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# Broadcom/VMware: Navigating foreclosure theories across different jurisdictions

The European Commission's latest Competition Merger Brief of October 2025 discusses the Broadcom/VMware merger, following the publication of the Decision on 13 May 2025. This case raised numerous interesting conceptual issues, including differing outcomes of the competitive assessments across 12 jurisdictions. While Broadcom needed to offer a remedy to secure a clearance in the EU, China and South Korea, the other agencies including the US FTC and the UK CMA cleared the merger unconditionally, despite all agencies agreeing that the relevant markets were global. This is a surprising outcome, particularly from the parties' perspective, that significantly increases the uncertainty related to cross-border transactions. We discuss how merging firms may minimize the risks of different conclusions across jurisdictions.

Broadcom designs and supplies a range of semiconductor solutions used in datacentre servers.[1] VMware is the leading supplier of virtualisation software for datacentre servers. The hardware devices in a server must be compatible with the virtualisation software running on that server. Hence, both the European Commission and the UK CMA (as well as other major agencies such as the US FTC and Chinese SAMR) considered a principal theory of harm involving potential leveraging of VMware's position in server virtualisation software into hardware device markets in which Broadcom competes, by reducing the interoperability of VMware software with Broadcom's rivals' hardware.

## Background on interoperability, driver certification and the EC's theory of harm

When software runs directly on a piece of hardware, e.g. in the case of an operating system and a central processing unit (CPU), the software and hardware suppliers interact closely to ensure interoperability. Often, as is the case for Broadcom devices, the virtualisation software (or an operating system on a non-virtualised server) communicates with a hardware device indirectly through a driver that can be thought of as an interface that translates the software's commands for the hardware – see Figure 1. In this case, hardware suppliers develop drivers for their devices unilaterally by mostly relying on the published APIs[2] of the software supplier that are device agnostic. The drivers that meet the required criteria are then certified by the software supplier. Accordingly, when a driver provides an interface between the two layers, the software supplier's direct involvement in achieving interoperability is more limited than when the software runs directly on the hardware.

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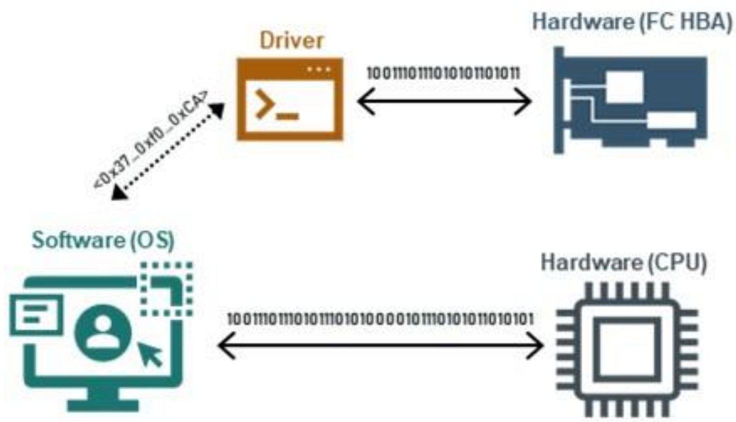
1 Broadcom devices considered in the foreclosure assessment were Ethernet Network Interface Cards (NICs), Fibre Channel Host Bus Adapters (FC HBAs) and Storage Adapters which are the only devices supplied by Broadcom that communicate with server virtualisation software albeit indirectly through a driver.

2 "API" stands for Application Programming Interface.

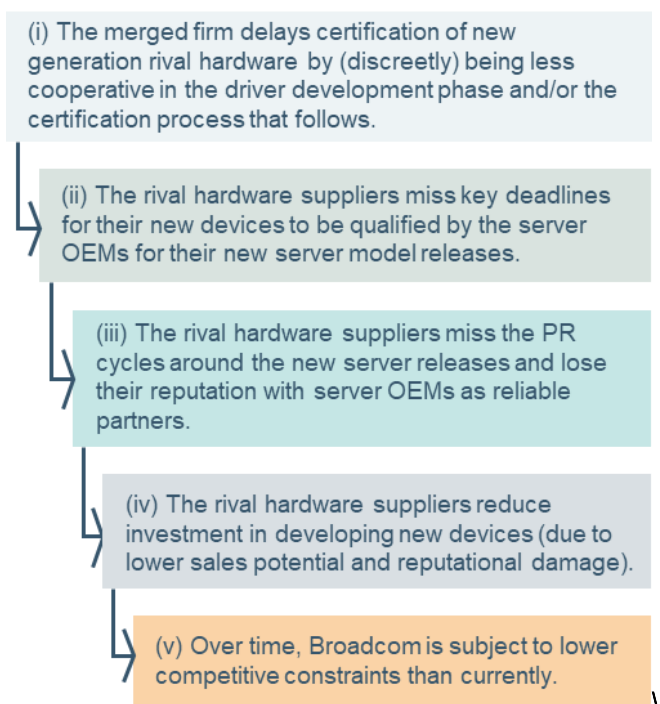
**Figure 1: Software-hardware interaction: Role of the driver**




Certification of the driver is not necessary for a customer to use a hardware device with the software. Running uncertified drivers may however introduce security risks and compatibility issues. Customers therefore typically prefer hardware with certified drivers. This led the agencies to treat an impact on certification as an impact on interoperability, with the European Commission using the phrase "certified interoperability" as the subject of foreclosure strategies.

In a nutshell, the Commission's main theory of harm involved partial foreclosure as depicted below.

**Figure 2: The EC's interoperability theory of harm**




## Ability to degrade interoperability in a discreet manner

The European Commission considered that the merged firm would not have the ability to engage in total foreclosure through refusing certification outright given that VMware's reputation as a neutral and open virtualisation software supplier is paramount to its success. Put differently, the Commission recognised that there are two sides to interoperability and hence not only the hardware supplier but also the software supplier loses when the software is not perceived as interoperable with a given hardware.

Nevertheless, the Commission considered that the reputational impacts from delays to certified interoperability on VMware's software and on rival hardware devices would differ if achieved in a discreet manner rather than by openly delaying the certification. According to the Commission, certification of device drivers is a long process that requires intense collaboration between VMware and the hardware supplier with many contact points that provide opportunities for discreet delays (e.g. by withholding information).[3] The Commission considered that such delays would be hard to detect by Broadcom's rivals or server OEMs, and would in any event only be detected much later after the rival hardware devices miss the qualification for new server models.

The UK CMA had the opposite view. It considered that even if the merged firm succeeded in imposing a delay, it would not have been able to do so by more than a few months without the delay being attributed to the merged firm. This would have no material impact on rival hardware suppliers, as (i) driver certification is completed long before release of new server models, (ii) server OEMs prefer to rely on existing devices and drivers when releasing new server models,[4] (iii) new server model sales are not concentrated around release dates, and (iv) the adoption of the relevant new hardware devices was sufficiently slow that there would be no impact from "being late to the market."

Therefore, the CMA considered that the merged firm would do better with an outright refusal to supply. Compared to a delay, outright refusal would be more effective in causing customers to switch from rival hardware devices to Broadcom devices and would not harm VMware's attractiveness substantially more than a meaningful delay (that would anyway be attributed to VMware). Accordingly, the CMA focused on a total foreclosure theory of harm where the merged firm would refuse to certify drivers for new generations of rival hardware devices. Further, the CMA noted that while the VMware brand would be affected by refusing to certify drivers, any such impact is part of the assessment to determine whether the merged firm would have incentives to foreclose.

## Incentives to foreclose by degrading interoperability

In non-horizontal mergers, the incentives to foreclose by non-price strategies are often assessed using vertical arithmetic that are in this case dependent on VMware's software margin, Broadcom's hardware margin and the diversion ratio from competitors' hardware devices to Broadcom.[5]

VMware's gross software margin per server is very large compared to the margin Broadcom makes on selling any of the relevant hardware.[6] As a result, the critical switching rate for foreclosing a rival hardware supplier's sale was very high for any of the relevant hardware. Hence, for incentives to exist, almost all users of VMware virtualisation solutions with rival hardware devices would need to switch to Broadcom

3 Contrary to the Commission's view, Broadcom considered that this description could be appropriate only for devices on which the software runs rather than devices that only interact indirectly with the software.

4 The server OEMs limit risk of customer dissatisfaction by not using new device models when launching a new server model based on a new CPU.

5 There is a common misconception that vertical arithmetic only applies to total foreclosure and not to partial foreclosure. This is incorrect when partial foreclosure is based on a non-price mechanism. In this case, the underlying profitability calculations for reducing sales of an input to a downstream rival by one unit and complete elimination of sales to the downstream rival depend on the same critical switching rate.

6 The margin for VMware in the vertical arithmetic accounted for the sale of server virtualisation software and certain add-on software such as VMware's storage virtualisation software (if installed) given that a loss of a virtualisation software license sale also results in the loss of these add-on software sales.

devices in the event of loss of interoperability.[7] The Parties argued that the actual switching rates were likely below the critical switching rates, and a survey conducted on behalf of the Parties supported this view.

Based on the evidence from customer questionnaires sent by the CMA and the Parties' survey, the CMA concluded that the merged firm would gain an insufficient amount of hardware device sales to make a total foreclosure strategy profitable. We agree with the CMA's conclusion. However, the European Commission reached a different view.

## The EC's assessment of incentives

The European Commission acknowledged that the critical switching rates were high but noted that because the absolute margin on VMware software is very high compared to Broadcom's hardware margin, this may indicate that actual switching rates would also be high under their hypothesised theory of harm.[8] We disagree with the Commission's argument – taking this approach risks turning vertical arithmetic into a one-sided test that can show existence of incentives but is incapable of showing absence of incentives when the critical switching rate in a transaction is high, because the accuracy of any estimate of the actual switching rate that is lower than the critical switching rate may be questioned.

Nevertheless, the Commission agreed that an assessment of the actual switching rate was necessary[9] and relied on its market investigation to conclude that *"virtually all end-customers are likely to switch from rival to Broadcom FC HBAs"*. Paragraphs 675-677 of the Decision suggest that this conclusion was based on qualitative evidence rather than a rate that could be directly calculated from the responses to the Commission's market investigation.

## Role of intermediaries as switching "amplifiers"

Currently, server OEMs offer both Broadcom and rival devices, which according to the Commission implies that neither end-customers nor server OEMs have any preference between Broadcom's and rival hardware suppliers' devices when all are interoperable with the relevant software. However, if rival devices lost interoperability with VMware, then server OEMs would not offer them in their server models (as the end-customers would not mind purchasing Broadcom devices instead).

In contrast, end-customers choose their virtualisation software, and they have strong preferences over it (due to switching costs). The Commission considered that under these circumstances, it was implausible for the foreclosure strategy to be defeated due to end-customers switching software.

The Commission's perception that the hardware devices are a "commodity" for which server OEMs could shift customer demand around without losing any server sales is difficult to reconcile with the observed market outcomes. This is because it essentially implies that hardware device supply is a Bertrand market.[10] However, the hardware suppliers make substantial margins (albeit less than VMware's in dollar terms) that are inconsistent with a Bertrand market. Hence, the assumption that the server OEMs can shift customer

7 As the merged firm could limit the foreclosure strategy to a specific hardware device, the vertical arithmetic was implemented separately for each relevant device.

8 See paragraph 670 of the European Commission Decision. The Commission considered that the relatively higher dollar margin for VMware's software could also indicate that customers have a substantially stronger preference for it than for Broadcom's hardware.

9 See footnote 785 of the European Commission Decision.

10 In a Bertrand market, all buyers value products/services in the same way and hence only the supplier offering the lowest price makes any sales. This is different from a horizontally differentiated product market where a firm that prices higher than its rival(s) can still make positive sales due to buyer preferences.

purchases easily between the suppliers of a hardware device is not supported by the margin evidence. A similar tension arises with respect to the Commission's effects analysis which we discuss below.[11]

## Analysis of foreclosure effects

The Parties argued that the partial foreclosure strategy outlined by the European Commission would not lead to an impediment to effective competition for the following reasons:

1. new generation rival hardware devices would not miss server release deadlines due to discreet delays;
2. even if deadlines were missed, there would be no lasting impact on competition as the server OEMs would include rival suppliers' existing products in new server releases[12] and introduce their new devices in the next quarterly update of the server model; and
3. slow adoption of new generation hardware devices by consumers means that rivals' new generation devices could only lose insignificant volumes due to the foreclosure strategy.

The Commission disagreed that the impact would be insignificant due to its view that *Broadcom is dominant or at least holds a very strong position, in the highly concentrated market for FC HBAs*[13] (where Broadcom faces competition from only one rival). The Commission argued that the rival's incentives to invest in this market would be affected by a perception that it would have a time disadvantage to bring new products to the market. Accordingly, given the Commission's view of Broadcom's dominance or very strong market position, any reduction in those incentives would amount to a significant impact on competition.

When a supplier faces only one competitor, a market share of 60-70% seems to be a far weaker indicator of dominance than in a setting with numerous competitors. Moreover, dominance in the FC HBA market seems to contradict the Commission's incentives assessment, in which it considered that the relevant hardware devices are essentially commodities. The server OEMs could therefore meet the end-user demand by offering any supplier's product without losing any server sales. That would imply strong competition in the market for supply of FC HBAs in contrast to the Commission's view on Broadcom's market position.

## Bundling theory of harm

Both the European Commission and the Chinese SAMR also considered whether the merged firm would bundle VMware's virtualisation software with another product. The Commission focused on Broadcom's (enterprise, security, or mainframe) software as the additional product in the bundle and concluded that the merged firm would not have the ability to bundle VMware's virtualisation software with Broadcom's software. The Commission found that VMware's virtualisation software and Broadcom's software are not complementary and are purchased by different divisions of customer organisations and / or at different points in time. In addition, the role of system integrators and OEMs in distribution of software also restricted the merged firm's ability to bundle, as these intermediaries could unbundle the software when selling to their customers.

Unlike the Commission, SAMR focused on Broadcom's hardware and concluded that the merged firm could engage in anticompetitive bundling/tying by pointing to the Parties' customers that were overlapping to an important extent and the lack of substitutes for the Parties' products (and the virtualisation software

[11] The CMA did not consider the foreclosure effects, as it concluded there was no incentive to foreclose.

[12] They could also include the new generation devices in servers purchased for use as bare metal (not virtualised) servers in which case the end-customer would not be looking for interoperability with VMware.

[13] Paragraph 791 of the European Commission Decision.

in particular). The assessment of incentives is broadly similar for bundling/tying and degradation of interoperability, but the nuances suggest that the incentives would be stronger for the latter.

Even if the merged firm did not certify any rival hardware,[14] customers of VMware's software can buy the software without hardware if they do not need the specific hardware or prefer to have the rival hardware even without certification. In contrast, with pure bundling, a customer cannot buy the software alone. Hence, the incentives for pure bundling would be lower than for denying certification to rival hardware, which still allows sales to customers who only want to buy the software. This balancing is less clear for mixed bundling where a bundle is sold alongside the standalone products.[15] Indeed, SAMR's concern appears to have extended beyond pure bundling, as the remedy it accepted includes a commitment to not price discriminate against customers who buy the products separately.[16]

## Conclusions

The Broadcom/VMware merger's more than year-long assessment offers numerous lessons for future cases. Specific to foreclosure theories of harm between hardware and software suppliers, it is extremely important to understand (i) the processes for achieving interoperability and its certification, (ii) the potential roles of any 3rd party stakeholders (such as server OEMs) in the certification and hardware sale processes, and (iii) the nature and pace of innovation in the relevant hardware.

For non-horizontal mergers, more generally, if the critical switching rates in the vertical arithmetic are very high, the Commission may be more critical of the estimates of actual switching rates than when the critical switching rates are more moderate. Therefore, merging firms need to produce robust evidence on those estimates early in the process. Similarly, merging firms should be prepared to address potential qualitative arguments the Commission may develop such as the role of intermediaries to discount the vertical arithmetic analysis.

Finally, the issues tackled in this global merger were undoubtedly complex and highly technical, and hence it is understandable that different agencies may take a different approach to the competitive assessment. That said, in a setting where all key agencies around the world concluded that the relevant markets are global, it seems sensible that the Parties would expect the regulatory proceedings to result in the same outcome everywhere given that all the agencies were presented with the same set of facts. While merging firms often use a staggered approach when dealing with agencies, we believe it is important to start the dialogue with all the main agencies, including the US agencies, the European Commission, the UK CMA and the Chinese SAMR, at once when dealing with complex mergers. This approach ensures that the combined experience of the agencies is reflected in the process and increases the chances of a more efficient outcome.

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*The authors advised VMware in the non-US merger reviews.*[17]

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14 As considered by the CMA's foreclosure strategy.

15 Mixed bundling is more profitable than pure bundling as the firm can charge higher prices to customers with very strong preferences for using product A with a rival's product B.

16 Separately, both the Commission and SAMR required commitments to safeguard commercially sensitive information VMware receives from Broadcom's rivals.

17 A team led by Prof Steven C. Salop, Dr Yianis Sarafidis, Dr Serge Moresi and Kenneth Kerr advised VMware in the US merger review. The APAC team included Dr Fei Deng and Dr Yi Cheng.

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