase 2 inquiry on the inquiry webpage on 29 March 2023 and the administrative timetable on the inquiry webpage on 13 April 2023.

2. On 21 April 2023, we published an Issues Statement on the inquiry webpage setting out the areas on which we envisaged that the phase 2 inquiry would focus. A non-confidential version of the Parties' response to the Issues Statement has been published on our inquiry webpage. We did not receive any responses from third parties.

3. We invited a wide range of interested parties to comment on the Merger. These included the Parties' competitors and customers. We obtained evidence from third parties using written requests. A number also provided us with information by video conference calls as well as by responding to supplementary written questions. Evidence submitted during the CMA's phase 1 investigation has also been considered in phase 2, as appropriate.

4. We received written evidence from the Parties in the form of submissions and responses to information requests, including a large number of internal documents.

5. On 26 and 27 April 2023, members of the Inquiry Group, accompanied by CMA staff, attended site visits with the Parties and their advisers.

6. On 18 May 2023, the Inquiry Group accepted interim undertakings from the Parties which were published on the inquiry webpage on 19 May 2023.

7. We held separate hearings with each of the Parties on 8 June and 14 June 2023.

8. Prior to the hearings, we sent the Parties a number of working papers for comment. The Parties were also sent an annotated issues statement, which outlined our emerging thinking to date prior to their respective main party hearings. The Parties provided comments on the annotated issues statement and working papers on 15 June 2023.

9. A non-confidential version of the provisional findings report has been published on the inquiry webpage. Interested parties are invited to comment by 17:00 on Wednesday 9 August.

10. We would like to thank all those who have assisted our inquiry so far.

Appendix C: Shares of Supply

Introduction

1.   This appendix sets out the shares of supply estimates submitted by the Parties, our assessment of the Parties' submissions, and the share of supply estimates we use in our Provisional Findings. We also set out other evidence of VMware's shares of supply for server virtualisation software which is relevant to our assessment.

The Parties' estimates

2.   The Parties submitted a number of analyses that estimate VMware's share in the supply of server virtualisation software using a range of data sources.

Revenue shares

3.   The Parties submitted shares based on revenue showing that VMware had a [✂]% share of 'x86 server virtualisation infrastructure' globally in 2021 based on Gartner data, and [✂]% of 'software-defined compute software' globally in 2021 based on IDC data.[1] However, the Parties submitted that these revenue shares overstate VMware's competitive position because they do not properly capture the constraint from vendors with alternative monetisation models, such as Microsoft's Hyper-V virtualisation software, which is integrated into its broader Windows Server product, or free open-source hypervisors such as KVM and Xen.[2]

Volume shares (Installed base)

4.   The Parties submitted volume shares commissioned from IDC based on the number of virtualised server CPUs installed globally (ie not using VMware's own internal data).[3] The Parties submitted that this showed that VMware had considerably lower shares than the analyses set out above, at [10-20]% in 2021 across all deployment types, including the public cloud, and [30-40]% for

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[1] FMN, paragraphs 15.387-15.390 and Annex Q15-024.
[2] FMN, paragraphs 15.352-15.354.
[3] FMN, paragraph 15.359. In relation to volume shares, the Parties noted that they do not currently track market shares systematically by volume and were not aware of any third-party data source that covers VMware's vSphere and competing virtualisation software. The Parties therefore commissioned share of supply estimates from IDC for the purposes of this merger investigation (FMN, paragraph 15.358).

traditional data centre and private cloud deployments (referred to collectively as **enterprise deployments**)[4]

5.   The Parties submitted their own estimates of VMware's share of supply based on the number of virtualised server CPUs installed globally using VMware's own internal data and IDC data for third party volumes. These estimates showed that VMware had a share of [40-50]% in 2021 when only including enterprise deployments and [20-30]% when including all deployment types.[5]

6.   However, the Parties also submitted that the shares based on CPUs installed do not accurately capture VMware's current and future position in the market.[6]

Volume shares (new licenses)

7.   The Parties submitted alternative shares of supply commissioned from IDC based on the number of new virtualised licenses shipped globally, which the Parties consider to be most appropriate.[7] The Parties submitted that according to this metric VMware's share of supply in 2021 was only [10-20]% for all deployment types (including the public cloud) and [20-30]% for enterprise deployments.[8]

8.   The Parties submitted that existing servers cannot be affected by any plausible foreclosure strategy and the relevance of the installed base of VMware licenses is limited only to the small portion of the server installed base that is to be refreshed. Taking this into account, the Parties submitted their own estimates of VMware's shares of supply based on the number of new licences shipped and of virtualised CPUs installed (that are to be refreshed) globally. The Parties use VMware's internal data and for third party volumes IDC data. This showed that VMware had a share of [30-40]% in 2021 for enterprise deployments.[9]

Shares from internal documents

9.   The Parties submitted that material presented to VMware's Board of Directors in April 2021 shows that VMware had a [✂]% share of workloads for enterprise deployments in 2021, with its share falling to [✂]% of workloads

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[4] As defined in the Phase 1 Decision, paragraph 58: 'In line with the Parties' submission, the CMA considers that virtualisation software deployed in data centres and in the private cloud belong to the same market (henceforth also referred to as **enterprise deployments**)' (emphasis in original); Based on aggregating Tables 51-55, and Tables 51-54 of the FMN respectively.
[5] FMN, paragraph 15.359.
[6] FMN, paragraph 15.364; Parties' response to the Phase 1 Issues Letter, 3 March 2023, paragraph 2.6(a).
[7] Parties' response to the Phase 1 Issues Letter, 3 March 2023, paragraph 2.6(b).
[8] FMN, Table 44; Parties' response to the Issues Statement, 10 May 2023, paragraph 4.5(a).
[9] Parties' VMware market position paper, 15 June 2023, Table 1.

when considering all deployment types (including the public cloud).[10] The Parties also noted that this material indicates that around [✁]% of all workloads were deployed in the public cloud in 2021.

10.   The Parties submitted that, based on the shares of supply estimated on a volume basis, VMware's shares have followed a declining trend over the last three years.[11]

Our assessment

11.   Measures of concentration, such as shares of supply, can be useful evidence when assessing the competitive constraints on the merger firms, particularly when there is persuasive evidence as to which potential substitutes should be included or excluded in the market, and when, although differentiated, the degree of differentiation between firms is more limited.[12] In other cases, such as where the boundaries of the market are not as clear-cut, where reliable estimates of shares of supply are not readily available, or where there is a high degree of differentiation, other sources of evidence on the competitive constraints on the merger firms may be relied on to a greater extent.[13]

12.   In the present case, we consider that shares of supply may be of more limited evidentiary value, relative to other evidence, in assessing the competitive strength of suppliers of server virtualisation software as the available data is less reliable and there is a degree of differentiation in the offering of virtualisation providers.

13.   Given this, we use the shares of supply evidence to understand the relative size of virtualisation providers, how their relative market positions have changed over time and to provide an initial indication of the competitive constraints on VMware in the supply of server virtualisation software. Furthermore, as we have not concluded on a bright-line market definition, we have calculated shares of supply on multiple different bases as set out below.

14.   We agree with the Parties that in the present case shares of supply based on revenues are of a lower probative value than those based on volumes, given that they do not capture providers with alternative monetisation models. However, while we have focused on shares of supply based on volumes as part of our assessment of VMware's market power, we consider that some

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[10] Parties' response to the Issues Statement, 10 May 2023, paragraphs 4.5(a) and 4.5(d)(ii), which references VMware internal document, Annex Q10(VM) - 011, pages 114 – 115.
[11] Parties' response to the Issues Letter, 3 March 2023, paragraph 2.6(a); Parties' response to the Issues Statement, 10 May 2023 paragraph 4.5(a).
[12] MAGs, paragraphs 4.14.
[13] MAGs, paragraphs 4.15.

evidential weight can be given to shares of supply based on revenues given VMware uses these estimates in the ordinary course of business.

15. We currently consider the Parties' own analysis of VMware's share of supply based on the number of virtualised server CPUs installed in enterprise deployments globally to be most relevant to the present case. This is because VMware's own internal data will be more accurate than any estimate of those figures prepared by IDC.

16. We consider that shares of supply based on the number of CPUs installed are likely to be more appropriate than the number of new virtualised licenses shipped:

(a) The former reflects the alternatives available to the entire VMware customer base, rather than only new servers or customers, which is likely to be more relevant as part of our assessment of VMware's market power given that any foreclosure strategy could affect existing vSphere licence holders as well as the purchase of hardware by new vSphere licence holders.

(b) In contrast, the latter would provide an indication of how the relative market positions of virtualisation software providers are changing and, in particular, whether VMware was growing or losing sales compared to other suppliers of server virtualisation software. However, this is also captured in our analysis based on the number of CPUs installed set out below.

17. Consequently, we do not consider that looking at shares of supply solely in relation to newly shipped licences is appropriate in this case.

18. In relation to the Parties' submission that the relevance of the installed base of VMware licences is limited only to the small portion of the server installed base that is to be refreshed, our view is that all of the installed base is relevant to the calculation of shares of supply given all of the installed base would ultimately be affected by the foreclosure strategy, even if this effect occurs over several years as servers are refreshed gradually.

Our analysis

19. We have estimated VMware's share of supply for server virtualisation software in enterprise deployments by supplementing the Parties' own analysis to include VMware's internal data and internal data obtained from third parties. Where the internal data of third parties was unavailable, we have

relied on the shares of supply estimated by IDC as part of analysis commissioned by the Parties. Our analysis is shown in Table 1 below.

Table 1: Shares of supply in server virtualisation based on number of CPUs installed in enterprise deployments globally, 2019-2021

			%
Virtualisation provider	*2019*	*2020*	*2021*
VMware	[40-50]	[40-50]	[40-50]
Microsoft	[20-30]	[20-30]	[20-30]
IBM	[5-10]	[5-10]	[10-20]
Oracle	[0-5]	[0-5]	[0-5]
SUSE	[0-5]	[0-5]	[0-5]
Nutanix	[0-5]	[0-5]	[0-5]
Others	[20-30]	[10-20]	[10-20]

Source: CMA analysis of FMN, paragraph 15.364 and Table 43; Response to Phase 1 virtualisation competitor questionnaire, question 3 [✂]. Figures adjusted to reflect third party internal data.

20.   Table 1 shows that, for enterprise deployments:

(a)   VMware has consistently had the largest share of supply in each year of the period 2019 – 2021, with over [40-50]% in each of these years. Contrary to the Parties' submissions, it does not show a declining trend.

(b)   VMware's share of supply was almost twice the size of the second largest supplier, Microsoft (with a share of [20-30]%), followed by IBM (with a share of [10-20]%), in 2021.

(c)   The supply of server virtualisation software in enterprise deployments is highly concentrated, with VMware and its two largest competitors representing around [70-80]% of supply and a tail of other suppliers (including Oracle, SUSE, and Nutanix) each having a share of supply of less than 5%

21.   We note that the enterprise deployment offerings of CSPs, such as AWS (with its Outposts product), Google (with its Anthos product), and Alibaba (with its Apsara Stack product), are included within the 'others' category set out in Table 1. We estimate that the combined share of these three suppliers was less than 5% in enterprise deployments in 2021.

22.   We have also considered shares of supply based on the number of virtualised server CPUs installed in all deployment types (ie enterprise deployments and the public cloud) globally. While we give greater weight to the shares of supply set out in Table 1 as we consider server virtualisation software to be more substitutable with vSphere than the virtualisation offerings of CSPs for

virtualisation customers' existing workloads, we acknowledge that VMware competes with CSPs for at least some workloads.[14]

23.   Table 2 shows the shares of supply based on the number of virtualised server CPUs installed in all deployment types globally. As with the analysis for enterprise deployments, we have supplemented the Parties' own analysis of VMware's share of supply based on the number of virtualised server CPUs installed globally by including the internal data we obtained from third parties. Where the internal data of third parties was unavailable, we relied on the shares of supply estimated by IDC.

Table 2: Shares of supply in server virtualisation based on number of CPUs installed in all deployment types globally, 2019-2021

			%
Virtualisation provider	*2019*	*2020*	*2021*
Microsoft	[20-30]	[20-30]	[20-30]
VMware	[20-30]	[20-30]	[20-30]
AWS	[10-20]	[10-20]	[10-20]
IBM	[5-10]	[5-10	[5-10]
Google	[0-5	[0-5]	[0-5]
Alibaba	[0-5]	[0-5]	[0-5]
Others	[20-30]	[20-30]	[20-30]

Source: CMA analysis of FMN, Tables 43 and 51-55; Response to Phase 1 virtualisation competitor questionnaire, question 3 [✂]. Figures adjusted to reflect third party internal data.

24.   Table 2 shows that, for all deployment types (ie enterprise deployments and public clouds):

(a)   Microsoft and VMware have had a similar share of supply in each year of the period 2019 – 2021, although VMware's share has fallen slightly faster than Microsoft's towards the end of this period. This is consistent with the Parties' submissions that VMware's share has followed a declining trend.

(b)   Microsoft was the largest supplier with a share of [20-30]% in 2021, followed closely by VMware with a share of [20-30]%. AWS was the third largest supplier with a share of [10-20]% in 2021, whose share has increased from [10-20]% in 2019. IBM was the fourth largest supplier in 2021 with a share of [5-10]%.

(c)   The supply of server virtualisation software across all deployment types is concentrated, with the four largest suppliers representing [60-70]% of supply and a tail of other suppliers (including Google and Alibaba) each having a share of supply of less than 5%.

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[14] See paragraphs 7.23 – 7.33 in the provisional findings.

Other evidence of VMware's share of supply

Internal documents

25. We consider that VMware views its own share in the supply of server virtualisation software as higher than [40-50]% in its own internal documents. Although we recognise that these shares have not been calculated on exactly the same basis as the analysis set out in Table 1 above, in our view they nevertheless show that in the ordinary course of business VMware considers it has a higher than [40-50]% share of supply of server virtualisation software:

    (a) In a document on [✂] dated June 2020, VMware estimates that it has a share of [✂]% by number of 'virtualised instances', with the next closest competitor being Microsoft with a [✂]% share. VMware has estimated this through responses to a customer outreach questionnaire.[15]

    (b) In VMware's 2021 multi-cloud strategy document, VMware estimates that it has a share of [✂]% in the overall on-premises server virtualisation market.[16] This rises to an estimate of [✂]% in the paid-for market.[17]

    (c) A report commissioned by VMware in April 2022 estimated that VMware had shares of [✂]% for non-cloud server virtualisation infrastructure (ie on-premises and off-premises data centres) in terms of usage based on a Gartner report in July 2019. The same document estimated that in 2021 VMware's share of supply was [✂]% for on-premises workloads (ie on-premises data centres and private clouds) based on the number of installed servers; however, the Parties noted this excludes off-premises private cloud workloads as well as workloads used by telecommunications companies.[18]

    (d) An MIT study tracking vSphere's share (dated July 2018) estimated that, from 2009 Q4 to 2018 Q2, VMware vSphere's share by virtualised OS instances was [✂]% (paid + virtualised).[19]

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[15] VMware internal document, Annex RSLV_00056380, page 7.
[16] VMware internal document, Annex RSLV_00028772, page 3; the Parties' response of 4 November 2022 to question 16 of the CMA's RFI, dated 28 October 2022.
[17] We understand that the [✂]% share is a revenue-based estimate using IDC reports. While we agree with the Parties that revenue-based estimates may be of lower probative value in the present case given alternative monetisation models, the document shows that VMware does rely on revenue-based estimates in the ordinary course of business.
[18] VMware internal document, Annex RSLV_00017150.
[19] VMware response to the s109 notice issued 2 May 2023, question 2, Annex Q2.20.a.

Views of third parties

26.   Third parties indicated that VMware's share in some server virtualisation segments is likely to be higher than [40-50]%:

   (a) One third party estimated that VMware has around a 60% share in Storage Area Network (SAN) deployment.[20]

   (b) Another third party estimated that VMware has a 70% share by the number of virtualised on-premises servers.[21]

   (c) A server OEM estimated that over [✂] of their server customers have ESXi through vSphere installed.[22]

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[20] Note of a call with [✂]. This is measured by the number of servers in the data centre that are running VMware OS.
[21] Note of a call with [✂].
[22] Note of a call with [✂].

Appendix D: Evidence from the 2023 MIT survey

Introduction

1.   The Parties commissioned the 2023 MIT survey for the purpose of providing evidence on possible VMware customer reactions to total foreclosure.[1] This appendix describes the survey; summarises an analysis of the Merged Entity's incentives to foreclose its rivals submitted by the Parties; and presents our assessment of the evidential value of the submission.

Summary description of the 2013 MIT survey design

2.   The Parties provided full and detailed information about the survey design and its results.[2,3] This is summarised below.

Recruitment, quota monitoring and screening

3.   The 2023 MIT survey used a similar respondent recruitment method to the Workload Study carried out by Management Insight Technologies (**MIT**) in 2021. Market research panels of IT professionals were used to carry out the fieldwork, which took place during March 2023.

4.   The survey covered customer organisations of all sizes larger than sole traders. Target quotas for industry type were in place and these were designed to [✂] (when compared with the 2021 Workload Study) the proportions of organisations represented from the [✂].[4]

5.   A sample of 1,204 completed responses was secured from panellists working in Europe, the UK or the US. Respondents were screened in the questionnaire to ensure that they were either software developers or IT decision makers / influencers with responsibility for choosing infrastructure platforms for the deployment of their organisation's workloads. Respondents were also screened to ensure also that their organisation used vSphere and that they did not work for either of the merging Parties or any of their main business rivals.

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[1] Total foreclosure here means a complete removal of interoperability between VMware's server virtualisation software and Broadcom's rivals' I/O hardware products.
[2] Management Insight Technologies survey for Broadcom & VMware, April 26, 2023.
[3] Broadcom-VMware Survey 2023, Main report, Management Insight Technologies, April 26, 2023.
[4] The Parties submitted that their prior research suggested that organisations in these sectors [✂].

Overall questionnaire structure

6.   Having recorded the numbers of existing workloads deployed by their organisation and of new workloads planned over the next two years (if any), the main questionnaire section was repeated for each of FC HBAs, storage adapters and Ethernet NICs. The device-specific sections were presented in random order.

7.   Each main section asked questions to establish how a hypothetical removal of compatibility between vSphere and future generations of non-Broadcom I/O hardware might affect the number of workloads running on vSphere through a combination of:

(a) Changing the number of existing workloads that were planned to be migrated away from vSphere.

(b) Changing the number of net new workloads that were planned to be deployed on vSphere.

8.   Further questions asked whether, in the event of a hypothetical total foreclosure, panellists' organisations would modify hypothetical plans for purchasing new vSphere servers with non-Broadcom I/O hardware so that users who wanted to continue to use vSphere could now use only Broadcom I/O hardware or older non-Broadcom I/O hardware that remained interoperable with vSphere.

Key findings in the Parties' analysis

9.   The Parties submitted the following overall findings from their analysis of the survey responses.[5]

Findings on plans to migrate / deploy workloads from / to vSphere

10.   The Parties submitted that if non-Broadcom I/O hardware were no longer compatible with vSphere:

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[5] Broadcom/VMware: Implications of the MIT Switching Survey, RBB Economics, 26 April 2023.

(a) **Impact on existing vSphere workloads**: For both FC HBAs and storage adapters, over [50-60]% of respondents would accelerate migration away from vSphere and would, on average migrate a further [50-60]% of their workloads away.[6]

(b) **Impact on net new workload deployments on vSphere**: For both FC HBAs and storage adapters, around [50-60]% of respondents planning to deploy net new workloads on vSphere would scale down these plans, reducing planned net new workload deployments on vSphere by [50-60]%, on average.

Findings on plans to purchase I/O hardware from Broadcom and its rivals

11. The Parties further submitted that if non-Broadcom I/O hardware were no longer compatible with vSphere then, in a scenario where the next version of vSphere is intended to be deployed on new servers with non-Broadcom I/O hardware was incompatible with them, just [✄]% of workloads (across both FC HBAs and storage adapters) would be moved to Broadcom I/O hardware.

Our assessment of the key findings

Assessment of the survey design

12. We were concerned that the Parties did not inform us in advance that they were planning to conduct the 2023 MIT survey. This weakens its evidential value on the grounds that it might not have been disclosed if the results had not been seen as supportive of the Parties' view of the Merger. We note also that it has not been possible for us to directly compare the distribution of the sizes of the achieved sample of responding organisations (in terms of workloads, applications, servers or CPUs) with published industry statistics.

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[6] The RBB Economics report (dated April 26, 2023) covers only FC HBAs and storage adapters. An email from the Parties' legal advisors Cleary Gottlieb Steen & Hamilton dated April 28, 2023, states 'We note that the results of the survey for NICs are very similar to FC HBAs and storage adapters and therefore the conclusions of the RBB survey paper can be read across to NICs as well.' Our review of the survey report prepared by MIT (Broadcom-VMware Survey 2023, Main report, Management Insight Technologies, April 26, 2023.) confirms this.

13. On the other hand, we recognise that the consulting firm commissioned had experience of researching virtualisation software (including that gained from conducting the 2021 Workload Study) and had previously undertaken other research for large technology businesses.[7] Furthermore, the research had been designed broadly in accordance with our published good practice guide and MIT took steps to ensure a good coverage of different sizes and types of business in the response by setting response quotas.[8]

14. On balance, we therefore regard unweighted results from the survey analysis (for instance, proportions of responding organisations) as likely to be broadly representative of VMware customers in Europe, the US and the UK.

Assessment of findings on plans to migrate / deploy workloads from / to vSphere

15. The effect of total foreclosure on the plans of respondent organisations to use vSphere was investigated in the 2023 MIT survey by presenting a hypothetical situation: broadly, that the next version of vSphere released would not be compatible with future releases of non-Broadcom I/O hardware. Respondents were asked if and how this would affect their plans to migrate workloads away from vSphere, and if and how it would affect their plans to deploy new workloads on vSphere.

16. We were concerned that the structure of the questions provided respondents with more options to indicate that they would tend to decrease their use of vSphere under total foreclosure than increase it, and that it was easier for respondents to indicate that they would no longer plan to deploy any new workloads on vSphere (with a single click) than to indicate that they would plan to deploy all new workloads on vSphere (requiring a click followed by a selection of a percentage). These features tend to bias responses towards reporting that they would use vSphere less under total foreclosure.

17. In response to these points, the Parties submitted that:

    (a) A [✂] of respondents planning to use vSphere more in the hypothetical situation might have been created simply by those respondents [✂]. This was unrelated to incompatibility and irrelevant to understanding the effects of the merger.[9]

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[7] A range of large technology businesses are listed as MIT clients in Broadcom-VMware Survey 2023, Main report, Management Insight Technologies, April 26, 2023.
[8] Good practice in the design and presentation of customer survey evidence in merger cases, 23 May 2018.
[9] Response to CMA critiques of MIT Switching Survey, RBB Economics, 15 June 2023, paragraph 3.1, footnote 11.

(b) A change of plan to deploying [✂] new workloads on vSphere following total foreclosure was an unlikely response and so [✂].[10]

(c) A very [✂] number of respondents [✂] made the two selections necessary to indicate that [✂]. This suggested that [✂].[11]

18. We agree that any biasing effects of the questionnaire design would likely have been relatively small. We are therefore able to place evidential weight on the 2023 MIT survey results as showing that the respondents indicated that over half of their existing virtualised workloads and over half of their planned new virtualised workloads would be switched away from vSphere in response to total foreclosure.

Assessment of findings on plans to purchase I/O hardware from Broadcom and its rivals

19. The hypothetical situation in the 2023 MIT survey was then extended to ask respondents about the potential purchase of servers containing non-Broadcom I/O hardware as an alternative to making less use of vSphere in response to total foreclosure.

20. We were concerned that a proportion of the survey respondents may have had little involvement in their organisation's buying of I/O hardware and may have known little about existing practice in purchasing Broadcom and non-Broadcom I/O hardware. Their organisations may already have been buying predominantly Broadcom I/O hardware. No screening questions were asked to test these points.

21. We were also concerned that the hypothetical scenario introduced was ambiguous concerning the exact timing of the introduction of a hypothetical incompatibility between vSphere and non-Broadcom I/O hardware.

22. Our review of the survey response data found that around [✂]% of the respondents gave answers that indicated they may have been unable to engage with the question.[12]

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[10] Response to CMA critiques of MIT Switching Survey, RBB Economics, 15 June 2023, paragraph 3.2.
[11] Response to CMA critiques of MIT Switching Survey, RBB Economics, 15 June 2023, Figure 1.
[12] These respondents either spread their workload switching proportions broadly equally across all [✂] response options or answered Don't Know.

23. In response to these points, the Parties submitted that:

   (a) Respondents were all screened to ensure they were IT professionals with experience of this kind of decision making within their respective organisations.[13]

   (b) Monitoring of pilot interviews and review of open-ended responses to the survey identified no respondents concerned about answering this question.[14]

   (c) Restricting the analysis to the half of the respondents who were IT decision makers (rather than IT decision influencers or software developers) did not materially affect the results.[15]

24. The population of interest for testing this extended hypothetical scenario was decision makers in the procurement of I/O hardware, working for organisations that planned to purchase predominantly non-Broadcom I/O hardware. The sampling and screening for the 2023 MIT survey was not designed to produce a representative sample from this population. On balance, therefore, our concerns lead us to give limited evidential weight to analysis based upon this part of the survey.

Our overall view of the evidential value of the 2023 MIT survey

25. In summary, we regard the results of the 2023 MIT survey as broadly representative of VMware customers in Europe, the US and the UK. Stated preferences under a hypothetical situation are not completely reliable predictors of actual behaviour in the face of incompatibility being introduced.[16] However, the survey provides evidence that a meaningful proportion of customers' existing and planned new virtualised workloads would be switched away from vSphere in response to total foreclosure. We give less weight to the Parties analysis of the proportion of the affected workloads that would be switched to run on servers using Broadcom I/O hardware.

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[13] Response to CMA critiques of MIT Switching Survey, RBB Economics, 15 June 2023, paragraph 3.3.1.
[14] Response to CMA critiques of MIT Switching Survey, RBB Economics, 15 June 2023, paragraph 3.3.1.
[15] Response to CMA critiques of MIT Switching Survey, RBB Economics, 15 June 2023, Figure 2.
[16] Inertia bias may result in survey respondents choosing responses that over-state their reaction to changes in the quality of a product, especially in scenarios where material cost would be incurred in switching to an alternative. The 2021 Workload study indicated that about [✁] vSphere users had no workloads deployed on other platform infrastructures; for these organisations at least, switching away from vSphere would be expensive. We recognise here the difficulty in quantifying the likely amount of actual switching precisely and characterise the evidence as indicative of switching of a 'meaningful proportion' of workloads.

Appendix E: Overview of evidence from virtualisation customers

Introduction

1. This appendix provides an overview of the evidence we have gathered from virtualisation customers.

2. We have engaged with virtualisation customers to better understand the competitive dynamics in the supply of server virtualisation software. In particular, we gathered evidence on (i) the importance of VMware's server virtualisation software to their business activities, (ii) whether the other virtualisation providers available to them are effective alternatives to VMware, (iii) their recent and intended movement of workloads between hypervisors and/or across deployment types, and (iv) on how virtualisation customers may respond to a loss of interoperability between VMware and the hardware supplied by Broadcom's competitors.

Virtualisation customer questionnaires

3. We primarily sought to obtain evidence from virtualisation customers through the use of questionnaires as part of our Phase 1 and Phase 2 investigations. We refer to these questionnaires generally as one single source of evidence throughout our competitive assessment unless specifically differentiating between the views of respondents to our Phase 1 and Phase 2 questionnaires.

4. As part of our questionnaires, we asked virtualisation customers about how they deploy their workloads as this is more straightforward to estimate than other volume metrics in multi-cloud environments (eg CPUs).

5. However, as set out in chapter 4 of the provisional findings, workloads are not homogeneous and include a wide variety of programs or applications that differ in (i) the importance to virtualisation customers (eg some could be critical to the operation of a business) and (ii) the ongoing effort needed to run a workload in storage systems, particularly in relation to the processing power they demand. Different deployment types use different charging structures, so there may be differences in the cost to run the same workload across different deployment types.

6. We differentiate between different workload types where appropriate and are careful in our interpretation of the evidence from virtualisation customers to

avoid making general inferences across workloads as part of our competitive assessment.

Phase 1 virtualisation customer questionnaire

7.   We received 24 responses from virtualisation customers to the Phase 1 questionnaire. These customers include a mix of small, medium, and large customers that use VMware's server virtualisation software.

8.   Respondents to the Phase 1 questionnaire represented [5-10]% of VMware's bookings (ie revenue) for its server virtualisation software in 2022 and are active in a range of industries: telecoms, financial services, IT services, manufacturing, utilities, technology, aerospace and defence, education and government.[1]

Phase 2 virtualisation customer questionnaire

9.   We received 25 responses from customers to our Phase 2 questionnaires, with these respondents representing [5-10]% of VMware's bookings for its server virtualisation software in 2022. Respondents to our questionnaire are active in a range of industries: telecoms, financial services, IT services, manufacturing, retail, utilities, technology, aerospace and defence, insurance, education, government and healthcare.[2]

10.   In Phase 2, we used two approaches to obtain evidence from VMware's virtualisation customers.[3]

   (a) We recontacted respondents to the Phase 1 questionnaire with additional questions.

   (b) We also contacted a number of VMware's top 100 customers by average total bookings in the period FY2020 – FY2022. These customers were selected with reference to their business activities and headquarters location.[4]

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[1] CMA Analysis of Annex RFI 4 Phase 1 Question 40 and RFI 2 Phase 2 Table 1. This includes bookings for all VMware products except from CloudHealth, Tanzu, Workspace ONE and Carbon Black.
[2] CMA Analysis of Annex RFI 4 Phase 1 Question 40 and RFI 2 Phase 2 Table 1. This includes bookings for all VMware products except from CloudHealth, Tanzu, Workspace ONE and Carbon Black.
[3] Where we set out responses to questions that were common to both the recontact and new questionnaire, we refer to this as the 'Phase 2 virtualisation customer questionnaire'. Where we differentiate between questions that were specific to either the recontact or the new questionnaire, we refer to the relevant questionnaire that was issued.
[4] In doing this, we used desktop research to identify the industry of VMware customers (eg banking and insurance, manufacturing, retail, the public sector, etc.) and whether they were located in the UK/Europe. We aimed to issue our questionnaire to a range of diverse VMware customers to capture their heterogenous preferences as part of our competitive assessment.

Response to foreclosure strategies

11.   As set out in chapter 7 of the provisional findings, we asked virtualisation customers about how they may respond to a range of foreclosure strategies that may be pursued by the Merged Entity.

Response of virtualisation customers to a material and long-lasting interoperability issue

12.   As part of both our Phase 1 and Phase 2 questionnaires, we asked virtualisation customers about how they may respond to a material and long-lasting loss of interoperability between the hardware components used in their servers and VMware's virtualisation software.

13.   We received 34 responses to this question across our Phase 1 (24) and Phase 2 (10) questionnaires, representing [5-10%] of VMware's bookings for its server virtualisation software in 2022.

Response of virtualisation customers to foreclosure scenarios

14.   As part of our Phase 2 investigation, we asked virtualisation customers about how they may respond to four hypothetical foreclosure scenarios.

15.   We received 24 responses to these questions, with these respondents representing [0-5]% of VMware's bookings for its server virtualisation software in 2022.

Calls with virtualisation customers

16.   We had calls with seven virtualisation customers as part our Phase 2 investigation, all of whom had responded to our Phase 1 and/or Phase 2 questionnaires.

17.   We discussed the issues covered in the written questionnaires, and these calls allowed us to probe customers' qualitative views on the market and to better understand their actions when posed with a loss of interoperability between the hardware components used in their servers and VMware's virtualisation software.

Appendix F: VMware's 2021 Workload Study

1.   In addition to our engagement with virtualisation customers, we used evidence from VMware's 2021 Workload Study (**WLS**) to better understand the typical behaviour of VMware's virtualisation customers.

2.   The WLS was conducted on behalf of VMware by Management Insight Technologies (**MIT**) between October and December 2021. The study was conducted in the ordinary course of business, ie not for the purposes of the Merger, to assess the level of risk for cloud migration by VMware customers.[1]

3.   We consider that the WLS does provide some reliable qualitative evidence, in particular in relation to questions regarding respondents' actual past or current behaviour as well as the plans for the movement of their workloads in the short term (ie in less than 24 months). However, the study does not allow us to understand – either qualitatively or quantitatively – the full extent of recent workload switching between providers and/or deployment types because these questions are biased by providing examples of moves that emphasise shifts from VMware products to the public cloud.[2] This applies to both questions about recent past behaviour and planned movements of workloads in the short term. As such, our analysis and interpretation of responses to these questions is cautious and in conjunction with other evidence (such as the responses of virtualisation customers to our questionnaires).

4.   We note that workloads are not homogeneous and include a wide variety of programs or applications that differ in (i) their importance to virtualisation customers (eg some could be critical to the operation of a business) and (ii) the ongoing resources needed to run a workload in storage systems, particularly in relation to the processing power they demand. Different deployment types use different charging structures, so there may be differences in the cost to run the same workload across different deployment types. We therefore present our analysis of the responses to this subset of questions from the WLS as one piece of qualitative evidence, alongside evidence from virtualisation customers obtained during our investigation and internal documents provided by the Parties.[3]

5.   In our analysis, we have focused on respondents who use VMware's products. When we extract the [60-70]% of respondents who use them, we

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[1] See DMN dated 19 August 2022, Annex Q15-011, preface to the submission.
[2] Further, questions asked in the context of a specific workload type carry less evidential weight than questions on overall workload deployment as respondents were not typically asked questions about the workload types most common in, or most critical to, their organisation.
[3] See: DMN dated 19 August 2022, Annex Q15-011, preface, and DMN dated 19 August 2022, Annex Q15-011, page 4.

obtain a 'convenience sample' of VMware customers. Respondents were recruited to the survey from [✂]. A preponderance of VMware customers was recruited by MIT [✂] recruits whenever the proportion of non-customers exceeded [✂]%. This was enforced by MIT because the survey was '[✂]'. Therefore, the survey responses cannot be regarded as representative of all VMware customers, and inferences to this wider population of interest for our investigation should not be drawn.

Glossary

Term	Definition
the **Act**	Enterprise Act 2002
API	Application Programming Interface
Bare Metal	When an OS runs directly on server hardware
Broadcom	Broadcom Inc.
BSN	Brocade Storage Networking Division
CMA	Competition and Markets Authority
CMA2	Guidance to the CMA's jurisdiction and procedure (CMA2)
the **Compatibility Guide**	Published list of VMware certified drivers
CPU	Central Processing Unit
CSI	Competitively Sensitive Information
CSPs	Cloud Service Providers
DCSG	Data Center Solutions Group
ECD	Emulex Connectivity Division
EMC	EMC Corporation (prior to acquisition by Dell in 2016)
Enterprise customers	Companies purchasing servers and related hardware components from OEMs
Enterprise deployments	Server virtualisation software used in data centres and the private cloud
Ethernet NICs	Ethernet Network Interface Controllers
E&W	England and Wales
FC	Fibre Channel
FC HBAs	Fibre Channel Host Bus Adapters

Term	Definition
FC Switches	Fibre Channel Switches
FC Switch Management Software	Software for communicating between FC Switches and server software eg vCenter
FMN	Final Merger Notice
FY22	For Broadcom, its financial year ended 30 October 2022 For VMWare, its financial year ended 28 January 2022
Hypervisor	Also called Sever Virtualisation Software (see Server Virtualisation, below)
IaaS	Infrastructure as a Service
the **Inquiry Group**	CMA Panel Members appointed on 29 March 2023
I/O	Input / Output
I/O Hardware and switches	Ethernet NICs, FC HBAs, storage adapters and FC switches together
I/O Hardware	Ethernet NICs, FC HBAs and storage adapters
MAGs	Merger Assessment Guidelines (CMA129)
Merged Entity	Broadcom and VMware (for statements relating to the future)
the **Merger**	The anticipated acquisition of VMware by Broadcom
the **Merger Agreement**	On 26 May 2022, the Parties entered into an agreement for Broadcom to acquire all of the outstanding shares of VMware
NDFC	Nexus Dashboard Fabric Controller (FC Switch management software provided by Cisco)
NICs	Network Interface Controllers
NSX	VMware network virtualisation software
OEMs	Original Equipment Manufacturers

Term	Definition
the **Ofcom market study**	Ofcom's 'Cloud services market study' interim report, 5 April 2023
On Premise	Private Cloud hosted by an enterprise for the benefit of its own users
Off Premise	Private Cloud hosted by a third party who owns a datacentre
OS	Operating System
PaaS	Platform as a Service
the **Parties**	**Broadcom** and **VMware** together
Private Cloud	A cloud computing environment dedicated to a single customer
Public Cloud	A multi-tenant cloud environment, where the same computing resources are shared among multiple customers
R&D	Research and Development
RFI	Request for information
RMS	Relevant Merger Situation
SaaS	Software as a Service
SAN	Storage Area Network
Server Virtualisation	The process of dividing a physical server into multiple unique and isolated virtual servers by means of a software application
SLC	Substantial lessening of competition
SPA	Share Purchase Agreement
Storage Adapter	Connects the host controller to other network and storage devices.
UK	United Kingdom

Term	Definition
Workloads	Programs or applications that run on traditional data centres, the private cloud, the public cloud, as well as other deployment types
WLS	Workload Study
vCenter APIs	APIs provided by VMware
VCF	VMware Cloud Foundation
VMs	Virtual Machines
VMC	VMware Cloud
VMware	VMware, Inc.
vSAN	VMware storage virtualisation software