

# NVIDIA – Arm

A report to the Secretary of State for Digital, Culture, Media & Sport on the anticipated acquisition by NVIDIA Corporation of Arm Limited

20 July 2021

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Please note that [X] indicates figures or text which have been deleted or replaced in ranges for reasons of commercial confidentiality.

## 1. Executive summary

- 1.1 This CMA report relates to the proposed acquisition by NVIDIA Corporation (**NVIDIA**) of the Intellectual Property Group business of Arm Limited (**Arm**) (the **Merger**).
- 1.2 This report is provided to the Secretary of State for Digital, Culture, Media and Sport (the **Secretary of State**) pursuant to a [public interest intervention notice](#) (**Notice**). This summary focuses on the CMA's competition assessment of the Merger.
- 1.3 NVIDIA and Arm are active at different levels of the global semiconductor technology industry. NVIDIA is a US-based company that supplies semiconductors (often referred to as 'chips', including graphics processing units (**GPUs**)), and network interconnect products to customers globally for a variety of applications. Arm is a UK-headquartered company which supplies semiconductor intellectual property (**IP**) based on a specific instruction set architecture (**ISA**). It primarily supplies IP relating to central processing units (**CPU IP**) to semiconductor suppliers and systems-on-chip (**SoC**) developers globally. Such suppliers (including NVIDIA) use Arm's IP to produce semiconductor chips and related products for a variety of applications. Arm estimates 70% of the world's population engages with Arm-based technology.
- 1.4 The semiconductor technology industry is worth billions of pounds and is critical to many of the products used every day by businesses and consumers across the UK. The Merger takes place against the background of important changes in the industry. These include the emergence of artificial intelligence, which has driven significant growth in sectors such as datacentres, internet-of-things and autonomous driving.
- 1.5 NVIDIA and Arm are important drivers of technological change in their fields, and the Merger would afford the merged business a significant degree of control over key technologies for a range of sectors.
- 1.6 The CMA received a substantial number of detailed and reasoned submissions from customers and competitors raising concerns in numerous markets. After careful examination, the CMA found significant competition concerns associated with the merged business' ability and incentive to harm the competitiveness of NVIDIA's rivals (that is, to 'foreclose') by restricting access to Arm's CPU IP and impairing interoperability between related

products, so as to benefit NVIDIA's downstream activities and increase its profits.

- 1.7 The CMA found significant competition concerns as a result of the effect of such foreclosure in the supply of CPUs, interconnect products, GPUs, and SoCs across several global markets, spanning the datacentre, internet-of-things, automotive and gaming console applications.
- 1.8 The CMA found that the foreclosure strategies identified would reinforce each other and would, individually and cumulatively, lead to a realistic prospect of a substantial lessening of competition (**SLC**), and consequently to a stifling of innovation, and more expensive or lower quality products.
- 1.9 NVIDIA offered a set of behavioural remedies seeking to address the CMA's concerns. The CMA found the offer to present considerable specification, circumvention, and monitoring and enforcement risks. Having regard to: (i) the complex and evolving nature of the contracts and markets involved; (ii) the magnitude of the competition concerns; and (iii) the breadth and technical nature of the offer, the CMA does not believe any form of behavioural remedy would address the competition concerns identified to the phase 1 clear-cut standard.
- 1.10 In conducting its investigation, the CMA has worked closely with other competition authorities around the world to carefully consider the impact of the Merger.

## **The CMA's report and decisions**

- 1.11 The Notice requires the CMA to investigate and report on its assessment of the Merger's effects on competition by midnight on 30 July 2021, following which the Secretary of State shall make its decision on the relevant public interest considerations. The CMA's decisions in this report are summarised below.
- 1.12 Jurisdiction: The CMA believes that NVIDIA and Arm are enterprises that would cease to be distinct as a result of the Merger, and that the turnover test under section 23(1)(b)(i) of the Act is met. Accordingly, arrangements are in progress or in contemplation which, if carried into effect, will result in the creation of a relevant merger situation.
- 1.13 Competitive assessment: The CMA has concluded that the Merger gives rise to a realistic prospect of an SLC within a market or markets in the United Kingdom (**UK**) and that the test for reference is met on competition grounds. The CMA found an SLC in:

- (a) the supply of CPUs for datacentre servers globally;
- (b) the supply of network-interface controllers enabling the transfer of data in datacentres globally;
- (c) the supply of GPUs for datacentre servers globally;
- (d) the supply of SoCs for high performance internet-of-things applications globally;
- (e) the supply of SoCs for automotive applications globally, in respect of:
  - (i) advanced driver assistance systems applications; and
  - (ii) information and entertainment applications; and
- (f) the supply of SoCs for gaming consoles globally.

1.14 Remedies: The CMA concluded that it would not be appropriate to deal with the competition concerns identified by way of undertakings in lieu of a reference to a phase 2 investigation.

## **The CMA's competitive assessment**

1.15 NVIDIA and Arm together are referred to as the **Parties** in this report and, for statements referring to the future, as the **Merged Entity**.

1.16 Several relationships arise between the Parties at different levels of the supply chain and across neighbouring sectors. The CMA therefore assessed the Merger by reference to **vertical** and **conglomerate** effects. Concerns relating to vertical effects can arise when a merged entity may use its control of an important input to harm downstream rivals. Concerns relating to conglomerate effects can arise when a merged entity may harm its rivals in one market by restricting their access to customers through its strong position in a related market.

### ***Vertical and conglomerate effects in datacentres***

1.17 Arm supplies CPU IP for use in (i) CPUs for datacentre servers (**Datacentre CPUs**); and (ii) enhanced network-interface controllers enabling the transfer of data in datacentres (**SmartNICs**). NVIDIA supplies SmartNICs and GPUs for use in datacentres (**Datacentre GPUs**), and is developing Datacentre CPUs. The majority of third parties (ie customers and competitors) that responded to the CMA's investigation in relation to datacentres raised concerns relating to vertical and/or conglomerate effects.

## *Vertical effects*

- 1.18 The CMA considered whether the Merged Entity could harm NVIDIA's rivals and lessen competition in the supply of (i) Datacentre CPUs and, separately (ii) SmartNICs. The CMA assessed whether the Merged Entity could do so by: (i) refusing to supply Arm's CPU IP for use in rival Datacentre CPUs and SmartNICs (total foreclosure) or (ii) by increasing the price or worsening the quality of this CPU IP supplied to them (partial foreclosure). For the reasons set out below, the CMA found that the Merged Entity would have the ability and incentive to foreclose rivals' access to Arm's IP, thereby harming downstream competition.
- 1.19 With regard to the Merged Entity's ability to foreclose rivals, the CMA found Arm controls an important input and has market power in the supply of CPU IP for Datacentre CPUs and for SmartNICs.
- (a) Third parties indicated Arm is a very important supplier of CPU IP due to technical proficiencies, the strength of Arm's software ecosystem and the 'open' nature of Arm's IP-only business model. Arm's CPU IP is key for Datacentre CPU suppliers without access to the x86 ISA (as used by Intel or AMD) or to in-house solutions. This includes cloud service providers which are driving growth in the Datacentre CPU market. Sales of Arm-based Datacentre CPUs have grown rapidly in recent years and are projected to continue this growth, thus exerting pressure on Intel and AMD's Datacentre CPUs. The CMA found the constraint posed by current or future alternative suppliers of CPU IP to third parties (such as RISC-V and MIPS) is weak, and that there are significant barriers to switching CPU IP licensor.
- (b) Arm is the leading supplier of CPU IP for SmartNICs with a longstanding, near-100% share of supply. The constraint posed by other CPU IP licensors such as MIPS and Power is weak, and there are significant barriers to switching CPU IP licensor.
- (c) Given the limited alternatives to Arm's CPU IP, the CMA does not consider licensees to have the buyer power to defend themselves against foreclosure.
- 1.20 The CMA found that the Merged Entity would be able to implement a total and/or partial foreclosure strategy. This could include targeting NVIDIA's rivals to restrict or downgrade future access, and/or develop or roll-out IP in a way that favours NVIDIA.
- 1.21 With regard to the Merged Entity's incentives, the evidence indicates that the benefits of foreclosure are likely to outweigh the costs of such strategy. The

CMA believes that the Merger may create incentives to change Arm's business model to favour NVIDIA and notes the rapid growth of the addressable Datacentre CPU and SmartNIC markets specifically.

### *Conglomerate effects*

- 1.22 Datacentre CPUs, Datacentre GPUs and SmartNICs perform key and complementary functions in datacentres. The CMA therefore considered whether the Merger could give rise to conglomerate effects through the Merged Entity restricting or degrading the interoperability between Datacentre GPUs and Arm-based Datacentre CPUs and/or SmartNICs. The CMA considered whether the Merged Entity could leverage its positions in the supply of: (i) CPU IP to foreclose rival suppliers of Datacentre GPUs; and/or (ii) Datacentre GPUs, to foreclose rival suppliers of Arm-based Datacentre CPUs and/or SmartNICs. The CMA found the Merged Entity would have the ability and incentive to foreclose rivals, thereby harming downstream competition.
- 1.23 With regard to the ability to engage in foreclosure, the CMA found (as outlined above) that Arm controls an important input and has market power in the supply of CPU IP for Datacentre CPUs and SmartNICs. As the longstanding leading supplier with over 90% share of supply, NVIDIA also has market power in the supply of Datacentre GPUs. The evidence indicates the Merged Entity could modify the interoperability between Datacentre GPUs and Arm-based Datacentre CPUs and/or SmartNICs, to enhance NVIDIA's products and undermine the operability of rivals' products, so as to *de facto* 'bundle' the supply of these products. The CMA believes that, given the importance of these products, customers would be incentivised to buy such product combinations.
- 1.24 With regard to the incentives, the CMA found that: (i) the above foreclosure strategies are consistent with NVIDIA's existing business practice to bundle certain products; and (ii) gains in Datacentre GPU, and Datacentre CPU and SmartNIC sales are likely to outweigh the costs.
- 1.25 The CMA believes that there is a realistic prospect that the foreclosure strategies (or combination thereof) outlined above would have the effect of substantially reducing competition in the supply of (i) Datacentre CPUs; (ii) SmartNICs; and (iii) Datacentre GPUs.

## ***Vertical effects in internet-of-things, automotive, and gaming consoles***

- 1.26 The CMA also considered total and/or partial foreclosure (referred to collectively as foreclosure below) by the Merged Entity restricting access to Arm's CPU IP to:
- (a) rival suppliers of SoCs for high performance internet-of-things applications;
  - (b) rival suppliers of SoCs for advanced driver assistance systems (**ADAS**) and infotainment automotive applications; and
  - (c) rival suppliers of SoCs for gaming console applications.
- 1.27 The CMA received a significant number of detailed and reasoned concerns from customers and competitors relating to these theories of harm.
- 1.28 With regard to the ability to foreclose, the CMA believes that Arm controls an important input and has market power in the supply of CPU IP for each of: (i) SoCs for high performance internet-of-things; (ii) SoCs for both ADAS and infotainment in automotive; and (iii) SoCs for gaming console applications.
- 1.29 Similarly to datacentre, common factors attesting to the importance of Arm's CPU IP across all of these products included evidence on the critical role of CPU IP for these SoCs, the technical advantages of Arm's CPU IP, the strength of Arm's software ecosystem, the lack of credible alternatives, the barriers to switching, and the absence of countervailing buyer power. For the reasons outlined in relation to datacentre, the CMA believes that the Merged Entity would be able to target rival SoC suppliers.
- 1.30 With regards to the incentives, the evidence indicates that, across each of these theories of harm, the benefits are likely to outweigh the costs of such a strategy. The markets for the supply of SoCs for each of high performance internet-of-things, ADAS and high-end infotainment applications are nascent and growing, which the CMA believes gives NVIDIA a strong incentive to gain a first-mover advantage through a foreclosure strategy.
- 1.31 The CMA believes that there is a realistic prospect that the effects of a foreclosure strategy in relation to the supply of CPU IP for use in internet-of-things, automotive and gaming console applications would substantially reduce competition in each of the downstream markets, namely the supply of SoCs for: (i) high performance internet-of-things; (ii) ADAS in automotive; (iii) infotainment in automotive; and (iv) gaming consoles.

## ***Conclusion on competitive assessment***

- 1.32 The CMA therefore believes that it is or may be the case that the Merger may be expected to result in an SLC in the following markets:
- (a) the supply of Datacentre CPUs globally;
  - (b) the supply of SmartNICs globally;
  - (c) the supply of Datacentre GPUs globally;
  - (d) the supply of SoCs for high performance internet-of-things applications globally;
  - (e) the supply of SoCs for automotive applications globally, in respect of:
    - (i) ADAS applications, and
    - (ii) infotainment applications; and
  - (f) the supply of SoCs for gaming consoles globally.
- 1.33 In addition, having regard to the important links between these markets, the CMA found that the effects of the individual foreclosure strategies would variously reinforce each other.
- 1.34 In addition to the theories of harm outlined above, the majority of customers and competitors that responded to the CMA's investigation in relation to general-purpose personal computers (**PCs**) also raised vertical foreclosure concerns along the lines outlined above. Within the constraints of the phase 1 process and limits on the information made available by the Parties to the CMA at this stage, the CMA has not been able to investigate this area sufficiently to come to a conclusion as to whether there is a realistic prospect of an SLC. The CMA believes that this is an area which may warrant further examination in any phase 2 investigation.

## **Undertakings in lieu**

- 1.35 The Parties offered a behavioural undertaking which purported to ensure an open licensing regime, based on equal access and interoperability, with protections against disclosure of competitively sensitive information.
- 1.36 The CMA does not consider that the conduct required to address the competition concerns identified can be specified with sufficient clarity, to provide a lasting remedy that is capable of effective monitoring and enforcement. This risk is significant in this case, having regard to: (i) the

complex and evolving nature of the contracts and markets involved; (ii) the magnitude of the concerns identified, spanning a number of markets and applications; and (iii) the breadth and technically specialist nature of the offer. The CMA found such a behavioural remedy would carry material specification, circumvention, and monitoring and enforcement risks. Therefore, the CMA does not believe any form of behavioural remedy would address the competition concerns identified to the phase 1 standard.

- 1.37 It also does not believe any partial divestment of Arm's IP business(es) would be sufficiently clear-cut and comprehensive for phase 1.

## Public interest

- 1.38 As required by section 44(3)(b) of the Act, the CMA has summarised representations received from third parties which relate to the national security public interest consideration mentioned in the Notice.

## 2. Legal Framework

- 2.1 In relation to anticipated mergers which are not subject to the public interest regime, the CMA is required to make a reference for an in-depth phase 2 inquiry where it believes that it is or may be the case that the creation of a relevant merger situation may be expected to result in an SLC within any market or markets in the UK for goods or services (section 33(1) of the Enterprise Act 2002 (**Act**)).

- 2.2 The Act permits intervention by the Secretary of State in cases where he or she believes that it is or may be the case that one or more than one public interest consideration is relevant to a consideration of the relevant merger concerned.<sup>1</sup> In such a case, section 33(1) does not apply<sup>2</sup> and instead the CMA is required to give a report to the Secretary of State within such period as he or she may require.<sup>3</sup> The report must contain:<sup>4</sup>

- (a) advice on the considerations relevant to the making of a reference under section 22 or 33 of the Act which are also relevant to the Secretary of State's decision as to whether to make a reference under section 45 of the Act; and

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<sup>1</sup> Section 42(2) of the Act. As to public interest mergers more generally, see Chapter 16, [Mergers: Guidance on the CMA's jurisdiction and procedure](#) (CMA2revised), December 2020 (**Guidance on the CMA's jurisdiction and procedure**).

<sup>2</sup> Section 33(3)(d) of the Act.

<sup>3</sup> Section 44(2) of the Act.

<sup>4</sup> Section 44(3) of the Act.

(b) a summary of any representations about the case received by the CMA and which relate to any public interest consideration mentioned in the intervention notice concerned (other than a media public interest consideration) and which is or may be relevant to the Secretary of State's decision as to whether to make a reference under section 45 of the Act.

2.3 In particular, the report must include<sup>5</sup> decisions as to whether the CMA believes it is or may be the case that:

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

(b) the creation of that situation has resulted or may be expected to result in an SLC within any market or markets within the UK for goods and services;

(c) it would be appropriate to deal with the matter (disregarding the relevant public interest consideration) by way of undertakings in lieu of a reference to phase 2.<sup>6</sup>

2.4 Following receipt of the CMA's report, the Secretary of State may<sup>7</sup> make a phase 2 reference to the CMA on public interest grounds. In deciding whether to make such a reference, the Secretary of State is required to accept the CMA's decision on the matters listed in paragraph 2.3 above.<sup>8</sup> The relevant legal framework in relation to the CMA's assessment of jurisdiction is set out in section 4.

### 3. Parties and Transaction

#### *Parties' relevant activities*

3.1 Arm is a UK-based company that develops and licenses semiconductor IP based on a specific ISA to semiconductor suppliers on a worldwide basis. Arm is ultimately owned by SoftBank Group Corp. (**SoftBank**), a company listed

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<sup>5</sup> The full list of requirements is set out in section 44(4) of the Act.

<sup>6</sup> Under paragraph 3 of Schedule 7 of the Act.

<sup>7</sup> Pursuant to section 45 of the Act.

<sup>8</sup> Section 46(2) of the Act. The Secretary of State is also required by section 46(2) to accept the CMA's decision as to whether it believes that it is or may be the case that it would be appropriate to deal with the matter (disregarding any public interest considerations mentioned in the intervention notice) by way of undertakings under paragraph 3 of Schedule 7 of the Act. This is considered at section 12 of this report.

on the Tokyo Stock Exchange. Arm's global turnover was £1,513.7 million in FY2020 (£[✂]) of which was generated in the UK.<sup>9</sup>

3.2 Arm licenses semiconductor IP for the following fields of application, amongst others:

(a) Datacentre applications. Arm's CPU IP is used by semiconductor suppliers and cloud service providers to design: (i) Datacentre CPUs; and (ii) SmartNICs,<sup>10</sup> amongst other semiconductor products.

(b) Automotive applications. Arm's CPU IP is used by semiconductor suppliers to design and supply SoCs for a variety of automotive applications.<sup>11</sup> IP for graphics processing units (**GPU IP**), image signal processors (**ISP IP**) and ancillary IP for use in automotive SoCs and interconnect fabrics (**System IP**) are also used in this way, albeit to a lesser extent.

(c) Gaming console applications. Arm's CPU IP is used by semiconductor suppliers to design and supply SoCs for inclusion in a variety of gaming devices, including consoles.

(d) High performance internet-of-things (HP IoT) applications. Arm's CPU IP is used by semiconductor suppliers to design and supply SoCs for inclusion in a variety of IoT devices.

3.3 NVIDIA is a US-based company that supplies semiconductors (primarily, GPUs) and computing platforms worldwide for a variety of fields of application. Through Mellanox, NVIDIA also supplies network interconnect products including SmartNICs. NVIDIA is listed on the NASDAQ stock exchange and had global turnover in FY2020 of £12,942.41 million (£[✂]) of which was generated in the UK.<sup>12</sup>

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<sup>9</sup> The Parties' email submission of 13 July 2021. Most of Arm's turnover is reported as generated outside of the UK (ie in the US and Asia) based on the location of its customers.

<sup>10</sup> Different types of SmartNICs exist, including SmartNICs based on application specific integrated circuits, field programmable gate arrays (**FPGAs**), SoCs and data processing units (**DPUs**) (see [Defining SmartNIC: What is a SmartNIC and How to Choose the Best One \(mellanox.com\)](#), accessed by the CMA on 8 July 2021). In this Report, the term SmartNIC is used to indicate all these different types of SmartNICs as well as the components the SmartNICs are based on (eg DPUs).

<sup>11</sup> The term 'SoC' is the generic name for an integrated circuit that combines all or many of the components of a computer system that are designed to carry out a computing task for a specific end application. The exact combination of components in a given SoC will depend on the application for which the SoC is designed; however, these will often include a general purpose compute engine (such as a CPU) and specialised processors and accelerators (such as GPUs). Further detail on the SoCs supplied by NVIDIA and its rivals is provided in the Competitive Assessment at Section 7.

<sup>12</sup> The Parties' email submission of 13 July 2021.

- 3.4 NVIDIA is active downstream of Arm’s IP licensing activities and supplies semiconductors for the following fields of application, amongst others:
- (a) Datacentre applications. NVIDIA supplies Datacentre CPUs, SmartNICs and Datacentre GPUs.
  - (b) Automotive applications. NVIDIA supplies SoCs and SoC-based platforms for a variety of automotive applications, in particular ADAS and infotainment (ie in-vehicle information and entertainment for drivers and passengers).
  - (c) Gaming console applications. NVIDIA supplies SoCs for gaming consoles (**Console SoCs**), amongst other semiconductors.
  - (d) HP IoT applications. NVIDIA supplies SoCs for inclusion in a variety of HP IoT devices.<sup>13</sup>

### ***Transaction***

- 3.5 On 13 September 2020, SoftBank Group Capital Limited and SVF Holdco (UK) Limited (both ultimately owned and controlled by SoftBank) agreed to sell the share capital of Arm to NVIDIA for US\$40 billion (approximately £31.3 billion). The Parties submitted that NVIDIA’s rationale for the Merger is a pro-competitive one to ‘turbocharge Arm’s CPU [datacentre] server investment and execution pace, ensuring that we have a competitive alternative to [Intel and AMD’s] x86 CPUs.’<sup>14</sup>
- 3.6 As outlined further in the competitive assessment at paragraph 7.5, the CMA believes that a number of NVIDIA’s internal documents are consistent with its stated rationale to expand the Merged Entity’s activities in datacentre. However, as regards NVIDIA’s statements of intention to grow Arm’s ecosystem<sup>15</sup> through maintaining Arm’s open licensing model,<sup>16</sup> the CMA notes that such statements were either made after the Merger was publicly announced, or to the NVIDIA board in likely anticipation of regulatory review of the Merger. The CMA will typically give less weight to positions expressed in such contexts.<sup>17</sup> The CMA received significant volume of reasoned concerns raised by third parties as regards the potential for foreclosure by the

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<sup>13</sup> NVIDIA also develops GPU IP for its own proprietary use. It does not license GPU IP (or any forms of semiconductor IP) to third parties.

<sup>14</sup> NVIDIA’s internal document entitled ‘Arm – company overview’, undated, original document name: Q2a - 4c-1 Arm - Company Overview.pdf, batch: NVIDIA Section 109 - Batch 1, page 1.

<sup>15</sup> NVIDIA’s internal document entitled ‘Arm – company overview’, undated, original document name: Q2a - 4c-1 Arm - Company Overview.pdf, batch: NVIDIA Section 109 - Batch 1, page 2.

<sup>16</sup> Letter from Jensen Huang to the Financial Times, October 13, 2020.

<sup>17</sup> [Merger Assessment Guidelines](#) (CMA129), 18 March 2021 (**Merger Assessment Guidelines**), paragraph 2.29 (a).

Merged Entity. The CMA has therefore placed limited weight on NVIDIA's above-referenced statements relating to maintaining Arm's business model, and considered such NVIDIA's statements in the round in the context of other evidence received.<sup>18</sup>

- 3.7 The CMA considers NVIDIA's US\$40 billion valuation of Arm indicates NVIDIA's positive expectations for Arm's future growth prospects.<sup>19</sup> The valuation, which shows a multiple of [REDACTED] of Arm, is [REDACTED].<sup>20</sup> The CMA further notes that, as the transaction price comprises approximately US\$12 billion in cash and US\$21.5 billion in stock,<sup>21</sup> SoftBank will continue to benefit (in part) through this shareholding after the Merger from any further growth in the value of the Merged Entity.

## Procedure

- 3.8 The Merger was considered at a Case Review Meeting.
- 3.9 The Merger is also the subject of competition review by a number of other competition authorities worldwide.

## 4. Jurisdiction

### Legal Framework

- 4.1 The CMA has jurisdiction over transactions where it believes that it is or may be the case that a relevant merger situation has been created. In the case of an anticipated transaction, a relevant merger situation has been created when:

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<sup>18</sup> See, for example, third-party views discussed at paragraphs 7.80, 7.188 and 7.236.

<sup>19</sup> NVIDIA's valuation methodology was based on a combination of [REDACTED]. NVIDIA used [REDACTED] for Arm in this calculation which shows [REDACTED]. In benchmarking multiples [REDACTED], NVIDIA chose [REDACTED].

<sup>20</sup> [REDACTED]

<sup>21</sup> Merger notice submitted by the Parties on 7 May 2021 (**Final Merger Notice**), paragraph 86.

- (a) arrangements are in progress or in contemplation which, if carried into effect, will lead to two or more enterprises<sup>22</sup> ceasing to be distinct.<sup>23</sup> Two enterprises will cease to be distinct if they are brought under common ownership or control;<sup>24</sup> and
- (b) either the thresholds under sections 23(1) (the turnover test) or 23(2) (the share of supply test) of the Act are satisfied.

## Assessment

- 4.2 The CMA believes the transaction (as described in paragraph 3.5) constitutes arrangements in progress or contemplation for the purposes of the Act.<sup>25</sup> Each of NVIDIA and Arm is an enterprise. As a result of the Merger, these enterprises will be brought under common ownership and control and will thus cease to be distinct.
- 4.3 Arm is a 'relevant enterprise' undertaking an activity specified under section 23A of the Act, including through its activities consisting of or including the 'owning, creating or supplying intellectual property relating to the functional capability of computer processing units'.<sup>26</sup> This is through, for example, the owning, creation and supply by Arm of IP relating to CPUs, as outlined at paragraph 3.2 above. As such, the £1 million turnover threshold set out in section 23(1)(b)(i) of the Act applies.
- 4.4 Arm's annual UK turnover exceeds £1 million (c [£] in 2020),<sup>27</sup> therefore meeting the turnover threshold in section 23(b)(ii) of the Act.

## Conclusion on jurisdiction

- 4.5 Accordingly, in accordance with sections 44(3)(a) and 44(4) of the Act, the CMA believes that it is or may be the case that arrangements are in progress or in contemplation which, if carried into effect, will result in the creation of a relevant merger situation.

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<sup>22</sup> 'Enterprise' is defined in section 129 of the Enterprise Act 2002 as the activities, or part of the activities, of a business. Guidance on the CMA's jurisdiction and procedure, paragraph 4.10.

<sup>23</sup> Section 33(1)(a) of the Act and Section 23 of the Act.

<sup>24</sup> Section 26 of the Act.

<sup>25</sup> Section 33(1)(a) of the Act.

<sup>26</sup> Section 23A(2)(c)(i) of the Act. This is not disputed by the Parties.

<sup>27</sup> The Parties' email submission of 13 July 2021.

## 5. Counterfactual

- 5.1 The CMA assesses a merger's impact relative to the situation that would prevail without the merger (ie the counterfactual).<sup>28</sup> In an anticipated merger the counterfactual may consist of the prevailing conditions of competition, or conditions of competition that involve stronger or weaker competition between the merger firms than under the prevailing conditions of competition.<sup>29</sup>
- 5.2 The Parties submitted that the CMA should assess the competitive effects of the Merger by reference to the prevailing conditions of competition. Arm further submitted that, absent the Merger, it does not have the resources or technical expertise required to develop its 'ecosystem'<sup>30</sup> (ie, the use and development of its IP by the broader customer network) outside of [REDACTED].<sup>31</sup>

- The CMA has assessed the impact of these arguments on Arm's future competitive prospects in datacentre and other non-mobile applications, to the extent relevant, below in its competitive assessment. In doing so, the CMA has had regard to the broader market context of the licensing of semiconductor IP and the supply of semiconductors respectively: namely, that
- 5.3 this is a dynamic sector in which all market participants (including Arm) invest significantly in R&D to innovate and develop new products. In particular, the CMA has not seen sufficient evidence to indicate that Arm's investment capabilities ([REDACTED]) are liable to undermine its effectiveness as a CPU IP licensor in non-mobile segments absent the Merger, or that Arm would have fundamentally altered its approach to investment and innovation. The CMA further considers that the US\$40 billion valuation of Arm does not appear to be consistent with an alleged inability to grow its ecosystem in datacentre and PC absent the Merger.<sup>32</sup>

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<sup>28</sup> Merger Assessment Guidelines, chapter 3.

<sup>29</sup> Merger Assessment Guidelines, paragraph 3.2.

<sup>30</sup> The Parties define ecosystem in the context of the industry as 'the set of products, technologies, innovation activities, contractual and non-contractual relationships, licensees, intermediaries (including manufacturers and OEMs), software developers, software tools, complementary hardware developers, and end-users that directly or indirectly rely on a particular Instruction Set Architecture'. See Compass Lexecon paper submitted by the Parties, entitled 'The Competitive Effects of the Transaction in the Datacenter and PC Markets', 22 June 2021 (**Compass Lexecon paper on Competition**), paragraph 2.1.

<sup>31</sup> As discussed further below at Section 7, Arm also submitted that options other than the Merger, [REDACTED], would likely significantly limit its ability to make long term investments outside of [REDACTED]. Issues Letter Follow-up Letter on Arm's ability to compete in datacentre in the absence of the Merger, submitted by Arm, 23 June 2021 (**Arm follow-up letter**), page 7.

<sup>32</sup> See, for example, paragraph 7.29 of this report, where the CMA notes that although the Parties submitted that the transaction price premium can theoretically be explained by synergies driven by NVIDIA, these claims have not been substantiated with evidence.

5.4 Accordingly, the CMA considers that the prevailing conditions of competition involve an environment where each Party (and other market participants) would have continued to invest and innovate. The CMA has assessed the impact of Arm’s resources on its competitive position in the relevant markets (along with available evidence relating to future development plans by other market participants) in the competitive assessment.

## 6. Frame of Reference

6.1 There are various non-horizontal relationships between the Parties, as Arm supplies semiconductor IP and NVIDIA supplies semiconductors and network interconnects downstream. For the purpose of frame of reference, the CMA has focused on these relationships by reference to:

(a) in relation to datacentre applications (theory of harm (**ToH** 1):

(i) supply of Arm’s CPU IP to suppliers of Datacentre CPUs;

(ii) supply of Arm’s CPU IP to suppliers of SmartNICs;

(iii) supply and, specifically, interoperability between Datacentre GPUs and Arm-based Datacentre CPUs and/or SmartNICs;

(b) in relation to HP IoT applications (**ToH 2**), supply of Arm CPU IP to suppliers of SoCs;

(c) in relation to ADAS and infotainment applications (**ToH 3**), supply of Arm CPU IP, potentially in combination with Arm GPU IP, ISP IP and System IP to suppliers of SoCs; and

(d) in relation to gaming consoles (**ToH 4**), supply of Arm CPU IP to suppliers of Console SoCs.<sup>33, 34</sup>

6.2 The assessment of the relevant market is an analytical tool that forms part of the analysis of the competitive effects of the merger and should not be viewed as a separate exercise. Market definition involves identifying the most significant competitive alternatives available to customers of the merger firms and includes the sources of competition to the merger firms that are the immediate determinants of the effects of the merger.<sup>35</sup> In line with the

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<sup>33</sup> As set out further below in the competitive assessment, the CMA also highlights concerns raised by third parties in respect of vertical effects in general-purpose PCs.

<sup>34</sup> These being the key segments in which a relevant non-horizontal relationship arises. The CMA notes in particular that although Arm supplies IP for lower performance IoT devices, and NVIDIA supplies SoCs for gaming devices other than consoles, the CMA has not focused on these in its assessment of the Merger in light of the limited extent and/or lack of the other merging party’s activities in these segments.

<sup>35</sup> Merger Assessment Guidelines, paragraph 9.2.

approach set out in the CMA's Merger Assessment Guidelines,<sup>36</sup> the CMA's assessment of the evidence for the purpose of its consideration of whether the Merger may be expected to result in an SLC in any market(s) in the UK does not depend on the precise definition of the relevant market(s) in any mechanistic way, as the CMA may take into account constraints outside the relevant market, segmentation within it or other ways that some constraints are more important than others.<sup>37</sup> Accordingly, in its competitive assessment, the CMA has considered the most important constraints on the Merged Entity.

## **Product scope**

### ***Parties' submissions***

- 6.3 The Parties submitted that Arm's activities upstream in the development and licensing of semiconductor IP should constitute a separate market from the manufacturing/supply of semiconductors downstream by NVIDIA.
- 6.4 The Parties further submitted that it is appropriate to segment the downstream supply of semiconductor processors (and by implication, the upstream supply of IP licensing also) by:
- (a) Processor type (ie as between CPUs and other semiconductor types, such as GPUs). The Parties also identified distinct markets as between discrete GPUs and GPUs integrated in SoCs, noting that the line between the two may not be clear-cut.
  - (b) Application (ie the field for which the IP / semiconductor is used). The Parties identified separate frames of reference as between datacentres, gaming consoles, automotive and HP IoT applications. Within automotive applications, the Parties further distinguished between ADAS and infotainment.

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<sup>36</sup> Merger Assessment Guidelines, paragraphs 9.2-9.5.

<sup>37</sup> Merger Assessment Guidelines, paragraph 9.4.

## **CMA assessment**

### *Supply chain levels (IP licensing / supply of semiconductor processors)*

- 6.5 The evidence obtained in the course of the investigation supports the view that IP licensing should be considered separately from the supply of semiconductor processors.<sup>38</sup>
- 6.6 As noted above, at the upstream level, the CMA's primary focus of assessment is Arm's licensing activities in CPU IP.<sup>39</sup> The CMA has also focused on NVIDIA's downstream activities in the supply of GPUs,<sup>40</sup> SmartNICs and CPUs (including: (i) NVIDIA's in-development CPU 'Grace'; (ii) CPUs integrated in NVIDIA's Console SoCs; (iii) CPUs integrated in NVIDIA's SoCs for automotive applications; and (iv) microprocessors integrated in NVIDIA's SoCs for HP IoT applications).

### *Segmentation by processor type*

- 6.7 The CMA believes that it is appropriate to distinguish between different semiconductor processor types at the upstream IP licensing level, given licensees cannot use IP that is only suitable for one type of processor for use in a different processor type (eg, to use CPU IP as a basis for a GPU).<sup>41</sup> Further, the scope of Arm's activities and competitive position in CPU IP differs materially from its position in some other types of IP which indicates that the competitive dynamics differ as between different forms of processor IP.<sup>42</sup> The CMA has taken into account the different competitive constraints within the supply of CPU IP including the material differences between the

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<sup>38</sup> The Parties' internal documents and third-party responses refer to these as distinct areas of activities. For example, see Arm Ltd. Discussion Materials, July 2020, original document name: 4c-9 Discussion Materials.pdf, batch: NVIDIA-CMA-001, which explains that Arm's business model is the 'designing and licensing of IP', while its licensees ('partners') use Arm's IP to create and manufacture semiconductors. Similarly, NVIDIA's documents indicate that it considers itself to be a 'vertically integrated' organisation which uses its own IP for its semiconductor supply business.

<sup>39</sup> And, to a lesser extent - in relation to the automotive segment only - Arm's licensing activities in GPU IP, ISP IP, and System IP.

<sup>40</sup> In addition to the GPUs which it currently supplies, [REDACTED]. Final Merger Notice, paragraph 129. NVIDIA is also developing CPUs.

<sup>41</sup> A document prepared by the Linley Group for Arm entitled 'A Guide to CPU Cores and Processor IP, Covers CPU, GPU, and NoC IP', 2017, original document name: Competitor-CPU-Linley2017.pdf, batch: AXON\_CMA\_20201124, discusses the implementation of CPU IP and GPU IP separately. One licensee told the CMA that 'the required IP/software are different' for different types of semiconductors.

<sup>42</sup> For example, Arm's internal document 'Semiconductor Market Trends and Challenges', 11 August 2020, original document name: SemiMarketAnalysis.pptx, batch: CMA-002 - Batch 03, page 28, indicates that over [REDACTED] % of Arm's royalty revenue was accounted for by the CPU IP (Cortex lines), while only under [REDACTED] % of Arm's royalty revenue was accounted for by its GPU IP (Mali) in Q4 2019. Arm's management presentation 'Arm Group Products, Technology and Engineering', 11 August 2020, original document name: 4c-7 Arm Group Products, Technology and Engineering MP.pdf, batch: NVIDIA-CMA-001, describes different functions of CPUs and GPUs in the automotive application, page 67.

supply of out-licensed IP to third parties and self-supply (without any third party out-licensing).

- 6.8 Regarding the downstream supply of semiconductor processors, feedback received from OEMs purchasing semiconductor processors indicates there is some, albeit limited, substitutability between semiconductor types, as these tend to perform specific individual functions.<sup>43</sup> As the focus of the CMA's assessment of the downstream supply of processors is on CPUs and GPUs, the CMA has focused on the extent of any substitutability between these processor types.
- (a) CPUs are general purpose processors that act as the 'brain' of computer system across all applications. Typical CPU functions include tasks such as running software, analysing data, managing network traffic, and fetching data from memory. The Parties submitted that these tasks cannot be performed by other types of processors as efficiently as by CPUs,<sup>44</sup> because such other processors are better placed to carry out certain other activities.
  - (b) The exact extent of substitutability between different processor types may differ depending on the application for which the processors are used. Certain individual functions can, in certain applications, technically be performed by other processors. For example, in datacentres, CPUs can carry out certain activities performed by GPUs,<sup>45</sup> namely accelerating a system, while GPUs can potentially perform some<sup>46</sup> but not all activities performed by CPUs.<sup>47</sup> However, and as discussed further below in the competitive assessment of ToH 1, the CMA considers this evidence indicates that such processors perform largely complementary functions.
  - (c) The identity and range of suppliers also varies between different processor types, indicating that competitive conditions differ between the two categories. For example, NVIDIA has an established position in the supply of GPUs as compared to its supply of CPUs generally.

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<sup>43</sup> For example, one third party told the CMA that 'different Processor Products ... are not interchangeable; they are complementary, but they each have their own specifications and use cases.' Another third party told the CMA that GPUs and CPUs are not substitutable.

<sup>44</sup> Final Merger Notice, paragraph 164. GPUs are designed to accelerate computer graphics and other applications, eg datacentre. SmartNICs connect computers to a network via a communications protocol and include on-board networking, storage, and security processing. Final Merger Notice, paragraphs 134.

<sup>45</sup> Final Merger Notice, paragraph 164.

<sup>46</sup> For example, one NVIDIA's internal document states: 'While traditional CPU-based approaches no longer deliver advances on the pace described by Moore's Law, we deliver GPU performance improvements on a pace ahead of Moore's Law, giving the industry a path forward.' NVIDIA's 'Form 10-K', 20 February 2020, original document name: Q1d - NVIDIA 10K (Annual report and accounts).pdf, batch: NVIDIA Section 109 - Batch 1, page 4.

<sup>47</sup> Final Merger Notice, paragraph 164.

6.9 For the reasons set out above, the CMA believes that it is appropriate to distinguish between GPU and CPU semiconductor processor types.

#### *Segmentation between processors and SmartNICs*

6.10 The evidence further indicates that it is appropriate in the context of datacentres to distinguish between the supply of SmartNICs (as a network interconnect product) and processors. SmartNICs connect computers to a network via a communications protocol and include on-board networking, storage, and security processing.<sup>48</sup> In enabling the transfer of data between servers and enabling applications to scale to datacentre sizes, SmartNICs perform a largely complementary function with CPUs and GPUs. As discussed further below in the competitive assessment of ToH 1, there is evidence that SmartNICs are, however, increasing in importance because they give servers more capability to accelerate. The CMA has assessed the impact of the Merger on the supply of CPU IP for, and the downstream supply of, SmartNICs separately from that of processors but considers the inter-relationship and competitive dynamics between Datacentre CPUs, SmartNICs and Datacentre GPUs further in the competitive assessment.

#### *Segmentation by application*

6.11 The evidence received by the CMA indicates that, at the upstream IP licensing level, some CPU IP products (such as Arm's Cortex-A, and semiconductor IP supplied by RISC-V and MIPS) can be used for multiple applications.<sup>49</sup> However, some other products (such as Arm's 'AE' automotive-enhanced range of IP) are tailored for (and are marketed for)<sup>50</sup> specific applications. The extent of CPU IP suppliers' and their customers' activities can also differ across certain applications, which also indicates that the competitive dynamics may differ to a degree between applications.<sup>51</sup> The CMA has therefore assessed the supply of CPU IP by reference to each relevant application (as it applies to each theory of harm) in its competitive assessment, but also by reference to the position in the supply of CPU IP overall (ie, without segmentation by application).<sup>52</sup>

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<sup>48</sup> Final Merger Notice, paragraph 148.

<sup>49</sup> For example, one licensee (NXP) uses Arm's Cortex-A72 in 'automotive applications, industrial systems, vision, HMI and single-board computers' (see <https://www.nxp.com/docs/en/fact-sheet/IMX8FAMFS.pdf>, accessed by the CMA on 8 June 2021). RISC-V IP and MIPS CPU IP are similarly used for a range of applications.

<sup>50</sup> See for example <https://www.arm.com/products/silicon-ip-cpu/cortex-a/cortex-a78ae> - Arm specifically describe this IP as being for use in autonomous vehicles, digital cockpit, and industrial automation.

<sup>51</sup> For example, Arm has an established leading position in the supply of CPU IP for mobile applications but has expanded its presence in other areas such as datacentres more recently.

<sup>52</sup> The CMA has considered the supply of GPU IP, ISP IP and System IP by reference by reference to each of the ADAS and (excluding ISP IP) infotainment applications.

- 6.12 At the downstream level, feedback from third parties indicates that there is a clear distinction between semiconductor processors for different applications (such that eg a NVIDIA Datacentre GPU may not be effectively substituted by a GPU used in a gaming console). NVIDIA also markets products to particular customer types with specific applications in mind.<sup>53</sup> This view was based on factors including that there are different technological requirements and functions for applications. The CMA has therefore focused its competitive assessment downstream on Datacentre CPUs, SmartNICs and Datacentre GPUs, SoCs for HP IoT applications, SoCs for automotive ADAS and infotainment applications, and Console SoCs, as these are where there is a vertical relationship between the Parties' activities. The CMA notes this is consistent with the Parties' submissions, as summarised at paragraph 6.4(b) above.
- 6.13 Within automotive applications specifically, the CMA considers that the competitive dynamics between ADAS and infotainment may differ to some extent on the basis that there are different downstream competitor sets and some differences in upstream Arm IP inputs (with Arm's ISP IP used for ADAS but not infotainment applications, for example). The CMA has considered any relevant distinctions between these in the competitive assessment at ToH 3, where relevant.

## **Geographic scope**

- 6.14 The Parties submitted that the geographic frames of reference for both the relevant IP licensing and the supply of semiconductor processors or SmartNICs are global, on the basis that competition at each level takes place worldwide, customers purchase from suppliers worldwide and transportation costs are low and do not prohibit global competition.<sup>54</sup>
- 6.15 The evidence received by the CMA is consistent with the Parties' submission.<sup>55</sup> Therefore, the CMA considers the geographic frame of reference for both the relevant IP licensing and the supply of semiconductor processors or SmartNIC to be global.

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<sup>53</sup> See for example <https://www.nvidia.com/en-gb/geforce/graphics-cards/30-series/> - NVIDIA markets a specific range of GPUs for gaming, versus those marketed for datacentre <https://www.nvidia.com/en-gb/data-center/data-center-gpus/>

<sup>54</sup> Final Merger Notice, paragraphs 169-170.

<sup>55</sup> The Parties' internal documents and analyst reports, and third-party views indicate that IP suppliers and semiconductor suppliers are active globally. For example, Arm's document IPG EC QBR, Q2 2018, original document name: IPG-EC-QBR-2018-FQ2.pptx, batch: AXON\_CMA\_20201124, indicates that Arm is supplying the IP on a global basis. Similarly, all parties active in the development and supply of semiconductors that responded to the CMA's investigation are active globally.

## Conclusion on frames of reference

- 6.16 In the light of the evidence described above and having regard to the principles set out at paragraph 6.2, the CMA has assessed the Merger by reference to the supply of:
- (a) CPU IP for CPUs<sup>56</sup> globally, both overall and by reference to each relevant application in its competitive assessment;
  - (b) CPU IP for SmartNICs globally as it applies to datacentre in its competitive assessment;
  - (c) GPU IP for GPUs<sup>57</sup> globally and ISP and System IP for SoCs globally as it applies to automotive ADAS and separately (excluding ISP<sup>58</sup> IP) automotive infotainment applications in its competitive assessment;
  - (d) CPUs for datacentre applications (ie, Datacentre CPUs) globally;
  - (e) GPUs for datacentre applications (ie, Datacentre GPUs) globally;
  - (f) SmartNICs for datacentre applications globally;
  - (g) SoCs for HP IoT applications globally.
  - (h) SoCs for automotive applications globally, and specifically in respect of:
    - (i) ADAS applications; and
    - (ii) infotainment applications; and
  - (i) SoCs for gaming console applications (ie, Console SoCs) globally.

## 7. Competitive Assessment

- 7.1 In formulating theories of harm, the CMA will consider how a merger might affect rivalry between firms seeking to win customers' business over time by offering them a better deal. The theories of harm will depend on the levels of the supply chain at which the merger firms operate; the links between the merger firms and with their rivals; the nature of competition and how firms

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<sup>56</sup> This includes CPUs integrated in SoCs and, in relation to SoCs for HP IoT applications, microprocessors integrated in SoCs. The CMA has referred to SoCs when assessing the Merger's impact in the: (i) ADAS/infotainment and gaming console applications to denote CPUs integrated in SoCs; and (ii) the HP IoT applications to denote microprocessors integrated in SoCs.

<sup>57</sup> Including GPUs integrated in SoCs for ADAS and infotainment applications.

<sup>58</sup> The Parties submitted that Arm's ISP IP is not used for infotainment applications (Final Merger Notice, footnote 262, page 150).

seek to win customers; and any long-run dynamics in the relevant sectors.<sup>59</sup> The CMA may consider several theories, sometimes affecting the same market.<sup>60</sup>

- 7.2 In this case, the CMA has assessed a number of theories of harm – across different applications and within the same application. The CMA has taken into account the nature of competition and market dynamics identified, and has considered not only each individual theory of harm separately but, as outlined further below, also their interaction so as to assess the impact of the Merger in the round. In doing so, the CMA has taken into account ecosystem dynamics relevant to each application, including the scale, relative importance and network effects associated with the hardware, software, other technologies and associated customer and developer relationships. The CMA has considered the implications of these wider ecosystem dynamics on its assessment of the competitive constraints posed on Arm.
- 7.3 The CMA has focussed its assessment on non-horizontal effects, as set out individually below. The CMA also notes the concerns expressed by third parties as regards general-purpose PC, as set out in section 8.7.

## **Datacentres**

### **Overview**

- 7.4 Datacentres are a key growth area for the computing industry. An important recent industry trend in the datacentre sector is the emergence of Arm. Datacentre CPUs supplied by Intel and AMD (based on the x86 CPU ISA) have historically accounted for the overwhelming majority of Datacentre CPUs globally. However, several significant customers including, for example, Amazon Web Services (**AWS**), Ampere, Fujitsu, Huawei and Nuvia, have now adopted Arm's CPU IP for Datacentre CPUs.<sup>61</sup> Accordingly, the prevalence of Arm-based CPUs downstream has been growing rapidly<sup>62</sup> and is projected to grow much further over the next decade.<sup>63</sup> Arm forecasted that its 'Infrastructure' revenues (which include datacentres and additional segments,

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<sup>59</sup> Merger Assessment Guidelines, paragraph 2.12.

<sup>60</sup> Merger Assessment Guidelines, paragraph 2.16.

<sup>61</sup> The CMA also notes that Arm recently launched its v9 architecture, and that several suppliers of Arm-based Datacentre CPUs signalled their support and their intention to continue their partnerships with Arm in the future. See [Arm launches v9 architecture – Arm@](#), accessed by the CMA on 1 July 2021.

<sup>62</sup> As outlined further below, the Parties estimate that the share of Arm-based Datacentre CPUs grew materially from less than [0-5]% in 2018 to [0-5]% in 2020 (on both a value and volume basis, see Final Merger Notice, Tables 11-12). Arm is also the predominant supplier of CPU IP for SmartNICs (see paragraph 7.45 below), which represent a rapidly growing market as illustrated by the expansion of its size (Final Merger Notice, Tables 17-20).

<sup>63</sup> See paragraph 7.25 below on the projected growth of Arm's share in datacentre, which is estimated to reach over 70% by 2030.

eg network infrastructure) would grow from US\$[redacted] in 2020 to US\$[redacted] in 2028.<sup>64</sup> Third parties also submitted that they expect the demand for Arm-based Datacentre CPUs to grow in the future (see paragraph 7.23 below).

7.5 Another trend is the emerging roles of GPUs and SmartNICs alongside CPUs in datacentres. The demand for artificial intelligence (**AI**) computing has driven the growth of GPUs which are well-suited to performing AI functions. Further, SmartNICs are expected to play a key role to offload computational demand from CPUs in datacentres and NVIDIA's CEO has said that every server in the world will include a DPU (ie SmartNIC) in the future.<sup>65</sup> The importance of controlling CPUs, SmartNICs and GPUs – recognised by NVIDIA as 'three core processors of the computer'<sup>66</sup> and described in a SoftBank document as the 'holy trinity' of computing – forms a key part of the Merger rationale.<sup>67</sup> This document goes on to describe this trinity as comprising: 'the CPU (Arm), the GPU (Nvidia), and the DPU (Mellanox); Combining leaders in cloud and edge AI to a global #1'. SmartNIC suppliers relying on Arm CPU IP include Intel, Xilinx, Marvell, [redacted], Broadcom and AWS.<sup>68</sup> The CMA considers that these trends suggest that there will be a major structural change as AI takes off in datacentres. The CMA also notes that this appears consistent with NVIDIA's rapid revenue growth in datacentres<sup>69</sup> and with NVIDIA's market valuation surpassing Intel's for the first time in 2020.<sup>70</sup>

7.6 The following diagram provides an overview of the Parties' vertical and conglomerate relationships in datacentres by reference to the supply of Datacentre CPUs, SmartNICs and Datacentre GPUs. Vertical relationships arise as Arm's CPU IP is used by semiconductor suppliers and cloud service providers (**CSPs**)<sup>71</sup> to design Datacentre CPUs and SmartNICs.<sup>72</sup> NVIDIA is developing a Datacentre CPU (Grace) and already supplies SmartNICs, both of which use Arm's CPU IP as inputs. Further, a conglomerate relationship

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<sup>64</sup> IPG Board Update, 20 February 2020, original document name: IPG Plan - February 2020 - As presented.pdf, batch: AXON\_CMA\_20201124, page 6.

<sup>65</sup> NVIDIA's earnings call Q3 2021, 2021, original document name: NVDA Q3 2021 Earnings Call 18-November-2020 5\_00 PM ET.pdf, batch: NVIDIA-CMA-019.

<sup>66</sup> NVIDIA's internal document entitled 'Arm – company overview', undated, original document name: Q2a - 4c-1 Arm - Company Overview.pdf, batch: NVIDIA Section 109 - Batch 1, page 1.

<sup>67</sup> SoftBank's document entitled 'NVIDIA + ARM BRINGING ALL THE AI PIECES IN ONE PLACE', 30 July 2020, original document name: 4c-7 NVIDIA + ARM, BRINGING ALL THE AI PIECES IN ONE PLACE.pdf, batch: AXON\_CMA\_20201124, page 3.

<sup>68</sup> Final Merger Notice, paragraph 605.

<sup>69</sup> See [Slide 1 \(q4cdn.com\)](#), accessed by the CMA on 7 July 2020.

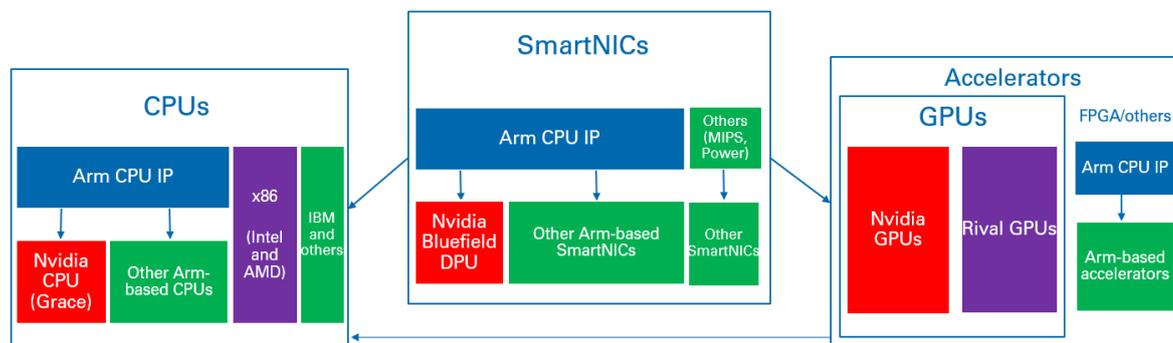
<sup>70</sup> See [Nvidia \(NVDA\) Market Cap Passes Intel \(INTC\) for First Time - Bloomberg](#), accessed by the CMA on 7 July 2021.

<sup>71</sup> CSPs offer a cloud-based platform, infrastructure, application or storage services, and include, for example, companies such as AWS, Alibaba, Microsoft, and Google (also referred to as **hyperscalers**), among others. CSPs build their own SmartNICs.

<sup>72</sup> These processors are used amongst accelerators such as field programmable gate arrays (which are also reliant on CPU IP) and GPUs (which are reliant on GPU IP).

arises as GPUs (supplied by NVIDIA) are complements to CPUs and SmartNICs (which use Arm inputs).

**Figure 1**



Source: CMA analysis

7.7 Against this background, the CMA’s competitive assessments focus on the impact of the Merger on the supply of Datacentre CPUs, SmartNICs and Datacentre GPUs. The assessments have regard to factors specific to each product individually, as well as to the linkages across these products collectively, taking account of the dynamic and evolving competitive conditions.

7.8 At the outset, the CMA notes that a significant number of third parties, of varying sizes and with varying levels of existing activity in the datacentre industry, have raised concerns covering both vertical and conglomerate aspects of the Merger. In general terms, as explained in further detail throughout the assessments below, many third parties expressed concerns that the Merged Entity could reduce their ability to compete by:

- (a) restricting access to Arm’s CPU IP, degrading the quality of its service provision and/or increasing the license fees for the CPU IP (so as to reduce these rival Datacentre CPU and SmartNIC suppliers’ competitiveness);
- (b) restricting interoperability between Arm-based products and rival Datacentre GPUs (so as to reduce the rival Datacentre CPU, SmartNIC and GPU suppliers’ competitiveness);
- (c) accessing competitively sensitive information of Arm’s customers (licensees) competing with NVIDIA downstream.

7.9 The CMA has therefore focussed on whether the Merger may give rise to:

- (a) vertical effects through foreclosure of rival suppliers of Datacentre CPUs from accessing Arm CPU IP (**ToH 1a**);

- (b) vertical effects through foreclosure of rival suppliers of SmartNICs from accessing Arm CPU IP (**ToH 1b**);
- (c) conglomerate effects through the Merged Entity restricting or degrading the relative interoperability between rival Datacentre GPUs and Arm-based Datacentre CPUs and SmartNICs, thereby: (i) leveraging its position in the supply of Arm CPU IP to foreclose rival suppliers of Datacentre GPUs; and/or (ii) leveraging its position in the supply of Datacentre GPUs to foreclose rival suppliers of Arm-based Datacentre CPUs and/or SmartNICs (**ToH 1c**).

***Vertical input foreclosure of rival suppliers of Datacentre CPUs (ToH 1a) and SmartNICs (ToH 1b)***

- 7.10 Non-horizontal mergers do not involve a direct loss of competition between the merger firms. Instead, they may result in the foreclosure of current or potential rivals if the merged entity is able to use its position in one market to harm the competitiveness of its rivals in the other. This would weaken the constraints that the merged entity faces and, as a result, harm competition and therefore customers. Another possible concern is that the merged entity may gain access to rivals' commercially sensitive information through its role as their supplier, thus allowing the merged entity to compete less aggressively and deter rivals from innovating. Such mergers may also give rise to other concerns such as incentive to increase the downstream party's prices.<sup>73</sup>
- 7.11 As noted above, the CMA has assessed whether the Merged Entity could use its control of Arm CPU IP to harm rival suppliers of Datacentre CPUs and of SmartNICs. The concern with an input foreclosure theory of harm is that the merged entity may use its control of an important input to harm its downstream rivals' competitiveness, for example by refusing to supply the input (total foreclosure) or by increasing the price or worsening the quality of the input supplied to them (partial foreclosure). This might then harm overall competition in the downstream market, to the detriment of customers.<sup>74</sup>
- 7.12 In line with the framework set out in its Merger Assessment Guidelines,<sup>75</sup> the CMA has assessed input foreclosure by considering: (i) whether the Merged Entity would have the ability to use its control of CPU IP to harm the competitiveness of downstream rival Datacentre CPU suppliers and SmartNIC suppliers; (ii) whether the Merged Entity would have the incentive to do so; and (iii) whether foreclosure would substantially lessen overall competition in

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<sup>73</sup> Merger Assessment Guidelines, paragraphs 7.2-7.4.

<sup>74</sup> Merger Assessment Guidelines, paragraph 7.9.

<sup>75</sup> Merger Assessment Guidelines, paragraph 7.10.

the supply of each of Datacentre CPUs and SmartNICs. The CMA has considered the effects limb for ToH 1a and ToH 1b for each of Datacentre CPUs and SmartNICs together with its assessment of the conglomerate effects under ToH 1c.

### *Ability*

- 7.13 In order to assess whether the Merged Entity would have the ability to foreclose competing suppliers of: (i) Datacentre CPUs; and (ii) SmartNICs (and harm their competitiveness by doing so), the CMA has considered:
- (a) The importance of Arm CPU IP and whether Arm has market power in relation to the supply of CPU IP for (i) Datacentre CPUs; and (ii) SmartNICs, including by reference to the credibility of alternative CPU IP suppliers. As part of this assessment, the CMA has considered the extent to which Arm's competitive position may be impacted by its investment capabilities absent the Merger.
  - (b) The mechanisms that the Merged Entity could use to foreclose rival Datacentre CPU and SmartNIC suppliers.

### *Importance of Arm CPU IP and whether Arm has market power*

- *Datacentre CPUs*
  - *Parties' submissions*

- 7.14 The Parties submitted that Arm has no market power in CPU IP licensing for datacentre CPUs, as technologically capable and commercially viable alternatives exist.<sup>76</sup> In particular, the Parties submitted that:
- (a) Only a small number of Datacentre CPUs currently use Arm IP and Arm faces significant challenges in its ability to grow the Arm ecosystem in datacentre absent the Merger.<sup>77</sup> In particular, Arm will struggle absent the Merger to make the necessary investments to compete against x86 and [X] in datacentres.<sup>78</sup> The fact that NVIDIA paid US\$40 billion to

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<sup>76</sup> Final Merger Notice, paragraphs 542-551; the Parties' Issues Meeting presentation dated 16 June 2021, pages 4, 27 and 31.

<sup>77</sup> Arm follow-up letter, pages 1-2.

<sup>78</sup> The Parties' Issues Meeting presentation dated 16 June 2021, page 16; Arm follow-up letter, page 2.

acquire Arm is not, according to the Parties, inconsistent with this position.<sup>79</sup>

- (b) Certain Arm forecasts projecting growth in demand for Arm's datacentre/cloud share are now outdated and/or are primarily based on demand from a minority segment of customers (CSPs) rather than the enterprise customers that account for the majority of demand for Datacentre CPUs.<sup>80</sup>
  - (c) Arm faces significant constraints from the proprietary x86 ecosystem, ie by Intel's and AMD's x86 CPUs. Following Intel's announcement in March 2021 that it will begin licensing its x86 IP to third parties in datacentres, the Parties submitted that that this creates a significant new competitive threat to Arm.<sup>81</sup>
  - (d) In addition to Intel and AMD, alternatives to Arm CPU IP exist, including solutions based on CPU IP licensed by competing licensors (eg MIPS) as well as CPUs based on open-source licences (eg RISC-V, Power and SPARC) and custom ISAs are viable alternatives in dedicated systems (eg IBM uses the z/Architecture).
- *CMA assessment*
    - *Importance of Arm CPU IP*

7.15 The importance of an upstream supplier for downstream suppliers is key to the assessment of whether a given entity has the ability to foreclose its rivals; however, it is not necessary for the upstream supplier to be supplying a critical or 'must have' product.<sup>82</sup>

7.16 In this context, the CMA notes that the CPU ISA is a critical function of the operation of the CPU and by extension, of the application for which that CPU is used. For example, Arm describes an ISA as defining 'how software controls the CPU', indicating its importance for how CPUs work.<sup>83</sup> Third parties have also indicated that the CPU ISA is a critical function of the operation of semiconductors generally: without it, semiconductors cannot

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<sup>79</sup> Compass Lexecon paper submitted by the Parties, entitled 'The relationship between the Transaction price and Arm's current competitive position', 23 June 2021 (**Compass Lexecon paper on Transaction price**).

<sup>80</sup> The Parties' Issues Meeting presentation dated 16 June 2021, slide 17; Issues Meeting dated 16 June 2021.

<sup>81</sup> NVIDIA's submission on competition from Intel dated 27 April 2021; the Parties' Issues Meeting presentation dated 16 June 2021, pages 13-14, 31; Arm follow-up letter, page 6; Compass Lexecon paper submitted by the Parties, entitled 'The Competitive Effects of the Transaction in the Datacenter and PC Markets', 22 June 2021 (**Compass Lexecon paper on Competition**), pages 7-8.

<sup>82</sup> See *Tobii AB v Competition and Markets Authority* [2020] CAT 1, paragraph 426; Merger Assessment Guidelines, paragraph 7.14(b).

<sup>83</sup> See [Instruction Sets – Arm Developer](#), accessed by the CMA on 1 July 2021.

function. One third party described the CPU ISA as ‘one of the most important inputs in the computing world...with effects that could last a generation given the time it takes to develop in this space’. The importance of CPU IP is also reflected in NVIDIA’s rationale to acquire Arm and use its CPU IP to better develop CPU products.<sup>84</sup> The CMA therefore considers that CPU ISA is a key determinant of product quality and innovation in the supply of downstream semiconductors generally (including both Datacentre CPUs and SmartNICs).

7.17 Third parties have further indicated that Arm’s CPU IP is particularly important for Datacentre CPU suppliers such as CSPs that do not have access to the x86 ISA (as Intel or AMD) or to in-house solutions (as IBM). A significant volume of third parties indicated that it was ‘very important’ for Datacentre CPU suppliers to be able to license CPU IP from Arm for the following reasons:

- (a) **Technical advantages of Arm’s CPU IP.** These included Arm’s power efficiency, the fact this supports customised offerings, and its software ecosystem. Moreover, the importance of Arm’s software ecosystem is also confirmed by, for example, two of Arm’s internal documents, which explain that Arm’s ecosystem is ‘broad and growing’ and ‘difficult to replicate’.<sup>85</sup>
- (b) The nature of Arm’s business model and the collaboration (eg through consulting with Arm on IP roadmaps) and the innovation this fosters. Third parties noted that Arm’s licensing model allows for optionality and variety and that this has facilitated the development of an active ecosystem of vendors that supply Arm-based servers. Third party feedback indicates that Arm has allowed CSPs in particular to innovate products tailored to their needs by developing Datacentre CPUs (and SmartNICs) without relying on x86. For example, one CSP submitted that Arm-based solutions offer market participants an opportunity to diversify away from, and reduce their dependence on, Intel. Arm regularly collaborates with its licensees by monitoring their needs and using pre-release versions of Arm IP to gather feedback from them and to improve its final released product.<sup>86</sup>

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<sup>84</sup> For example, NVIDIA’s internal document entitled ‘Arm – company overview’, undated, original document name: Q2a - 4c-1 Arm - Company Overview.pdf, pages 1-2 state that ‘NVIDIA needs [X] ... NVIDIA will supercharge Arm’s R&D and elevate Arm data center CPUs to world-class levels.’

<sup>85</sup> Arm’s internal document entitled ‘Arm Neoverse roadmap and products’, 3Q 2020, original document name: Roadmap-Infrastructure.pdf, batch: AXON\_CMA\_20201124, pages 33-34; Arm Ltd. Discussion Materials, July 2020, original document name: Q2b - 4c-9 Discussion Materials.pdf, batch: NVIDIA Section 109 - Batch 1, page 8.

<sup>86</sup> Narrative Response of Softbank Group Corp. and Arm Limited dated 23 April 2021, page 53.

- 7.18 Regarding the perceived value of Arm's current business model as outlined above, the Parties submitted that, while Arm has an 'open' business model, the terms of Arm's relationship with its licensees (on eg license fees) already vary significantly on an individual basis ([X]).<sup>87</sup>
- 7.19 However, the CMA believes that the value of Arm's current CPU IP offering for Datacentre CPU suppliers without access to the x86 ISA is not dependent on all such customers receiving identical commercial terms. As noted above, third parties have indicated that licensees value the fact that, as Arm does not compete with them to supply Datacentre CPUs, they feel able to share with Arm commercially sensitive information and collaborate on producing tailored Datacentre CPUs. NVIDIA has itself publicly noted in a press release announcing this Merger that Arm's 'global customer neutrality' has been 'foundational to its success'.<sup>88</sup>
- 7.20 As outlined further below at paragraph 7.38 below, the CMA believes this key feature of licensees' relationships with Arm could limit the future constraint posed by Intel in its capacity as an IP licensor to third parties. While individual licensees do have varying degrees of influence over Arm's product developments and R&D priorities, the CMA believes (as outlined further below) that, post-Merger, the balance of the Merged Entity's incentives (eg in determining product development priorities or availability) will change in favour of NVIDIA over other licensees. The CMA does not consider that the existence of negotiations between Arm and some of its licensees, or the fact that Arm has made concessions, necessarily indicates that any licensee can counter Arm's market power.<sup>89</sup> Similarly, the fact that Arm already favours certain licensees pre-Merger indicates that it has the ability to favour NVIDIA post-merger.
- *Arm's competitive position and future growth*
- 7.21 The Parties submitted that market power cannot be 'presumed' based on third-party feedback, but needed to be evidenced by data (which, in this case, they submitted indicated Arm has no market power in datacentres given its

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<sup>87</sup> The Parties' Issues Meeting presentation dated 16 June 2021, page 7.

<sup>88</sup> [NVIDIA to Acquire Arm for \\$40 Billion, Creating World's Premier Computing Company for the Age of AI | NVIDIA Newsroom](#)

<sup>89</sup> See for example, CAT judgment for case 1099/1/2/08 *National Grid PLC v The Gas and Electricity Markets Authority*, paragraphs 66-67. This point was not affected by the Court of Appeal's subsequent judgment in the same case. The CMA has also not received evidence showing the details of these negotiations and exchanges between Arm and Arm licensees.

share of licensing of CPU IP used in Datacentre CPUs was below [0-5]% in 2020).<sup>90</sup>

- 7.22 The CMA first notes that it is not required to find that an entity has a dominant position in order to find an SLC as a result of foreclosure concerns.<sup>91</sup> The CMA further notes that the overall body of evidence received indicates that Arm's competitive position has grown materially in the recent past and will continue to do so in the future.
- 7.23 Third-party feedback received by the CMA indicates that Arm-based CPUs are increasingly used in datacentres and are growing as an alternative to x86-based Datacentre CPUs. For example, one Datacentre CPU supplier told the CMA that it believes that 'there will be a massive shift from x86-based processors to Arm-based processors' and that in the 'next couple of years Arm-based products will become the platform of choice in datacentre'. Another Datacentre CPU supplier submitted that the success of its Arm-based Datacentre CPU in 2020 has been so exceptional that it led to that supplier planning to equip around [X]% of its new datacentre servers with an Arm-based Datacentre CPU in 2021.
- 7.24 Arm's successful growth is also demonstrated by the recent adoption and success of Arm's Neoverse CPU IP product. In addition to Cortex,<sup>92</sup> Neoverse has been (or is being) adopted by Arm licensees including India's Ministry of Electronics and Information Technology, Oracle, AWS, Alibaba and Tencent.<sup>93</sup> As noted further below, Arm has designed Neoverse with datacentre applications specifically in mind. The success of Arm's Neoverse is illustrated by an Arm internal document dated Q3 2020 (extract provided as Figure 2 below).<sup>94</sup> This shows the variety and range of downstream Datacentre CPU competitors who could be affected by the Merger, with Neoverse licensees ranging from large CSPs and semiconductor suppliers such as AWS and Tencent, to smaller Datacentre CPU suppliers such as Ampere.

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<sup>90</sup> Arm's internal document entitled 'Cloudflare & ARM Sync', 21 February 2020, original name: Arm\_Cloudflare\_Feb2020.pptx, batch: CMA-002 - Batch 01, page 41.

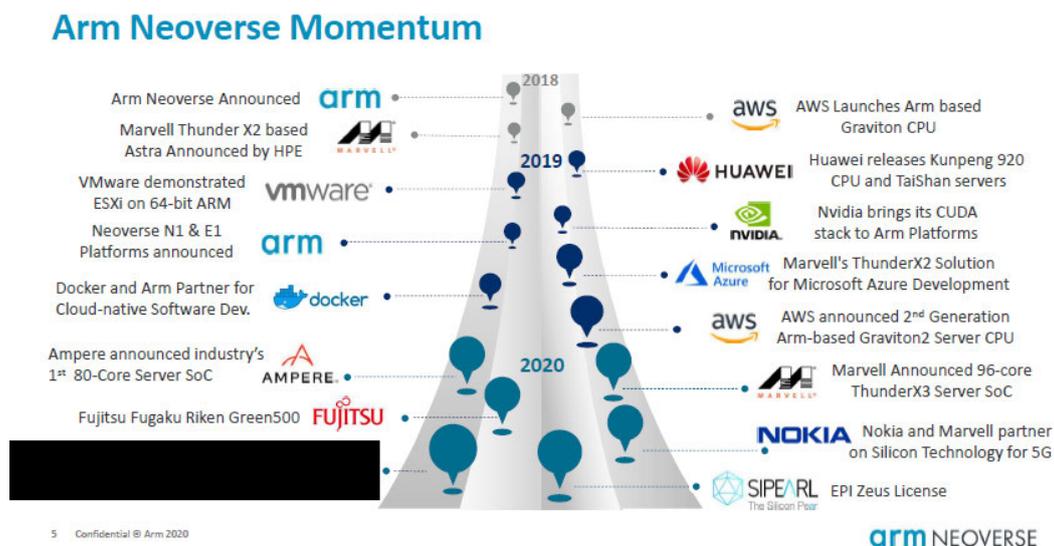
<sup>91</sup> CAT's judgment in *Intercontinental Exchange, Inc. v CMA* [2017] CAT 6 (*ICE v CMA*), paragraphs 283-284.

<sup>92</sup> Cortex is a category of Arm CPU IP products. Cortex-A, in particular is designed for complex compute tasks including cloud and edge computing, among others. See <https://developer.arm.com/ip-products/processors/cortex-a>, accessed by the CMA on 9 July 2021.

<sup>93</sup> *Transforming compute for next-generation infrastructure – Arm*. Neoverse is Arm's CPU series designed for the cloud infrastructure. See <https://www.arm.com/products/silicon-ip-cpu/neoverse/neoverse-n1>, accessed by the CMA on 9 July 2021.

<sup>94</sup> Arm's internal document entitled 'Arm Neoverse roadmap and product Infrastructure Business Line', 3Q 2020, original name: Roadmap-Infrastructure.pdf, batch: AXON\_CMA\_20201124, page 5.

Figure 2



7.25 The CMA considers that the increasing strength of Arm’s market position is further demonstrated by the rapid growth of its market share and forecasts of future growth. In relation to Datacentre CPUs specifically, the Parties submitted that Arm’s share of licensing of CPU IP used in Datacentre CPUs was below [0-5]% in 2020.<sup>95</sup> However, the CMA considers that there are a number of reasons why such shares are not a reliable indicator of Arm’s market power in this case. Importantly, historical market shares do not reflect the relative strengths of the constraint posed by the Parties and their competitors in evolving and/or nascent markets, or their market importance. The growth of Arm’s importance and penetration in Datacentre CPU IP is, in addition to the body of evidence outlined above, illustrated by the rapid growth of the usage of Arm-based Datacentre CPUs. The Parties’ submitted shares indicate Arm-based Datacentre CPUs grew materially from less than [0-5]% in 2018 to [0-5]% in 2020 (on both a value and volume basis).<sup>96</sup> A June 2020 Arm presentation to SoftBank forecasts that Arm’s datacentre/cloud share will expand from [0-5]% in FY2019 to [10-20]% in FY2024,<sup>97</sup> and SoftBank’s 2020 annual report forecasts that Arm’s market share in datacentre will exceed 25% in 2028.<sup>98</sup> Moreover, a third-party report on datacentre servers prepared by Wikibon predicted that Arm’s share would grow and reach over 70% by 2030.<sup>99</sup> The CMA notes that other market commentators have also indicated

<sup>95</sup> Arm’s internal document entitled ‘Cloudflare & ARM Sync’, 21 February 2020, original name: Arm\_Cloudflare\_Feb2020.pptx, batch: CMA-002 - Batch 01, page 41.

<sup>96</sup> Final Merger Notice, Tables 11-12.

<sup>97</sup> Arm’s internal document entitled ‘New Arm Discussion Materials’, June 2020, original name: Arm Discussion Materials -6 July 2020 - Masa Final.pdf, batch: CMA-002 - Batch 03, page 18.

<sup>98</sup> SoftBank’s [ANNUAL REPORT 2020 \(group.softbank\)](https://www.softbank.com/annual-report-2020), accessed by the CMA on 9 June 2021, page 23.

<sup>99</sup> See, for example, <https://wikibon.com/arm-yourself-heterogeneous-compute/>, accessed by the CMA on 11 June 2021. The CMA notes that Wikibon prepared market assessment for Arm where it predicted significant

an expectation that Arm's use in datacentres may grow significantly in the coming years.<sup>100</sup>

- 7.26 More broadly, the CMA also notes the Parties' submitted shares include proprietary IP or self-supply (including Intel, AMD and IBM), not currently available to third parties. As such, they significantly understate the importance of Arm CPU IP to third parties. Accordingly, specifically in relation to datacentres, and as a general point applicable throughout this report, the CMA has given limited relative weight to historical and static shares of supply as an evidence source in its assessment of the Merger where other evidence suggests these shares will change materially in future.
- 7.27 With respect to the above-cited forecasts of Arm's future position in the supply of CPU IP for use in Datacentre CPUs, the Parties submitted that Arm's June 2020 forecasts were obsolete and that Arm will not achieve its forecasted 2021 numbers in datacentre. The Parties referred instead to a third-party report [REDACTED] prediction that Arm's server share will only account for [0-5]% in 2025.<sup>101</sup> However, the CMA notes that the June 2020 forecasts show Arm's expectation of significant growth in the longer term, irrespective of whether it will meet its target in 2021. In addition, SoftBank's 2020 annual report was prepared for investors and the CMA will, therefore, typically give greater weight to documents prepared under regulatory requirements over unevicenced assertions made in the course of the CMA's proceedings.<sup>102</sup> The Parties have not provided further documents or forecasts of equivalent probative value that indicate its datacentre share of supply forecasts should be materially downgraded from its 2020 annual report statements. The CMA further notes that Arm also internally recognises that [REDACTED] under-reports Arm's activity in datacentres (suggesting that [REDACTED] projections are not the best indicator of Arm's current or future competitive position).<sup>103</sup> Furthermore,

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growth of Arm's share. See, for example, the Next Decade: Arm-based Datacenter Server Processors Match x86 in Revenue by the end of the Decade, 19 December 2019, original document name: The Next Decade\_ Arm-based Datacenter Server Processors Match x86 in Revenue by the end of the Decade.pdf, batch CMA-002 - Batch 01, page 3.

<sup>100</sup> For example, a report prepared by Dell'Oro Group entitled 'DATA CENTER CAPEX FIVE YEAR FORECAST REPORT 2020 – 2024' submitted by Arm, original document name: CL22A\_Data\_Center\_Capex\_Forecast\_Report\_Jul20.pdf, batch: CMA-002 - Batch 03, July 2020, states that Arm's open platform has been steadily gaining support from a growing list of ecosystem partners and vendors. Similarly, McKinsey & Company document prepared for Arm, 21 October 2019, original document name: 20191021 Arm - IPG Strategic Discussion\_v4.pdf, batch: CMA-002 - Batch 02\_v2, page 8, predicted growth of Arm's share in datacentre servers. See also [Arm pushing into HPC and datacenter markets, says Digitimes Research](#), accessed by the CMA on 8 July 2021; [It's Happening. Arm Server CPUs are Coming to the Data Center | Data Center Knowledge](#), accessed by the CMA on 8 July 2021.

<sup>101</sup> The Parties' Issues Meeting presentation dated 16 June 2021, page 17.

<sup>102</sup> See, for example, Merger Assessment Guidelines, paragraph 2.30.

<sup>103</sup> An Arm internal document states that [REDACTED] was under-reporting Arm server processor units 'by 10x' in 2018-2019 – Arm's internal document entitled 'x86 Risk Assessment and Strategic Response Infrastructure Business Line', March 2020, original name: Competitor-x86\_Risk\_Assesment\_April2020.pptx, batch AXON\_CMA\_20201124, page 38.

Arm's significant growth trajectory is supported by the third party feedback and recent success of Neoverse described above.

- 7.28 As noted above at paragraph 7.14(b), the Parties further submitted that most of Arm's growth in CPU IP for use in Datacentre CPUs was based on CSPs. According to the Parties, CSPs are a minority customer segment of Datacentre CPU suppliers compared to enterprise customers. The CMA recognises that there may be some differentiation between datacentre customer segments (eg in terms of technical requirements). However, the CMA believes that CSPs represent a substantial and growing proportion of the datacentre market. In particular, NVIDIA estimated that the hyperscalers' share of the Datacentre CPU Total Addressable Market (**TAM**) will grow from [X] % in 2021 to more than [X] % in 2025.<sup>104</sup> Therefore, the CMA considers that Arm's success with CSP customers represents an important part of its future growth in the supply of CPU IP to Datacentre CPU suppliers overall. Further, the CMA notes that Arm has also had success with datacentre high-performance computing customers.<sup>105</sup>
- 7.29 The CMA further notes that the significant standalone growth forecasted by Arm in relation to datacentres (outlined in paragraph 7.25 above) undermines the Parties' submissions that Arm's ability to compete in the future as supplier of CPU IP for use in Datacentre CPUs would be hampered absent the Merger.<sup>106</sup> In both a 10-year forecast<sup>107</sup> and forecast to 2024<sup>108</sup> presented to the Arm board in 2020, Arm forecasts significant revenue growth for the infrastructure division (in which datacentres sit (and comprise a significant portion of)) over these timeframes. For example, the 10-year forecast shows Arm's infrastructure division's revenue growing from US\$[X] in 2019 to US \$[X] in 2028. As noted in the Transaction section, NVIDIA's valuation of Arm is benchmarked based on multiples of [X].<sup>109</sup> In this

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<sup>104</sup> The Parties' response to the CMA RFI 2, Annex 2, tab 'Datacenter TAM'.

<sup>105</sup> See, for example, [Fujitsu A64FX: Arm-powered Heart of World's Fastest Supercomputer - Arm Blueprint](#), accessed by the CMA on 2 July 2021. NVIDIA estimated that the scientific computing's share of the Datacentre CPU TAM would be around [X] % in 2021 and around [X] % in 2025 – see [X] (the CMA understand that 'scientific computing' corresponds to high performance computing in NVIDIA's estimates).

<sup>106</sup> Arm follow-up letter. The CMA notes that the Parties provided no evidence to substantiate their assertions that pursuing an IPO option [X] (Final Merger Notice, paragraph 43).

<sup>107</sup> Arm's internal document entitled 'IPG Board Update', 20 February 2020, original document name: IPG Plan - February 2020 - As presented.pdf, batch: AXON\_CMA\_20201124, slide 6.

<sup>108</sup> Arm's internal document entitled 'Accounting and Finance', August 2020, original document name: 4c-10 Finance & Accounting.pdf, batch: AXON\_CMA\_20201124, slide 14.

<sup>109</sup> Adjusted to reflect the different accounting period used by NVIDIA. See, for example, NVIDIA's document entitled 'Board of Directors Meeting', 26 August 2020, original document name: Q2a - 4c-14 Auckland Materials in NV Board Book-Redacted.pdf, batch: NVIDIA Section 109 - Batch 1, slide 50, footnote 1 of which states that 'Auckland Management Plan presented on Newton FY basis. Newton FYE is 31<sup>st</sup> January.'

respect the Parties' submissions that the transaction price premium can theoretically be explained by synergies driven by NVIDIA have not been substantiated with evidence and the CMA has not therefore placed weight on this as an evidence source.<sup>110</sup>

- 7.30 The Parties submitted that Arm's 'IP-only' model limits Arm's ability to constrain x86 and 'Arm's R&D budget is an order of magnitude smaller than Intel and AMD's'.<sup>111</sup> However, the CMA notes that the company-level R&D data of Intel, AMD and Arm are not directly comparable given the differences in the product scope and the stage of the value chain at which these companies are active. For example, both AMD and Intel supply finished semiconductors and additionally Intel operates a foundry business, whereas Arm is mainly active in the design of IP. Moreover, the CMA considers that Arm's open licensing model is predicated on collaboration with its licensees. As such, the R&D spend by Arm alone, which excludes the R&D spend of a range of suppliers that develop Arm-based products, understates the degree of investments and innovation in the Arm ecosystem as a whole. Therefore, the CMA considers that there is insufficient evidence to suggest that Arm's IP-only model and its R&D level would necessarily limit its ability to compete with x86.
- 7.31 The Parties also submitted shares of supply for Arm's upstream position in CPU IP licensing by reference to downstream sales (including non-licensed products).<sup>112</sup> These show that Arm has a share of around [30-40]% (by value) in CPU IP generally (including non-licensed solutions) worldwide and is the leading non-proprietary CPU IP licensor for third parties by a significant margin ([70-80]% by value).<sup>113</sup> Third parties have also attested to the strength of Arm's existing ecosystem and customer relationships across CPU IP generally.
- 7.32 The Parties submitted that the strength of Arm's ecosystem across CPU IP generally is not a meaningful concept as no 'general CPU IP' ecosystem exists.<sup>114</sup> They submitted that, absent the Merger, Arm does not have the necessary resources or technical expertise outside of mobile to enable Arm-based ecosystems to emerge.<sup>115</sup> However, the CMA notes that Arm perceives one of its strengths as being its broad 'endpoint to cloud' ecosystem.<sup>116</sup>

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<sup>110</sup> Compass Lexecon paper on Transaction price.

<sup>111</sup> The Parties' Issues Meeting presentation dated 16 June 2021, page 13; Final Merger Notice, paragraph 851; Compass Lexecon Paper on Competition, Annex II, paragraph 23.

<sup>112</sup> Final Merger Notice, Tables 11-12.

<sup>113</sup> The Parties' response to the CMA RFI of 17 May 2021.

<sup>114</sup> The Parties' Issues Meeting presentation dated 16 June 2021, page 9.

<sup>115</sup> Arm follow-up letter, page 2.

<sup>116</sup> Arm's internal document entitled 'Cloudflare & ARM Sync', 21 February 2020, original name: Arm\_Cloudflare\_Feb2020.pptx, batch: CMA-002 - Batch 01, page 41.

NVIDIA also recognised as part of its Merger rationale that Arm is ‘the world’s leading CPU with a vast ecosystem’ (without reference to a specific field of application), indicating that it believes that Arm’s position across different applications (including its customer relationships<sup>117</sup>) are a meaningful barometer for Arm’s overall competitive strength.

- *Competitive constraints on Arm*

- 7.33 The Parties submitted that Arm is constrained by the x86 ecosystem, which they submitted comprises >90% share of supply of Datacentre CPUs.<sup>118</sup>
- 7.34 The CMA believes that x86-based Datacentre CPUs from Intel and AMD compete strongly with Arm-based Datacentre CPUs: a number of Arm’s internal documents monitor a perceived threat from x86<sup>119</sup> or refer to Intel’s historic dominance.<sup>120</sup> The CMA also notes that Intel and AMD are not reliant on Arm for access to CPU IP for Datacentre CPUs (and are unlikely to be so in the future). However, the CMA believes that the importance of x86-based Datacentre CPUs downstream for server OEMs is declining based on Intel’s decreasing share of supply, and that there are limitations to the constraint posed by Intel at the IP licensing level for those Datacentre CPU suppliers that do not have access to the x86 ISA.
- 7.35 First, the evidence indicates that Intel’s historic pre-eminence is declining. The estimated shares of supply provided by the Parties indicate that Intel’s share decreased between 2018 and 2020 from [90-100]% to [80-90]% by volume and from

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<sup>117</sup> [REDACTED]. NVIDIA also notes in another internal document the benefits of Arm’s [REDACTED].

<sup>118</sup> Final Merger Notice, paragraph 550, Tables 11-12 (based on IDC and Arm estimates); Compass Lexecon paper on Competition, Annex II, paragraph 1.

<sup>119</sup> For example, Arm’s internal documents suggest that it sees x86 as Arm Neoverse’s main competitor in datacentres: x86 Risk Assessment and Strategic Response, Infrastructure Business Line, March 2020, original document name: Competitor-x86\_Risk\_Assesment\_April2020.pptx, batch: AXON\_CMA\_20201124; Arm Neoverse roadmap and products, Infrastructure Business line, 3Q 2020, original document name: Roadmap-Infrastructure.pdf, batch: AXON\_CMA\_20201124, pages 11-41.

<sup>120</sup> An internal email chain from SoftBank, 30 July 2020, original document name 4c-7 NVIDIA + ARM, BRINGING ALL THE AI PIECES IN ONE PLACE.pdf, page 4, indicates that while ‘For years, cloud players had little choice but Intel and x86; The last ten years the picture has changed with the emergence of artificial intelligence (AI) and the explosive growth of data. An email exchange of Arm, February 2020, original document name RE: IPG RRC (Risk Review Committee) - ML GRR / IPG-ST03 / x86 Risk.msg, batch: CMA-002 - Batch 01, notes that [REDACTED] and that [REDACTED]’ A previous email exchange at Arm January 2019, original document name: Re: 1 million Arm-based servers shipping in 2018 - CAN WE CLAIM SUCCESS?.msg, batch: CMA-002 - Batch 02\_v2, further notes that at that stage, Arm were already considering that Intel were, notwithstanding their high market share, losing [REDACTED].

[90-100]% to [90-100]% by value.<sup>121</sup> As discussed above, this share estimate is in any event made up of proprietary IP, not currently available to third parties and thus will overstate Intel's importance to third parties.

Nevertheless, in addition, a number of Arm's internal documents note Intel's decline in server processor shipments notwithstanding market growth.<sup>122</sup> As noted in paragraph 7.23 above, third-party feedback also indicates that Arm-based CPUs are increasingly used in datacentres and are growing as an alternative to x86-based Datacentre CPUs.

7.36 Second, as noted above at paragraph 7.19, the fact that Arm does not compete downstream with Datacentre CPU suppliers is a strong part of the importance of its CPU IP for Datacentre CPU suppliers as an existing or potential future option. This context limits the current constraint posed by Intel on Arm. The change in Arm's business model post-Merger to a vertically integrated model may, as discussed further below in the section on Incentive to Foreclose, reduce the Merged Entity's incentives post-Merger to continue licensing on an open basis to third parties. In turn, such a change in licensing model would decrease the degree to which Arm's licensees stimulate innovation in Datacentre CPUs.

7.37 The CMA also believes that the fact Arm does not compete downstream would likely limit any future constraint posed by Intel as a licensor of CPU IP to third parties. The Parties cited Intel's announcement in March 2021 that it is establishing a foundry business that will also offer customers an IP portfolio including x86 cores as further evidence of a strong future constraint.<sup>123</sup> However, the fact that Intel competes in the supply of Datacentre CPUs (and SmartNICs and GPUs) with any future licensees active in these markets may, based on the evidence cited at paragraph 7.17(b), limit the range of downstream suppliers willing to license x86 IP and collaborate with Intel. One licensee posited that Intel is likely to impose on its licensees the use of its foundries, and that using Intel x86 architecture would thus strongly increase its dependence on one of its competitors. While Arm has a strong track record of delivering to several significant datacentre customers, and its usage is growing, it is unclear whether Intel's offerings will be equivalent to Arm's and whether third party licensees would want to take these up. Two Arm licensees that supply Datacentre products listed an out-licence of x86 as an alternative to Arm CPU IP. However, both licensees noted that this remained a

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<sup>121</sup> Final Merger Notice, Tables 11-12.

<sup>122</sup> See, for example, Arm's internal email exchange, February 2020, original document name: RE: IPG RRC (Risk Review Committee) - ML GRR / IPG-ST03 / x86 Risk.msg, batch: CMA-002 - Batch 01, which indicates Arm's view that [REDACTED].

<sup>123</sup> See: [Intel CEO Announces 'IDM 2.0' Strategy for Manufacturing, Innovation](#). The CMA notes that Intel has not published yet when IFS will start licensing IP to third parties.

hypothetical alternative only since Intel has not yet published concrete details about its future licensing model.

7.38 The CMA understands that Intel's licensing of x86 IP will be conditional on its customers also using Intel Foundry Services (**IFS**).<sup>124</sup> One licensee posited that Intel is likely to impose on its licensees the use of its IFS, and that using Intel x86 architecture would thus strongly increase its dependence on one of its competitors. Such conditions may reduce the attractiveness of Intel as a potential CPU IP supplier, as Arm licensees value Arm's open licensing model that allows for customised offerings (see paragraph 7.17(b) above), including the flexibility to choose other foundries to manufacture their products.<sup>125</sup> [REDACTED]:

(a) [REDACTED].

(b) [REDACTED].

(c) [REDACTED].

(d) [REDACTED].

7.39 The evidence also indicates that existing alternative suppliers of CPU IP to third parties are currently, and are likely to remain, weak alternatives to Arm for Datacentre CPU suppliers that have no access to x86 or in-house solutions.

7.40 MIPS, RISC-V, Power/IBM, and SPARC/Oracle were all rated as, at most, 'weak' competitive alternatives to Arm CPU IP now and in the next five years by almost all Datacentre CPU supplier respondents. For example, one third party submitted that none of these alternatives are comparable to Arm in respect of similar performance, functionality or features for Datacentre CPUs. By contrast to the momentum of Arm's Neoverse offering, [REDACTED]. In-house solutions were not considered a competitive alternative to Arm CPU IP by any Arm-based Datacentre CPU supplier respondent. For example, one respondent explained that CPU core development requires significant re-engineering efforts in terms of time and investment.

7.41 One third party rated RISC-V as a 'medium' competitive alternative but went on to explain that it considers RISC-V is 'at least five years behind [Arm] in terms of development' and is 'currently better suited toward ... lower performance demands'. Several third parties also told the CMA that RISC-V is

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<sup>124</sup> [REDACTED] and [Fact Sheet: \(intel.com\)](#).

<sup>125</sup> This view is confirmed by third-party analyst report submitted by Arm entitled 'Neoverse is ARM's big opportunity', original document name: Neoverse is ARM's big opportunity to.pdf, batch: CMA-002 - Batch 01, which states that potential design freedom is among the reasons why customers choose Arm over Intel.

not (at least for the next five to ten years) a viable alternative as it lags behind Arm, in particular because of its inferior software ecosystem and power.

7.42 Third-party views on the weakness of other CPU IP suppliers for datacentres are supported by Arm's internal documents. Arm's internal documents recognise MIPS and RISC-V as competing licensors of CPU IP but do not, in the round, indicate that Arm views these as providing a strong constraint on its own position in datacentres. Arm's Competitors Reports dated between November 2019 and September 2020 indicate that Arm [REDACTED].<sup>126</sup> The CMA has identified a number of Arm internal documents in which Arm monitors RISC-V. These documents indicate that Arm may perceive RISC-V as a potential competitive threat in the long term. However, any such perceived constraint appears to be limited, and does not explicitly relate to datacentre in the short term.<sup>127</sup> By contrast, an Arm internal document dated August 2020 shows that Arm considers it is more competitive than RISC-V, including due to Arm's superior ecosystem, its portfolio of patents and Arm's offering beyond CPU IP (eg System IP, software security framework validation, tools ecosystem and support).<sup>128</sup>

7.43 Several Arm licensees also submitted that there are a number of barriers to switching CPU IP supplier away from Arm for datacentre applications (covering both Datacentre CPUs and SmartNICs), including: (i) the time and cost required to redesign software and hardware compatible to the new ISA; (ii) the investments already made by licensees and their ecosystem partners around Arm; and (iii) customer familiarity and preference for Arm.

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<sup>126</sup> For example, Arm's internal document entitled 'Competitive Strategy report W40', 2 October 2020, original name: Competitor Reports – by date.pdf, batch: AXON\_CMA\_20201124, pages 5-40.

<sup>127</sup> For example, Arm's internal document entitled 'IPG Plan – February 2020', March 2020, original document name: IPG Plan - February 2020 - As presented.pdf, batch: AXON\_CMA\_20201124, page 47 states: [REDACTED]. Another Arm's internal document entitled 'Competitor Reports - by date.pdf', batch: AXON\_CMA\_20201124, page 34 indicates that Arm has been monitoring RISC-V.

<sup>128</sup> For example, Arm's internal document entitled 'Arm Group Products, Technology and Engineering Management Presentation', 11 August 2020, original document name: 4c-7 Arm Group Products, Technology and Engineering MP.pdf, batch: NVIDIA-CMA-001, page 103. Similarly, Arm's internal document entitled 'Competitive Strategy report W40-02-Oct-20', 2020, original document name: Competitor Reports - by date.pdf, batch: AXON\_CMA\_20201124, page 34 states that [REDACTED]

- *SmartNICs*
  - *Parties' submissions*<sup>129</sup>

7.44 The Parties submitted that Arm has no market power in CPU IP licensing for SmartNICs and that commercially viable alternatives to Arm CPU IP for SmartNICs exist, including MIPS IP, Synopsys IP and RISC-V (and that RISC-V-based CPU IP is supplied by suppliers including SiFive and Andes Technology).<sup>130</sup> Specifically, they noted that:<sup>131</sup>

- (a) CPU IP is not the key to SmartNICs and any existing CPU technology is sufficient.
- (b) The vast majority of SmartNICs are built by CSPs, and most use off-the-shelf FPGAs.

- *CMA assessment*

7.45 As noted at paragraph 7.16 above, third parties have indicated that the CPU IP is a critical function of the operation of semiconductors. Third parties have further indicated that Arm CPU IP specifically is important for SmartNIC suppliers.<sup>132</sup> A significant volume of third parties that supply/develop SmartNICs that responded to the CMA questionnaires submitted that it is 'very important' for them to be able to license CPU IP from Arm for the following reasons.

- (a) **Arm is predominant in CPU IP for SmartNICs due to technical proficiencies:** One SmartNIC supplier told the CMA that Arm CPU IP is 'predominant' in SmartNICs and that Arm-based processors are an 'essential piece' of a SmartNIC as they have the right mix of power, performance and ability to interface various IP blocks needed in a SmartNIC. This third party also submitted that SmartNICs are becoming increasingly critical in datacentres as control points for CPUs, GPUs and other accelerators, and that there is an ongoing transition from 'CPU-centric' to '[SmartNIC]-centric' datacentres. This view is in line with

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<sup>129</sup> The CMA notes as an overarching general point that the Parties' Issues Meeting presentation dated June 2021 and following submissions largely focussed on competition between Arm's ecosystem and the x86 ecosystem in relation to Datacentre and PC CPUs, rather than on SmartNICs, Datacentre GPUs, and other applications.

<sup>130</sup> Final Merger Notice, paragraphs 589-594; the Parties' Issues Meeting presentation dated 16 June 2021, page 34.

<sup>131</sup> The Parties' Issues Meeting presentation dated 16 June 2021, page 34.

<sup>132</sup> As noted at paragraph 7.5 above, SmartNIC suppliers that rely on Arm CPU IP include Intel, Xilinx, Marvell, [X] and Broadcom, as well as AWS which uses Arm CPU IP to develop its in-house SmartNIC ([Nitro]).

NVIDIA's own expectation that [SmartNICs] will play a key role in datacentres.<sup>133</sup>

(b) **The strength of Arm's ecosystem:** one SmartNIC supplier submitted it relies on Arm's large software ecosystem and performant cores. Another SmartNIC supplier submitted that Arm is the only credible and viable CPU IP supplier; one SmartNIC supplier submitted that SmartNICs are almost entirely Arm based.

7.46 In relation to the Parties' submission that the vast majority of SmartNICs are built by CSPs, and most use FPGAs (see paragraph 7.44(b) above), the CMA notes that [redacted]. Further, in relation to FPGAs, the CMA notes that one FPGA supplier [redacted]. Therefore, the CMA considers that also suppliers that use FPGAs in their SmartNICs may require Arm CPU IP.

7.47 The importance of Arm CPU IP to SmartNIC suppliers is also illustrated by the fact that, as noted by SmartNIC suppliers, Arm is the predominant supplier, leading other suppliers by a very significant margin. The Parties' submitted shares of supply show that Arm-based SmartNICs comprise nearly [90-100]% of downstream SmartNIC sales. This also reflects the fact that Intel uses Arm CPU IP in its SmartNICs (see paragraph 7.5 above) rather than its own CPU IP, which suggests that Arm CPU IP is particularly critical for SmartNICs. MIPS and Power each account for a much smaller proportion of sales volumes and value and have not shown any growth in these positions over the last three years.<sup>134</sup>

7.48 The CMA has not seen evidence to indicate that MIPS, Power or any other suppliers will expand materially in future so as to pose a constraint on Arm. Andes Technology, MIPS, RISC-V, SiFive, and Synopsys were all rated as at most 'weak' competitive alternatives to Arm CPU IP for SmartNICs now and in the next five years by a significant proportion of SmartNIC suppliers that responded to the CMA investigation. As noted above at paragraph 7.41, although one third party rated RISC-V as 'medium', it is seen as unlikely to be viable in the foreseeable future as an option for either Datacentre CPUs or SmartNICs. The weakness of other CPU IP licensors for datacentres is further demonstrated by Arm's internal documents, set out at paragraph 7.42 above.

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<sup>133</sup> For example, NVIDIA's earnings call Q3 2021, 2021, original document name: NVDA Q3 2021 Earnings Call 18-November-2020 5\_00 PM ET.pdf, batch: NVIDIA-CMA-019, states that 'A single BlueField-2 DPU can deliver the same data center services that can consume up to 125 CPU cores. This frees up valuable CPU cores to run a wide range of other enterprise applications ... We believe that, over time, DPUs will ship on millions of servers, unlocking a 10 billion total addressable market.'

<sup>134</sup> The Parties' submission to the CMA of 2 July 2021 (RFI Submission of 2 July 2021), RFI 5, page 44, Tables 7-8.

7.49 As noted in paragraph 7.43 above, third parties indicated that there are a number of barriers to switching suppliers of CPU IP for SmartNICs.

- *Conclusion on importance of Arm CPU IP and market power*

7.50 For the reasons outlined above, the CMA considers that Arm's CPU IP is an important input to the supply of Datacentre CPUs for all suppliers without access to proprietary x86 CPU IP, and such importance is growing as the Arm ecosystem further advances. The CMA considers that Arm has market power based on the totality of the evidence – namely, the rapid growth of Arm's competitive position in recent years, positive indications for future growth, limitations to the constraint posed by Intel, the lack of credible alternative licensors of CPU IP and the difficulties for licensees to switch suppliers.

7.51 The CMA also believes that Arm's CPU IP is an important input for SmartNIC suppliers, and that Arm has market power in relation to the supply of CPU IP for SmartNICs given its predominance, the lack of credible alternatives and the difficulties for licensees to switch suppliers.

7.52 As illustrated previously at paragraph 7.31 above, Arm also has a strong position in the supply of CPU IP overall (ie without segmentation by application) worldwide. The CMA believes that the strength and existence of Arm's ecosystem across the CPU IP spectrum are interlinked to, and reinforce, Arm's market power in the narrower segmentations of CPU IP for Datacentre CPUs and SmartNICs (a feature which is relevant across the theories of harm).

#### *Mechanisms the Merged Entity could use to achieve foreclosure*

- *Parties' submissions*

7.53 The Parties submitted that foreclosure of Datacentre CPU and SmartNIC suppliers would not be possible because:

- (a) Arm licensees are contractually protected against foreclosure.<sup>135</sup> Arm's architectural licensees<sup>136</sup> have long-term agreements that protect them against foreclosure, which are binding and enforceable.<sup>137</sup> Arm's

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<sup>135</sup> Final Merger Notice, paragraphs 552-559 and 595; the Parties' Issues Meeting presentation dated 16 June 2021, page 34; Compass Lexecon paper on Competition, page 9.

<sup>136</sup> Under its architectural license, Arm allows customers to make their own chip designs compatible with Arm's ISA – Final Merger Notice, footnote 226.

<sup>137</sup> Final Merger Notice, paragraphs 552-558; the Parties' Issues Meeting presentation dated 16 June 2021, pages 4, 6 and 31.

implementation licensees<sup>138</sup> are also contractually protected against foreclosure by long-term (sometimes perpetual) licences with fixed royalty rates and stringent terms that preclude early termination.<sup>139</sup> Even if the Merged Entity stopped licensing Arm CPU implementation IP, architectural licensees cannot be foreclosed as they create their own CPU IP based on Arm ISA and will ensure vibrant competition.<sup>140</sup>

- (b) Arm's business model prevents the Merged Entity from selectively restricting CPU suppliers' access to Arm IP, as Arm's CPU IP is general-purpose, non-customised CPU IP, and Arm is not aware of the precise applications (eg CPUs or SmartNICs) for which licensees use CPU IP.<sup>141</sup> They submitted that Arm currently receives a limited amount of information from its customers, and such information is generally not competitively sensitive and, in any case, not sufficient to engage in any 'targeting' strategy.<sup>142</sup>
- (c) The Merged Entity will be constrained by Arm's licensees', OEMs' and CSPs' buyer power, as these are all sophisticated customers that would not tolerate a restriction of choice and would switch to alternative solutions.<sup>143</sup> The Parties submitted that 'powerful' licensees such as [X] have been able to negotiate favourable terms in their negotiations with Arm.<sup>144</sup>

- *CMA assessment*

7.54 The CMA has considered whether the Merged Entity could harm Datacentre CPU and SmartNIC suppliers by engaging in total foreclosure – ie preventing NVIDIA's competitors from using Arm IP through withdrawal of licences, denying access to products, or other means – and/or partial foreclosure strategies. The CMA's views on the methods of foreclosure as outlined in this section are, in addition to datacentre specifically, applicable across all other applications and theories of harm explored in this report.

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<sup>138</sup> Under its implementation licence, Arm provides the finished CPU design netlist to customers. Arm's IP customers license Arm CPU cores and integrate them into their integrated chips, without making any changes to the IP design. Most Arm customers use this licence. Final Merger Notice, footnote 226.

<sup>139</sup> Final Merger Notice, paragraph 559.

<sup>140</sup> The Parties' Issues Meeting presentation dated 16 June 2021, page 6.

<sup>141</sup> Final Merger Notice, paragraphs 560-561 and 596-604; the Parties' Issues Meeting presentation dated 16 June 2021, pages 31 and 34.

<sup>142</sup> The Parties' Issues Meeting presentation dated 16 June 2021, page 22.

<sup>143</sup> Final Merger Notice, paragraphs 562-566 and 605-606; Compass Lexecon paper on Competition, page 9.

<sup>144</sup> The Parties' Issues Meeting presentation dated 16 June 2021, pages 4-5.

- *Total foreclosure mechanisms*

- 7.55 As a starting point, and consistent with the CMA's Merger Assessment Guidelines, when considering vertical mergers, the CMA is unlikely to place material weight on contractual protections when considering the ability of the merged entity to foreclose its rivals through, for example, denying access to future upgrades of the input. This is because contracts might not protect all ways in which the competitiveness of rivals could be harmed.<sup>145</sup> In the context of this Merger, the CMA notes that the current licences may provide Arm licensees with some degree of contractual protection, at least in the short term and for existing Arm CPU IP products that are covered by the current licences. However, a number of third parties highlighted the significant limitations to such contractual protections, and that foreclosure could arise in ways that would not be easily detectable, or enforceable as a matter of contract law (either as a matter of contractual drafting or because of the waves of product development that arises under an overarching licence).
- 7.56 Further, the CMA considers that the Merged Entity could develop new Arm designs or features in future for in-house use only, and not make them accessible to third parties under their current licences (even the perpetual ones). This applies not only to implementation licensees, but also to architecture licensees because Arm's architecture is subject to future evolution, extensions and a 'rolling program of substantial enhancements'.<sup>146</sup> For instance, one architectural licensee submitted that its licence does not oblige Arm to provide any future version of the Arm ISA after the license expiration, and that this would potentially deprive its products of important new innovations. As such, the Merged Entity could still engage in total foreclosure by denying rivals' access to new products, as well as refusing to license to new entrants in datacentres (as these would not be protected by pre-Merger licenses).
- 7.57 Total foreclosure concerns were raised by several third parties. In particular, a significant volume of Arm licensees, including both implementation and architectural licensees,<sup>147</sup> submitted that it would be possible for the Merged Entity to prevent them from using Arm's IP post-Merger. Several licensees

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<sup>145</sup> Merger Assessment Guidelines, paragraph 7.15.

<sup>146</sup> For example, Arm states that 'Arm is constantly working with lead partners to evolve its architecture to meet future needs. Armv9-A is a set of extensions to the Armv8-A architecture, and part of a rolling program of substantial enhancements to the architecture to be deployed over the next few years', see <https://www.arm.com/why-arm/architecture/cpu>. An internal Arm email exchange from November 2020, original document name: [REDACTED].msg, batch: CMA-002 - Batch 01, notes the concerns expressed by [REDACTED], an architectural licensee, that post-Merger (i) its future architectural access would get blocked; (ii) its ability to implement (or not implement) changes to future architecture would negatively affect its competitive position [REDACTED]; and (iii) its access to required features would be delayed [REDACTED].

<sup>147</sup> The CMA also notes that a several Arm licensees have both architectural and implementation licences.

further explained that Arm could refuse to provide access to new licences/ISA versions or to renew the existing licences after their expiry. Several Arm licensees have (at least some) time-limited CPU IP licences, and the Merged Entity could totally foreclose these licensees after their licences expire. One licensee submitted that in 2020 Arm ceased offering perpetual licences. Arm confirmed that it prefers to license on a term or per-use basis [X].<sup>148</sup>

o *Partial foreclosure mechanisms*

7.58 A significant number of third parties, including both implementation and architecture licensees, submitted that the Merged Entity could engage in partial foreclosure strategies by:<sup>149</sup>

(a) Modifying the quality of the product/service/technical support Arm provides its licensees that compete with NVIDIA.

(b) Raising Arm's licence fees and/or royalties.

(c) Changing the level of R&D specific to NVIDIA's rivals' products.

(d) Delaying competitors' access to new Arm cores and IP, giving NVIDIA an unfair 'time-to-market advantage'.

7.59 The CMA has also considered whether the Merged Entity could use commercially sensitive information (provided by its licensees) so as to give itself a competitive advantage against NVIDIA's competitors downstream. This could provide additional mechanisms to allow the Merged Entity to further disadvantage rivals and to compete less aggressively. For example, the Merged Entity could use such information to better understand its rivals' product development pipelines, launch similar products ahead of its rivals and deter rivals from innovating.<sup>150</sup>

7.60 Contrary to the Parties' submission that Arm is not aware of the purpose for which its IP is used and generally does not receive competitively sensitive information from licensees (see paragraph 7.53(b) above), many Arm licensees confirmed that they do share commercially sensitive information with Arm. They also submitted that this information can include granular details such as: (i) the field of application (eg datacentre, automotive, etc) for which they supply products based on Arm IP; (ii) specific end products (eg server components, consoles, etc) for which they supply products based on

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<sup>148</sup> Final Merger Notice, paragraph 526.

<sup>149</sup> In some cases, the licensees explained these strategies would be possible after their licenses expire.

<sup>150</sup> See also Merger Assessment Guidelines, paragraph 7.3.

Arm IP; and (iii) their pipeline product development/R&D plans. Licensees further confirmed that they share information on the types of products (eg CPUs, GPUs, etc) for which they use Arm's IP and also their sales trends, values and/or volumes.<sup>151</sup> The feedback indicates that the sharing of such information is a necessary part of the close collaboration Arm states it makes with its licensees, which it views (and publicly refers to) as partners rather than customers.<sup>152</sup> This is inconsistent with the Parties' position outlined at paragraph 7.53(b) above. A further submission from the Parties also stated that intelligence about demand from customers guides the development of competitive IP products, indicating that Arm does receive information on how the IP will be used.<sup>153</sup> The CMA also notes that some licensees (eg Ampere and AWS) are publicly known as primarily active in datacentres rather than other applications, allowing Arm to infer the fields of application they are and are not active in.

7.61 Moreover, the CMA notes that Arm designs different Arm CPU IP products at least to some extent for specific applications and/or tasks.<sup>154</sup> For example:<sup>155</sup>

- (a) Neoverse is 'specifically designed for handling cloud-native workloads, allowing cloud providers to build a cloud infrastructure'.
- (b) Cortex-A is 'designed for devices requiring memory-intensive and demanding safety-critical tasks, and other complex compute tasks such as edge and cloud computing, operating a system platform, and supporting multiple software applications'.
- (c) Cortex-M is 'optimized for cost and energy-efficient microcontrollers found in a broad range of applications, including IoT, industrial, and everyday consumer devices'.
- (d) Arm's automotive-enhanced IP are denoted by the abbreviation 'AE' in the product name, such as the Cortex-A78AE.

7.62 Further, in the context of explaining Arm's incentives, the Parties submitted that Arm is not 'neutral' insofar as larger licensees have a greater degree of

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<sup>151</sup> For example, one licensee explained that such commercially sensitive information is shared with Arm to optimise the design and 'meet specific requirements in a given market / application', as well as to help Arm consider their needs when developing Arm roadmaps for future product planning. Other reasons mentioned by licensees included royalty reporting and to enable troubleshooting.

<sup>152</sup> For example, Arm makes statements on its website that they collaborate closely with its licensee partners. See [Why Arm - Shape the Future of Computing – Arm®](#), accessed by the CMA on 8 July 2021, and [Arm launches v9 architecture – Arm®](#), accessed by the CMA on 8 July 2021.

<sup>153</sup> Compass Lexecon paper on Competition, paragraph 6.20.

<sup>154</sup> Narrative Response of Softbank Group Corp. and Arm Limited dated 23 April 2021, pages 7-8.

<sup>155</sup> *Ibid.*

influence over Arm's product development priorities.<sup>156</sup> This position is inconsistent with a claim that the Merged Entity could not target foreclosure at individual rivals, as Arm already has the ability to alter its offerings for different licensees on an individual basis.

- 7.63 Therefore, the CMA considers that the Merged Entity would have the ability to target both specific rivals (for example, by increasing royalties or degrading service for one particular competitor) and types of rivals according to their applications (for example, the Merged Entity could affect datacentre competitors by delaying competitors' access to new versions of Neoverse).<sup>157</sup>
- 7.64 The CMA's concerns as regards the inherent limitations of contractual protections apply equally in respect of partial foreclosure. Contractual terms including royalty levels can be re-negotiated, and some aspects of a competitive offering cannot be fully specified in a contract.<sup>158</sup> For example, several licensees submitted that Arm provides them with technical support that is, at least to some degree, discretionary, and other aspects of offerings such as future R&D intensity beneficial to licensees cannot be specified in a contract.
- 7.65 In relation to the Parties' submission on the Merged Entity being constrained by Arm's licensees', OEMs' and CSPs' buyer power, the CMA considers that these third parties' buyer power depends on the availability of good alternatives to which they can switch.<sup>159</sup> The CMA considers that the limited alternatives to Arm discussed at paragraphs 7.39-7.43 above will undermine any buyer power (and any contractual protection) that licensees may have, particularly Datacentre CPU suppliers who currently have no access to x86 IP (but instead have to purchase finished products) or in-house solutions and all Datacentre SmartNIC suppliers. Moreover, even if some larger Arm licensees, OEMs, CSPs and/or potential new entrants had a degree of buyer power, they would not protect smaller licensees who do not have the same degree of buyer power. Accordingly, any such buyer power is insufficient to mitigate the Merged Entity's ability to engage in foreclosure.

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<sup>156</sup> As noted at paragraph 7.18 above, the Parties submitted that contract terms, licence fees and royalties vary significantly across all licensees, which indicates that the Merged Entity could selectively disadvantage individual competitors.

<sup>157</sup> The Parties submitted that some Arm customers can and do use Neoverse for non-datacentre applications (the Parties' Issues Meeting presentation dated 16 June 2021, page 22). However, the CMA is not aware of any example of Arm licensees using Neoverse for other applications. Moreover, as explained above, Arm described Neoverse as 'specifically designed for handling cloud-native workloads'.

<sup>158</sup> Merger Assessment Guidelines, paragraph 7.15.

<sup>159</sup> See also Merger Assessment Guidelines, paragraph 4.20.

- *Conclusion on mechanisms the Merged Entity could use to achieve foreclosure*

7.66 For the reasons outlined above, the CMA considers there to be a range of mechanisms through which the Merged Entity could harm the competitiveness of NVIDIA's rivals (including new entrants). These include both total and partial foreclosure strategies, including using commercially sensitive information. Different mechanisms may be more effective at different times in the short or medium/long term, and when used (individually or in combination) against particular rivals or types of rivals (eg datacentre competitors).

#### *Conclusion on ability*

7.67 The CMA considers that: (i) Arm has market power in the supply of CPU IP, including CPU IP used by Datacentre CPU and SmartNIC suppliers due to the importance of Arm's CPU IP, the lack of credible alternatives and barriers to switching; and (ii) that the Merged Entity has the ability to target total and partial foreclosure at rival suppliers of Datacentre CPUs and SmartNICs.

#### *Incentive to foreclose*

#### *Parties' submissions*

7.68 In relation to Datacentre CPUs, the Parties submitted that foreclosure, in addition to being unprofitable in the short term, would cause irreversible damage to the Merged Entity's business. In particular:

(a) In the long-term:<sup>160</sup> (i) Arm would lose ecosystem network effects<sup>161</sup> of third-party silicon manufacturers, OEMs and software developers that are crucial to challenge x86 in datacentre; (ii) harming downstream competition would damage the Merged Entity's business and reduce third parties' and customers' incentives to adopt the Arm ecosystem;<sup>162</sup> and (iii) the Merged Entity would lose diversification of risks downstream.

(b) In the short term:<sup>163</sup> (i) Arm licensees represent a very small portion of the Datacentre CPU market such that there would be little downstream sales to recapture; (ii) NVIDIA would have [✂] of the CPU

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<sup>160</sup> Final Merger Notice, paragraphs 574-583; the Parties' Issues Meeting presentation dated 16 June 2021, page 32.

<sup>161</sup> The Parties' Issues Meeting presentation dated 16 June 2021, page 25; Compass Lexecon paper on Competition, pages 2, 11; Compass Lexecon paper on Competition, Annex I, paragraphs 9-31.

<sup>162</sup> Similar points are repeated in Compass Lexecon paper on Competition, page 10; and Compass Lexecon paper on Competition, Annex II, paragraph 35.

<sup>163</sup> Final Merger Notice, paragraphs 567-573; the Parties' Issues Meeting presentation dated 16 June 2021, page 32; Compass Lexecon Paper, page 9.

market [REDACTED]; and (iii) NVIDIA does not expect [REDACTED].

7.69 In relation to SmartNICs, the Parties submitted that a foreclosure strategy would harm NVIDIA:

- (a) In the medium to long term as:<sup>164</sup> (i) foreclosing the SmartNIC market would forgo opportunities both upstream and downstream as the SmartNIC, and stifle market growth; and (ii) foreclosure of SmartNIC suppliers would invite retaliation against NVIDIA in other markets – in particular: NVIDIA relies on Intel and AMD (its GPUs are used in x86 servers and PCs) and NVIDIA relies on [REDACTED] for switches and networking components for the majority of NVIDIA’s datacentre and reference systems.
- (b) In the short term as:<sup>165</sup> (i) Arm would forgo significant licensing revenues from SmartNIC suppliers, including from large customers such as Broadcom and Marvell that use the same Arm cores for a variety of products; (ii) the SmartNIC market is currently fragmented, with a multitude of suppliers offering differentiated products (as there is currently no consensus on the best way to design a SmartNIC), and NVIDIA would not be guaranteed to generate sufficient additional sales to justify the upstream foregone revenue; and (iii) foreclosure could antagonise NVIDIA’s customers in the larger CPU and GPU markets.

7.70 The Parties further submitted that the benefit to the Merged Entity of maintaining downstream competition to increase adoption of its ecosystem outweighs the benefits of monopolising a downstream market,<sup>166</sup> and that the create a level playing field between licensees.<sup>167</sup>

#### *CMA assessment*

7.71 The CMA believes – as a general point relevant to all applications – that, while Arm currently has an incentive to license its CPU IP as widely as

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<sup>164</sup> Final Merger Notice, paragraphs 612-614; the Parties’ Issues Meeting presentation dated 16 June 2021, page 35.

<sup>165</sup> Final Merger Notice, paragraphs 608-611; the Parties’ Issues Meeting presentation dated 16 June 2021, page 35.

<sup>166</sup> The Parties’ Issues Meeting presentation dated 16 June 2021, page 26; Compass Lexecon paper on Competition, pages 11-12; Compass Lexecon paper on Competition, Annex I, paragraphs 38-58.

<sup>167</sup> The Parties’ Issues Meeting presentation dated 16 June 2021, page 7.

possible on an open basis, the Merger is likely to create incentives to change Arm's business model and favour NVIDIA (as NVIDIA competes downstream with many Arm licensees). Several third parties submitted that the Merger represents a significant threat to Arm's 'neutral/open business model'. One Arm licensee submitted specifically in relation to datacentres that the Merged Entity would have an incentive to end Arm's neutral business model to protect and advantage NVIDIA's products and maximise its downstream revenues, which are far larger than Arm's upstream licensing revenues.

7.72 The available evidence indicates that the Merged Entity may benefit from weakening downstream Datacentre CPU and SmartNIC rivals. First, the Datacentre CPU and SmartNIC addressable markets are growing rapidly, creating a strong incentive for the Merged Entity to capture this growth at the expense of NVIDIA's rivals:

(a) In relation to Datacentre CPUs, NVIDIA's forecasts show that it expects the TAM to grow from US\$[X] in 2021 to US\$[X] in 2025, ie a [X]% increase.<sup>168</sup>

(b) In relation to SmartNICs, NVIDIA's forecasts show that it expects the DPU Total Addressable Market (TAM) to grow from US\$[X] in 2021 to US\$[X] in 2025 (a [X]% increase).<sup>169</sup> Moreover, NVIDIA's CEO stated in an earnings call with analysts that 'over time, DPUs will ship on millions of servers, unlocking a 10 billion total addressable market', and 'the importance is really quite tremendous and [...] every single server in the world will have a DPU inside someday'.<sup>170</sup> In line with NVIDIA's view, one third party submitted that SmartNICs are becoming increasingly critical in datacentres (see paragraph 7.45(a) above).

7.73 Second, the CMA considers that NVIDIA would be well placed to capture these growth opportunities in Datacentre CPUs and SmartNICs given the Merged Entity's ability to weaken NVIDIA's rivals that rely on Arm CPU IP. In particular:

(a) Controlling the development, availability and timing of the licensing of Arm CPU IP to Datacentre CPUs and SmartNIC suppliers could give NVIDIA a substantial time-to-market advantage on new product launches and winning contracts. Several third parties expressed concerns about the Merged Entity's ability to delay access to new Arm cores and IP (see paragraph 7.58(d) above).

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<sup>168</sup> The Parties' response to the CMA RFI 2, Annex 2, tab 'Datacenter TAM'.

<sup>169</sup> *Ibid.*

<sup>170</sup> Annex 4 to the Parties' response to the CMA RFI 1, NVDA Q3 2021 Earnings Call, original document name: 18-November-2020 5\_00 PM ET.pdf, page 6.

The CMA [REDACTED].<sup>171</sup> The CMA considers that the Merged Entity would stand to benefit from selling any future NVIDIA products more effectively ahead of its rivals, by delaying and degrading access to Arm CPU IP to NVIDIA's rivals.

- (b) Specific to Datacentre CPUs, the CMA considers that NVIDIA, even though still entering the market, would be well-placed to capture a material proportion of market growth.<sup>172</sup> In particular, Arm's importance is growing in Datacentre CPUs, and Arm-based CPUs are becoming more common as an alternative to x86 (see paragraphs 7.21-7.32 above). The Merged Entity could give NVIDIA preferential access to Arm CPU IP, and thus NVIDIA could grow at the expense of other Arm-based CPU suppliers. In this context, NVIDIA customers provided mixed feedback on whether Grace will be an alternative to x86 and Arm-based CPUs. Several Arm-based CPU suppliers told the CMA that [REDACTED].
- (c) NVIDIA is particularly well-placed to capture market growth in SmartNICs, since all major SmartNIC competitors are Arm-based and would therefore be subject to foreclosure. The market shares submitted by the Parties illustrate a rapid growth in NVIDIA's share of SmartNICs from 2018-2020.<sup>173</sup> This pattern indicates NVIDIA is already capturing current growth and is well placed to take advantage of future growth. In relation to the Parties' submission that SmartNICs are differentiated and NVIDIA would not generate sufficient additional sales as a result of foreclosure (see paragraph 7.69(b) above), the CMA notes that a significant proportion of SmartNIC suppliers responding to the CMA's questionnaire [REDACTED]. Several SmartNIC customers submitted that Arm-based SmartNIC suppliers (including Broadcom, Intel, Marvell and Xilinx) represent a competitive alternative to NVIDIA,<sup>174</sup> further confirming the closeness of competition between NVIDIA and Arm-based SmartNIC suppliers.<sup>175</sup> Moreover, the CMA considers that the Merged Entity could target foreclosure to its closest SmartNIC competitors (see paragraph 7.63 above). In any event, the CMA notes that the Parties did not provide evidence to support their

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<sup>171</sup> For example, [REDACTED].

<sup>172</sup> [REDACTED].

<sup>173</sup> From [0-5]% by value in 2018 to [10-20]% by 2020, for example. See Final Merger Notice, Tables 19-20.

<sup>174</sup> NVIDIA customers' responses to the CMA questionnaires.

<sup>175</sup> The Parties describe NVIDIA's own SmartNICs as 'leading', 'world-class' and 'widely recognized as a benchmark against which others are measured, including Intel and AMD' (Final Merger Notice, paragraph 471).

submission that differentiation between SmartNICs would eliminate the Merged Entity's incentive to foreclose.

- (d) As noted above (see paragraphs 7.50-7.51 above), Arm CPU IP is important for both Datacentre CPU and SmartNIC competitors. Third party feedback indicates that Arm has allowed market participants (including CSPs) to innovate in a range of Datacentre CPUs and SmartNICs products flexibly to suit their requirements, without relying on x86-based finished products (see paragraph 7.17 above). By controlling access to Arm CPU IP, the Merged Entity may have an incentive to raise barriers to entry and innovation, to expand NVIDIA's position in Datacentre CPUs and SmartNICs.
- (e) The ability to target rivals would make foreclosure strategies more likely to be profitable, as the Merged Entity would be able to limit losses by targeting foreclosure on applications or uses where switching to NVIDIA is likely.

7.74 Third, the CMA considers that the Merged Entity will have the ability to offer Datacentre CPU/SmartNIC-Datacentre GPU bundles that are more effective and more interoperable than the offerings of its rivals (this is discussed in ToH 1c below). The CMA notes the heightened significance of this in the context of a potentially significant structural change and expansion as the deployment of AI gains traction in datacentres through the 'holy trinity' of Datacentre GPUs, CPUs and SmartNICs. This could further strengthen the Merged Entity's incentive to weaken Arm-based Datacentre CPU and SmartNIC competitors and advantage NVIDIA's position in each of Datacentre CPUs, SmartNICs and GPUs.

7.75 Fourth, as noted in the Ability section at paragraphs 7.17 and 7.45 above the CMA notes that one of Arm's competitive advantages is the emergence of its ecosystem. In principle, were foreclosure to reduce substantially the adoption of Arm CPU IP in Datacentre CPUs and SmartNICs, the network effects arising from the breadth of the Arm ecosystem could potentially be weakened. However, the CMA considers that the costs of foreclosure upstream to Arm's ecosystem and the risk of undermining the network effects are likely to be limited. The importance of Arm CPU IP for both Datacentre CPUs and SmartNICs indicates that Arm's ecosystem would continue to grow in the future. In relation to Datacentre CPUs, for example, as illustrated in Figure 2 above, several third parties have recently adopted Arm's Neoverse CPU IP. In relation to SmartNICs, as noted in paragraph 7.51 above, Arm is the predominant CPU IP supplier. Moreover, licensees and ecosystem partners have made significant investments around Arm's ISA (see paragraph 7.43 above). While foreclosure would weaken Arm-based competing Datacentre

CPU and SmartNIC suppliers, NVIDIA would continue to benefit from customers' demand for Arm-based products and to capture a material proportion of the sales lost by its Arm-based competitors. Given customers' growing preference to seek alternatives to x86-based CPU suppliers, the CMA considers that Intel and AMD are less well-placed than NVIDIA to capture such opportunities, including those that flow from AI expansion. The limitations of other alternative ISAs (eg RISC-V) also indicates that the risk of Arm licensees switching to them, and an alternative competing ecosystem in the foreseeable future, is limited. Further, the CMA notes that the Parties have not provided evidence supporting their submission that the benefit to the Merged Entity of maintaining downstream competition to increase adoption of its ecosystem outweighs the benefits of monopolising a downstream market (see paragraph 7.70 above).

7.76 The CMA considers that the downstream profits are much greater than any potential upstream losses. Arm's upstream revenues represent only a small fraction of the downstream value of finished Datacentre CPUs and SmartNICs. The CMA estimates that Arm earns around [REDACTED] of the value of a Datacentre CPU/SmartNIC.<sup>176</sup> Were the Merged Entity to engage in total input foreclosure, the maximum potential losses would be Arm's entire upstream revenues (excluding revenues to NVIDIA). However, in reality the Merged Entity's potential losses would be significantly smaller than this given that many Arm licensees would be unable to switch to alternatives. By contrast, downstream margins are far higher than Arm's upstream revenues. On SmartNICs, [REDACTED].<sup>177</sup> [REDACTED].<sup>178</sup> The CMA believes that downstream profits are substantially greater than upstream profits in the short-term and that this will continue in the medium to long term.

7.77 Finally, in relation to the Parties' submissions on retaliation (see paragraph 7.69(a) above), the Parties did not provide evidence to substantiate the claim

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<sup>176</sup> Royalties represent around [REDACTED]% of Arm's total revenues for the 'Infrastructure' Line of Business (which includes datacentres) – the Parties' RFI Submission of 2 July 2021, RFI 5, page 6, Table 4. The Parties submitted that the cost of Arm's CPU IP royalties represents only [REDACTED]% of the cost of a Datacentre CPU. Arm licensees' responses to the CMA questionnaires confirm that the cost of Arm's royalties ranges between [REDACTED]% of the cost of a Datacentre CPU/SmartNIC.

<sup>177</sup> [REDACTED].

<sup>178</sup> [REDACTED]

that the purported retaliation would be effective in countering foreclosure by the Merged Entity. For example, the CMA has not seen evidence suggesting that these other competitors have the ability and incentive to deny NVIDIA of important inputs for which there would be limited credible alternatives. In any event, even if some licensees could potentially retaliate against NVIDIA, this would not protect other licensees that do not have the option to retaliate. Therefore, the CMA does not believe that any threat of retaliation would be sufficient to preclude the Merged Entity from foreclosing rivals.

#### *Conclusion on incentive*

- 7.78 For the reasons outlined above, the CMA believes that the Merged Entity would have the incentive to foreclose competing suppliers of Datacentre CPUs and SmartNICs both in the long and short-term.

#### ***Conglomerate foreclosure of rival suppliers of Datacentre GPUs, Datacentre CPUs and SmartNICs (ToH 1c)***

- 7.79 The concern with a conglomerate theory of harm is that the merged entity may restrict its rivals in one market from accessing customers using its strong position in another related market. The merged entity could do this through linking the sales of the two products in some way (eg through a technical tie), thereby encouraging customers to purchase these products together, at the expense of rivals. The CMA will typically use the ability, incentive and effect framework to analyse this theory of harm.<sup>179</sup>
- 7.80 As noted at paragraph 7.5 above, Datacentre GPUs, Datacentre CPUs and SmartNICs are important pillars of datacentre computing as they perform largely complementary functions, and their complementarity is expected to become stronger in future due to compute-intensive AI applications. The CMA has therefore considered whether the Merger would give rise to conglomerate effects alongside vertical input foreclosure. As discussed further below, NVIDIA already has the ability and intention to link the sales of its Datacentre CPUs, Datacentre GPUs and SmartNICs. The CMA has considered whether owning Arm may allow NVIDIA to sell these product combinations more effectively through modifying product interoperability in NVIDIA's favour, specifically: (i) enhancing the interoperability between NVIDIA's own GPU, CPU and/or SmartNIC combinations; and (ii) undermining the interoperability between competitors' Arm-based CPUs and SmartNICs with NVIDIA's GPUs. The Merger may allow NVIDIA to modify such interoperability as it would give NVIDIA control over future developments of Arm CPU IP and determine how it

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<sup>179</sup> Merger Assessment Guidelines, paragraphs 7.30-7.32.

works together with NVIDIA's GPUs. Several third parties have raised reasoned concerns regarding conglomerate effects (including through impacting interoperability) in datacentre applications.

- 7.81 The CMA has considered whether this strategy would allow the Merged Entity to leverage Arm's position in the supply of CPU IP to foreclose rival suppliers of Datacentre GPUs. This strategy may also allow the Merged Entity to leverage NVIDIA's position in the supply of Datacentre GPUs to foreclose rival suppliers of Arm-based Datacentre CPUs and/or SmartNICs, thus adding to the effects of input foreclosure through CPU IP described in ToH 1a and 1b above. The CMA has assessed conglomerate effects by reference to whether the Merged Entity would have: (i) the ability to foreclose rival Datacentre GPU, CPU and SmartNIC suppliers through this strategy; and (ii) the incentive to do so. The CMA has assessed whether the effect of such a foreclosure strategy would result in a substantial reduction in competition in the downstream supply of Datacentre GPUs, Datacentre CPUs and SmartNICs together with the impact on competition of the vertical effects of ToHs 1a and 1b.

#### *Ability*

- 7.82 The CMA has assessed whether the Merged Entity would have the ability to foreclose rival Datacentre GPU, Datacentre CPU and SmartNIC suppliers by considering:
- (a) whether (i) Arm has market power in relation to CPU IP licensing for Datacentre CPUs and SmartNICs, and whether (ii) NVIDIA has market power in relation to Datacentre GPUs;
  - (b) whether it would be feasible for the Merged Entity to modify the interoperability of Arm-based Datacentre CPUs and SmartNICs with rival and NVIDIA Datacentre GPUs (thereby augmenting its own product combinations); and
  - (c) whether the Merged Entity's rivals would lose sales as a result of this foreclosure strategy.

#### *Market power*

- *CPU IP licensing for Datacentre CPUs and SmartNICs*

- 7.83 For the reasons detailed in the assessment of ToH 1a and ToH 1b, the CMA considers that Arm has market power in the supply of CPU IP, including in CPU IP licensing for both Datacentre CPUs and SmartNICs.

- *Supply of Datacentre GPUs*

- 7.84 The Parties submitted that, as found by the European Commission (**EC**) in *NVIDIA/Mellanox*,<sup>180</sup> NVIDIA does not have sufficient market power in the Datacentre GPU market to give rise to conglomerate concerns. In particular, the Parties submitted that NVIDIA faces competitive constraints from Intel, AMD, and new entrants in the supply of datacentre accelerators such as AWS Trainium and Inferentia, Cambricom, Cerebras Systems, Huawei Ascend, Baidu Kunlun, Tianshu Zhixin, SambaNova, Esperanto, TensorTorrent, Unthether, Google, Groq and Graphcore.<sup>181</sup>
- 7.85 The CMA notes that NVIDIA has a long-established position as the leading supplier of Datacentre GPUs. This position has remained consistent through recent material market expansion and the evolution of AI/machine learning.<sup>182</sup> Third parties responding to the CMA's market investigation have referred to NVIDIA as being a clear market leader from the GPU customers' perspective (particularly in relation to AI/machine learning), with a significant number of customers submitting that it is 'very important' for their datacentre business to be able to acquire GPUs from NVIDIA.<sup>183</sup> Third parties also referred to NVIDIA's CUDA ecosystem as conferring competitive advantages *vis-à-vis* its competitors. NVIDIA's strength is further illustrated by the Parties' submitted market shares, which show NVIDIA as having a persistently over 90% share of Datacentre GPU sales in the last three years.<sup>184</sup> The CMA has not seen any evidence to indicate that NVIDIA's strong position is expected to change materially in future.
- 7.86 By contrast, AMD and Intel have a materially smaller market presence and the CMA has not seen any evidence to indicate their presence will grow in the foreseeable future.<sup>185</sup> Third parties also provided mixed feedback on the viability of AMD and Intel as alternative suppliers of Datacentre GPUs. While some customers considered AMD and/or Intel as competitive alternatives, several other customers considered them at most 'weak'. No other Datacentre

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<sup>180</sup> COMP/M.9424, *NVIDIA / Mellanox*, 19 December 2019.

<sup>181</sup> Final Merger Notice, paragraphs 748-752; the Parties' Issues Meeting presentation dated 16 June 2021, page 36.

<sup>182</sup> One Arm's internal document entitled Project Axon: Board Update, 30 July 2020, original document name: 4c-6 Project Axon Board Update.pdf, batch: AXON\_CMA\_20201124 states: 'NVIDIA's GPU users include the largest cloud providers in the world' and that 'Nvidia dominates GPU compute. Datacenter business has first >\$1 billion quarter'.

<sup>183</sup> One third party told the CMA that Google's tensor processing unit (**TPU**) is the only exception to NVIDIA's dominance in machine learning.

<sup>184</sup> [REDACTED]

<sup>185</sup> See Final Merger Notice, Tables 6-7.

GPU or accelerator supplier was mentioned by datacentre customers as a potential alternative to NVIDIA.<sup>186</sup>

7.87 Based on the above evidence, the CMA considers NVIDIA has market power in the supply of Datacentre GPUs.

#### *Feasibility of controlling interoperability*

- *Parties' submissions*

7.88 The Parties submitted that Arm does not provide any means for the Merged Entity to change the degree of interoperability across different types of processors for datacentres as Arm does not provide complete chip designs, and Arm's customers, not Arm, design their own chips and determine what interconnects to use.<sup>187</sup> The Parties also submitted that Arm cannot overlay Arm's ISA in a way that would favour one licensee over the others<sup>188</sup> or 'flex' interoperability to disadvantage rivals. The Parties submitted this is because: (i) the IP that enables an Arm core to interoperate with a peripheral via certain standards (eg PCIe) sits outside the Arm core; (ii) the majority of NVIDIA's business relies on interconnecting with third-party components in an x86 environment, and thus NVIDIA's GPUs and SmartNICs depend on PCIe-compatibility; and (iii) a product without PCIe would be isolated from customer opportunities.<sup>189</sup>

7.89 The Parties also submitted that, since NVIDIA already offers GPUs and SmartNICs and is developing a CPU independent of the Merger, there cannot be any merger-specific conglomerate concern.<sup>190</sup>

- *CMA assessment*

7.90 Several third parties raised concerns about the Merged Entity's ability to modify the interoperability of Arm-based Datacentre CPUs and SmartNICs with other datacentre products to favour NVIDIA. Although certain standards

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<sup>186</sup> The CMA notes that, while in 2019 the EC found that NVIDIA's position in Datacentre GPUs was being challenged by Intel and NVIDIA (see [NVIDIA/Mellanox](#), paragraph 264), the shares of supply and third party evidence now available to the CMA indicates that Intel and AMD still have a materially smaller presence than NVIDIA.

<sup>187</sup> The Parties' response to the CMA RFI 3, paragraph 11.

<sup>188</sup> The Parties' response to the CMA RFI 3, paragraph 24. Specifically, the Parties reasoned that: (i) Arm's only requirement in relation to interoperability and compatibility is for the licensees to ensure that all software written for the ISA will run on the licensees' chips; (ii) Arm's ISA is 'backwards-compatible', and Arm cannot require any licensees to use any new ISA overlay or feature that they do not want; (iii) Arm cannot force any software developers to use any ISA features that would hypothetically 'favour' one licensee versus another; and (iv) the Arm ISA does not dictate how a supplier's products interoperates with other chips in a system.

<sup>189</sup> The Parties' Issues Meeting presentation dated 16 June 2021, pages 23 and 36.

<sup>190</sup> Final Merger Notice, paragraphs 725 and 780-783; the Parties' Issues Meeting presentation dated 16 June 2021, page 38.

(eg PCIe) currently exist for enabling different semiconductors to be technically compatible with one another, the evidence indicates that interoperability is not binary, and that the Merged Entity would have a stronger ability to control interoperability through ownership of Arm and inclusion of related proprietary interfaces or software.

- 7.91 For example, NVIDIA has stated it supports or plans to support proprietary interfaces to connect NVIDIA's CPUs, GPUs and network interconnects, and that it plans already to use NVIDIA's proprietary NVLink interface to connect the Grace [X] to boost efficiencies among NVIDIA products.<sup>191</sup> Several third parties expressed concerns that the Merged Entity would introduce NVIDIA proprietary and closed extensions within Arm's interfaces and/or PCIe and XCL protocols which they cannot use without the Merged Entity's products. This suggests that there are additional means outside the Arm core through which the Merged Entity can control interoperability.
- 7.92 Several third parties indicated other ways in which the interoperability between semiconductor types can be modified through control of Arm, namely:
- (a) Altering Arm's ISA and CPU architecture to limit the functionality of Arm-based processors with third party products and/or advantage NVIDIA's products by optimising the ISA (eg by favouring Arm IP's interoperability with NVIDIA's CUDA over Arm IP's interoperability with rival products and platforms).
  - (b) Limiting Arm's flexibility around the development of custom instruction sets and limiting engagement and technical information sharing on its products.
  - (c) Choosing not to enable an NVIDIA driver that facilitates interoperability with NVIDIA's GPUs.
- 7.93 Moreover, the CMA considers that interoperability modifications can be used to favour NVIDIA's own combined offerings. NVIDIA's intention and feasibility to supply combined offerings is demonstrated as follows:
- (a) CPU-GPU: NVIDIA already offers or is developing linked sales of Datacentre CPUs/SmartNICs with Datacentre GPUs. NVIDIA is currently

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<sup>191</sup> The Parties response to the CMA RFI 3 response, paragraph 40.

developing Grace, a CPU [REDACTED].<sup>192</sup>

- (b) SmartNIC-GPU: NVIDIA already offers BlueField-2X, a SmartNIC (DPU) that is enhanced with an NVIDIA Ampere GPU.<sup>193</sup> An internal document shows that NVIDIA is planning [REDACTED].<sup>194</sup>
- (c) A combined offering forms a key part of the Merger rationale, as evidenced in internal documents. As noted above at paragraph 7.5, the rationale is closely linked to control by the Merged Entity of the Datacentre CPU, SmartNIC and Datacentre GPU ‘holy trinity’. One Arm internal document lists as one of the Merger’s synergies the possibility of [REDACTED],<sup>195</sup> and one of NVIDIA’s internal documents states that the Merged Entity could create an ‘NVIDIA-Arm [REDACTED] alternative to x86’.<sup>196</sup>
- (d) A number of third parties submitted that NVIDIA already engages in ‘aggressive bundled pricing’ to increase costs for customers that buy Datacentre GPUs and SmartNICs individually compared with customers that buy Datacentre GPU-SmartNIC bundles.

7.94 In relation to the Parties’ submission that NVIDIA already offers Datacentre GPUs, SmartNICs and is developing a Datacentre CPU, and that thus there are not merger-specific conglomerate concerns, the CMA considers that the Merger may enhance the Merged Entity’s ability to engage in conglomerate foreclosure strategies. As explained above, ownership of Arm could allow the Merged Entity to modify the interoperability between Arm-based Datacentre CPUs and SmartNICs and other semiconductors to favour the attractiveness of NVIDIA’s products and weaken rival products and bundles, which would not have been possible prior to the Merger.

#### *Loss of sales by rivals*

7.95 The Parties submitted that:

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<sup>192</sup> See: [NVIDIA Announces CPU for Giant AI and High Performance Computing Workloads | NVIDIA Newsroom](#)

<sup>193</sup> See: [Network and Data Processing Units | NVIDIA](#); and [NVIDIA Introduces New Family of BlueField DPUs to Bring Breakthrough Networking, Storage and Security Performance to Every Data Center | NVIDIA Newsroom](#).

<sup>194</sup> [REDACTED]

<sup>195</sup> [REDACTED]

<sup>196</sup> [REDACTED].

- (a) NVIDIA has no ability to exploit its position in GPUs because only a minority of datacentres are accelerated with GPUs, and because OEMs, cloud and internet firms have purchasing power to new architectures or oppose a contractual tie;<sup>197</sup>
- (b) Intel and AMD could respond by bundling their CPUs, SmartNICs and GPUs;<sup>198</sup> and
- (c) NVIDIA would have no ability to exclude rivals through bundling given the lack of a sufficiently large common pool of customers, and the industry procurement structure leaves no room for contractual tying.<sup>199</sup>

7.96 As explained at paragraph 7.5 above and further discussed in the incentive section below, the demand for AI computing has driven substantial growth of GPUs used for datacentres, and GPU is considered to be one of the ‘holy trinity’ of datacentres (alongside CPU and SmartNIC). The importance of SmartNICs is also expected to increase significantly in datacentres (see paragraph 7.72(b) above). This means the pool of customers demanding combinations of CPU, SmartNIC and GPU in datacentres will become much larger than today. The joint importance of Datacentre GPUs, Datacentre CPUs and SmartNICs and the existence of demand for these products together is confirmed by third-party feedback:

- (a) Many customers told the CMA that they use Datacentre GPUs alongside Datacentre CPUs and, very often, also SmartNICs.
- (b) Several customers expressed concerns that they would be forced to take a bundle as result of the Merged Entity improving interoperability between its own Datacentre CPUs, GPUs and SmartNICs relative to combinations of rival products.
- (c) Some customers submitted that buying from the same supplier can be beneficial in terms of cost, technical support and performance. However, some other customers submitted that using different suppliers allows them to meet specific workload needs and to stimulate innovation and competition.

7.97 In relation to the Parties’ submission that the Parties’ do not have a sufficiently large pool of common customers (see paragraph 7.95(c) above), the CMA notes that conglomerate effects may arise when the merger parties are active

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<sup>197</sup> Final Merger Notice, paragraphs 753-756; paragraphs 763-764; the Parties’ Issues Meeting presentation dated 16 June 2021, page 36.

<sup>198</sup> Final Merger Notice, paragraph 765-767; the Parties’ Issues Meeting presentation dated 16 June 2021, page 36.

<sup>199</sup> The Parties’ Issues Meeting presentation dated 16 June 2021, page 36.

in markets that are ‘related in some way’ (and are not dependent on, for example, the merger parties being active at the same level of supply).<sup>200</sup> In addition, as explained above, the CMA considers that the joint importance and demand of Datacentre CPUs, Datacentre GPUs and SmartNICs is increasing, and the CMA expects that the common set of third parties demanding NVIDIA’s products and Arm-based products in datacentre will grow.

7.98 In light of the above, the CMA considers that NVIDIA has the ability to offer combinations of Datacentre CPUs, Datacentre GPUs and SmartNICs, and the Merger would allow it to modify interoperability between these products to favour the Merged Entity and disadvantage its rivals. This can have a negative impact on NVIDIA’s rival Datacentre GPU, Datacentre CPU and SmartNIC suppliers, given the importance of interoperability between these products (see paragraphs 7.90-7.94 above).

7.99 The CMA also considers that rivals could not sufficiently mitigate any loss through creating their own offering. The CMA understands that the only supplier that currently offers Datacentre CPUs, SmartNICs and Datacentre GPUs is Intel. AMD also currently supplies Datacentre CPUs and Datacentre GPUs. However, SmartNIC suppliers, including Intel, rely on CPU IP from Arm as no other competitive CPU IP suppliers currently exist (as already explained above). SmartNIC suppliers would therefore suffer the effects of the Merged Entity limiting interoperability with these products. The CMA considers that this would limit the ability of rivals to replicate NVIDIA’s combined offerings.

#### *Conclusion on ability*

7.100 For the above reasons, the CMA considers that the Merged Entity would have the ability to engage in conglomerate foreclosure. This is because: (i) Arm has market power in the supply of CPU IP, including for Datacentre CPUs and SmartNICs, (ii) NVIDIA has market power in the supply of Datacentre GPUs, (iii) controlling interoperability would be feasible and enhanced by the Merger; and (iv) customers would be incentivised to buy a combination of the Merged Entity’s Datacentre GPUs and SmartNICs and/or Datacentre CPUs thereby substantially depriving rival suppliers of sales.

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<sup>200</sup> Merger Assessment Guidelines, paragraphs 2.17 and 7.1.

## *Incentive*

### *Parties' submissions*

- 7.101 The Parties submitted that Arm has, and the Merged Entity will have, no incentive to overlay or adjust Arm's ISA in a way that would favour certain licensees, as this would risk reducing the attractiveness and take-up of new Arm architecture,<sup>201</sup> which is critical to its success.<sup>202</sup>
- 7.102 The Parties further submitted that the Merged Entity would have no incentive to engage in conglomerate foreclosure as: (i) the vast majority of NVIDIA's revenues come from the x86 ecosystem; (ii) the majority of x86 Datacentre CPUs are not accelerated by a GPU; (iii) customers would switch to all-Intel or all-AMD systems; and (iv) Intel and AMD would retaliate through their control of the PCIe roadmap.<sup>203</sup>

### *CMA assessment*

- 7.103 The CMA has considered whether, through modifying interoperability between Datacentre GPUs with Arm-based Datacentre CPUs and SmartNICs, the Merger may (i) reinforce the Merged Entity's position in Datacentre GPU; and (ii) allow the Merged Entity to expand its position in Datacentre CPUs and SmartNICs. The CMA has considered (i) evidence of the business strategy of the Merged Entity; (ii) potential gains in Datacentre GPUs, Datacentre CPUs and SmartNICs; and (iii) potential losses due to customers who do not prefer NVIDIA's product combinations switching to competitors' products.
- 7.104 As noted above at paragraph 7.93, NVIDIA already offers or is developing Datacentre CPU/SmartNIC-Datacentre GPU bundles and is supporting proprietary interfaces to connect these. This indicates that complementarity between Datacentre CPUs/SmartNICs with Datacentre GPUs is already an important part of NVIDIA's pre-Merger business strategy. Control of this 'holy trinity' is also, as noted above at paragraph 7.93(c), an important part of the Merger rationale.
- 7.105 The CMA considers that the Merged Entity would likely (i) gain sales in the Datacentre GPU market to reinforce NVIDIA's existing strong position, and (ii) gain sales in Datacentre CPU and SmartNIC markets to enhance NVIDIA's expansion, as a result of a foreclosure strategy. The CMA considers that this strategy would allow the Merged Entity to control three important

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<sup>201</sup> The Parties' response to the CMA RFI 3, paragraph 30.

<sup>202</sup> The Parties' response to the CMA RFI 3, paragraph 31.

<sup>203</sup> The Parties' Issues Meeting presentation dated 16 June 2021, page 37.

semiconductors in datacentres and deter potential entrants from starting to supply any of these products, so as to further reduce competitive constraints in future. This is for the following reasons:

- (a) **Protection of market power in Datacentre GPUs.** The Datacentre GPU addressable market is growing rapidly, with NVIDIA's forecasts showing that it expects the Datacentre GPU TAM to grow by around [REDACTED]% between 2021 and 2025, to around US\$[REDACTED].<sup>204</sup> As [REDACTED],<sup>205</sup> this provides a strong incentive for the Merged Entity to aim for growth at the expense of NVIDIA's existing rival Datacentre GPU suppliers (eg AMD and Intel). NVIDIA is well-placed to continue to capture a substantial proportion of future growth given its very strong existing position in this market. Further, NVIDIA will have an incentive to reduce the threat from suppliers of Datacentre accelerators (eg Graphcore, Groq) which also compete with GPUs to some degree, [REDACTED].<sup>206</sup>
- (b) **Expansion in Datacentre CPUs and SmartNIC.** By modifying interoperability and thereby increasing the attractiveness of its CPU/SmartNIC-GPU combined offer, the Merged Entity could make rival bundles or discrete Arm-based Datacentre CPUs and SmartNICs less competitive. As noted at paragraph 7.72 above, the demand for Datacentre CPUs and SmartNICs is increasing. Therefore, NVIDIA would be well-placed to capture a substantial proportion of growth from foreclosed Datacentre CPU and SmartNIC suppliers. This further reinforces the input foreclosure strategies outlined in ToHs 1a and 1b above. Moreover, for the reasons outlined at paragraphs 7.96-7.99 above, the CMA considers that the Merged Entity's combined offering would be attractive for customers and that rivals cannot offer similarly attractive bundles, thereby increasing the likely success of such a strategy.

7.106 The CMA considers that the risk of lost sales as a result of customers switching away from the Merged Entity's products in Datacentre CPU/SmartNICs and Datacentre GPU is limited, for the following reasons.

- (a) The Merged Entity would be unlikely to lose material sales in Datacentre GPU given NVIDIA's predominant position in this market, and that customers would be attracted by a combination of Datacentre CPUs,

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<sup>204</sup> The Parties' response to the CMA RFI 2, Annex 2, tab 'Datacenter TAM'. The CMA has considered the growth of the 'Hyperscale Accelerator IC TAM' and 'Scientific Computing Accelerator IC TAM'.

<sup>205</sup> NVIDIA's [REDACTED] (the Parties' response to the CMA RFI 1, Annex 62, slide 44).

<sup>206</sup> NVIDIA's internal document entitled [REDACTED]: NVIDIA Section 109 - Batch 1, Slide 28.

SmartNICs and Datacentre GPUs offered by the Merged Entity for the reasons outlined above.

- (b) The Merged Entity would be unlikely to lose material sales to rival Arm-based Datacentre CPUs and SmartNICs due to its ability to undermine the competitiveness of their products through control of CPU IP input (as discussed in ToHs 1a and b), and reduce their interoperability with NVIDIA's GPUs.
- (c) As noted at paragraph 7.99 above, the CMA understands that the only supplier that currently offers Datacentre CPUs, SmartNICs and Datacentre GPUs is Intel. AMD also currently supplies Datacentre CPUs and Datacentre GPUs. However, SmartNIC suppliers, including Intel, rely on CPU IP from Arm as no other competitive CPU IP suppliers currently exist, and could therefore be foreclosed by the Merged Entity.
- (d) As explained at paragraph 7.75 above, the CMA does not expect the Arm CPU IP ecosystem to suffer a material loss from licensees switching to other ISAs as a result of a foreclosure strategy. Even if Arm were to lose some CPU IP licensing revenues, the magnitude of this loss would be far smaller than the size of the potential gains that the Merged Entity could earn in Datacentre CPUs and SmartNICs (see paragraph 7.76 above), as well as in Datacentre GPUs (see paragraph 1(a) above).

7.107 In relation to the Parties' submission that AMD and Intel could retaliate through their control of the PCIe roadmap (see paragraph 7.102 above), as explained at paragraph 7.77 above the Parties did not provide evidence to substantiate the claim that the purported retaliation would be effective in countering foreclosure by the Merged Entity. Even if Intel and AMD could potentially retaliate against NVIDIA, this would not protect other licensees that do not have the option to retaliate. Therefore, the CMA does not believe that any threat of retaliation would be sufficient to preclude the Merged Entity from foreclosing rivals.

#### *Conclusion on incentive*

7.108 For the reasons outlined above, the CMA considers that the Merged Entity would have an incentive to foreclose rivals in the Datacentre CPU, SmartNIC and Datacentre GPU markets. The CMA also considers that the incentive as regards ToH 1c is further enhanced by the incentives at play under ToH 1a and 1b, and *vice versa*, consistent with the Merger rationale for NVIDIA to control three important datacentre semiconductors.

## ***Effect (relevant to ToH 1a, 1b and 1c)***

### *Parties' submissions*

7.109 In relation to vertical effects in the supply of Datacentre CPUs, the Parties submitted that foreclosure would have no material effect on competition. In particular, the Parties submitted that:

- (a) the majority of datacentre servers use x86 CPUs and would be unaffected by foreclosure;
- (b) customers could continue to choose Arm-compatible systems from architectural licensees such as Qualcomm, Huawei, etc;
- (c) Arm CPU IP licences represent only [~~8~~] % of the cost of a CPU and a negligible amount of the cost of an entire server;
- (d) NVIDIA would continue to be exposed to the competitive constraint imposed by x86;<sup>207</sup> and
- (e) all previous attempts (including from Qualcomm, Broadcom, Calxeda and Marvell) to challenge Intel and AMD failed, and that mere Arm licensees cannot challenge x86.<sup>208</sup>

7.110 In relation to vertical effects in the supply of SmartNICs, the Parties submitted that partial foreclosure would have no material effect on competition as the cost of Arm CPU IP licences represents a small fraction of the cost of a SmartNIC. As for total foreclosure, the Parties submitted that NVIDIA would continue to be exposed to the competitive constraint imposed by alternative sources of IP.<sup>209</sup>

7.111 In relation to conglomerate effects, the Parties submitted that any hypothetical conglomerate concern could not have appreciable effects on competition as the vast majority of datacentres are not equipped with GPUs.<sup>210</sup> The Parties submitted that, even if NVIDIA engaged in mixed bundling, this would benefit OEMs and datacentre customers by raising competitive pressure on Intel and AMD.<sup>211</sup>

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<sup>207</sup> Final Merger Notice, paragraphs 584-586; the Parties' Issues Meeting presentation dated 16 June 2021, page 31.

<sup>208</sup> The Parties' Issues Meeting presentation dated 16 June 2021, page 31; Compass Lexecon paper on Competition, paragraph 4.4; Compass Lexecon paper on Competition, Annex II, paragraph 14.

<sup>209</sup> Final Merger Notice, paragraph 615.

<sup>210</sup> Final Merger Notice, paragraph 784.

<sup>211</sup> Final Merger Notice, paragraph 785.

## *CMA assessment*

7.112 The CMA considers that, were the Merged Entity to foreclose rival Datacentre CPU, SmartNIC and/or Datacentre GPU suppliers through vertical and/or conglomerate foreclosure strategies, competition for the supply of Datacentre CPUs, SmartNICs and/or Datacentre GPUs would be substantially reduced.

7.113 In relation to Datacentre CPUs, the CMA notes that, while Intel and AMD would not be directly affected by the vertical or conglomerate foreclosure strategies outlined above, customer preference for Arm is growing strongly, and Arm's market position has strengthened and is expected to grow much further.<sup>212</sup> Arm's growth has been notably driven by the entry of a range of third-party CPU suppliers (see paragraph 7.17 above). The CMA believes that the effect of the foreclosure strategies identified above, would be to substantially reduce competition from existing and potential Arm-based Datacentre CPU suppliers against x86 competitors. In particular, the Merger could increase prices, reduce choice for customers, reduce the intensity and variety of innovation generated in the Arm ecosystem, and/or increase barriers to entry in the supply of Datacentre CPUs given Arm provides an important CPU IP input for others to innovate. As such, the CMA considers that Datacentre CPU suppliers that would be foreclosed play a sufficiently important role in the competitive process that competition in the supply of Datacentre CPUs would be substantially harmed.<sup>213</sup>

7.114 With regards to the Parties' submission that previous attempts to challenge Intel and AMD have failed, the evidence presented above at paragraph 7.17 indicates that Arm has enabled a range of suppliers of Datacentre CPUs (including CSPs) to compete. Given Arm's growth trajectory, the CMA considers that these suppliers may represent a significant competitive threat to Intel and AMD.

7.115 In relation to SmartNICs, the CMA has found that all of the main SmartNIC suppliers (including Intel and potentially AMD) rely on Arm. The CMA considers that their foreclosure could lead to an increase in price and reduction of customer choice, a reduction of innovation generated in the Arm ecosystem, and raised barriers to entry in the supply of SmartNICs.

7.116 In relation to Datacentre GPUs, the CMA considers that the conglomerate strategy identified (modifying the interoperability of Arm-based Datacentre CPUs and SmartNICs with Datacentre GPUs) the Merged Entity would weaken NVIDIA's existing Datacentre GPU rivals and raise barriers for new

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<sup>212</sup> See paragraphs 7.22-7.27 above.

<sup>213</sup> Merger Assessment Guidelines, paragraph 7.21.

and recent entrants, in turn strengthening NVIDIA's market power in the supply of Datacentre GPUs.

7.117 Accordingly, the CMA considers that the effects of each of ToHs 1a, 1b and 1c would be to substantially reduce competition in each of these individual downstream frames of reference. In addition, the effects of these foreclosure strategies would reinforce each other and would, both individually and cumulatively, lead to a reduction in competition and innovation in the supply of various semiconductors for datacentre applications as a whole.

### ***Conclusion on ToH 1***

7.118 For the above reasons, the CMA believes that the Merged Entity would have the ability and incentive to engage in vertical and conglomerate strategies to foreclose rival suppliers of Datacentre CPUs, SmartNICs and Datacentre GPUs. Accordingly, the CMA has found the Merger gives rise to a realistic prospect of significant competition concerns as a result of (i) vertical effects in relation to the supply of Datacentre CPUs and SmartNICs; and (ii) conglomerate effects in relation to the supply of Datacentre CPUs, SmartNICs and Datacentre GPUs.

## **Internet-of-things (IoT)**

### ***Overview***

7.119 IoT devices are used across multiple industries and usages. There is a broad spectrum of IoT devices from low performance (**LP**) devices such as smart appliances for consumer use to more advanced, high performance / HP or autonomous HP IoT devices, eg for industrial, robotics and medical applications, which typically require greater computational power. As explained in this section, the HP IoT segments are nascent and growing.

7.120 NVIDIA supplies autonomous SoCs based on microprocessors (**MPUs**) for HP IoT devices.<sup>214</sup> NVIDIA's main products are its 'Jetson' platforms, which are based on Arm's CPU IP and NVIDIA's GPU, SoC system design, and software solutions.<sup>215</sup> Jetson targets applications including robotics, avionics, medical, video analytics, and industrial. NVIDIA also supplies its 'Tegra' SoCs in IoT applications, either incorporated into its Jetson platform or on a standalone basis. In addition, NVIDIA has been developing 'Isaac', a virtual robot simulator used to train autonomous IoT devices.<sup>216</sup> The Parties

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<sup>214</sup> Final Merger Notice, paragraphs 327; 339; 359.

<sup>215</sup> Jetson platforms can either be used in the device itself or as micro-edge servers.

<sup>216</sup> The Parties' RFI Submission of 2 July 2021, RFI 9, paragraph 1.7.

submitted that Intel [redacted] target similar AI-intensive applications. The Parties identified [redacted] as potential competitors that are Arm-based.<sup>217</sup> Intel, NXP, Xilinx, Mediatek, Rockchip, Renesas, and Qualcomm as competing in the supply of HP IoT processor products, to differing degrees.<sup>218</sup>

7.121 Arm licenses CPU IP and other IP to NVIDIA and to other semiconductor suppliers for use in IoT applications. The main products are the HP IoT-oriented ‘big CPU IP’ (Cortex-A) for use in MPUs. These are optimised for performance-intensive applications such as robotics, face recognition, and video analytics. Arm also licenses LP IoT-oriented ‘smaller CPU IP’ (Cortex-M) for use in microcontrollers (**MCUs**) and other peripheral IP (including GPU, ISP and System IP).<sup>219</sup> These MPUs or MCUs control the SoCs in IoT devices. Intel self-supplies proprietary CPU IP for SoCs in IoT devices. Other suppliers of CPU IP to third parties include RISC-V, MIPS and Synopsys.

### ***Vertical input foreclosure of rival suppliers of SoCs for HP IoT applications***

7.122 The Parties submitted that their vertical relationship in IoT is limited to the autonomous HP IoT segment, for which NVIDIA uses Arm CPU IP (Cortex A57) for its SoC-based platforms.<sup>220</sup> They further submitted that IoT is only a small part of the Parties’ activities, with Arm’s CPU IP primarily used in LP IoT, a commoditised segment where NVIDIA is not active, and Arm’s offerings in HP IoT limited to areas where NVIDIA is not active.<sup>221</sup>

7.123 The CMA considers that there is a vertical relationship between the Parties in HP (including autonomous HP) IoT applications. In addition to autonomous HP IoT based on Arm’s CPU IP, NVIDIA also supplies a wider range of HP IoT products from ‘entry level’ to ‘mid-range’ and ‘high performance’.<sup>222</sup>

7.124 Similarly, in addition to the performance-intensive ‘big CPU IP’ referenced above at paragraph 7.121, Arm’s internal documents indicate that it is increasingly targeting growth in autonomous HP IoT applications, including for

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<sup>217</sup> Final Merger Notice, paragraphs 689-693. The Parties were unable to provide market shares for autonomous HP IoT due to lack of third-party data source (Final Merger Notice, paragraphs 433-435; the Parties’ RFI Submission of 2 July 2021, RFI 9, paragraph 3.4.

<sup>218</sup> List of Arm based Partner Products that compete with Nvidia, A&I, 9 October 2020, [original document name: Nvidia Questions Oct20.pptx, batch: CMA-002 - Batch 01](#). One third party stated that NVIDIA competes closely alongside Intel, AMD and Arm-based suppliers (HiSilicon, Rockchip, NXP), and moderately against Qualcomm, TI and Renesas in the supply of SoCs for IoT devices.

<sup>219</sup> Final Merger Notice, footnote 500 and paragraph 365 *et seq.*

<sup>220</sup> Final Merger Notice, paragraph 391.

<sup>221</sup> Final Merger Notice, paragraph 365 *et seq.*

<sup>222</sup> See NVIDIA [redacted]: The Parties’ response to the CMA RFI 1, [redacted]

industrial automation and robotics.<sup>223</sup> Arm provides and will increasingly provide an input which enables downstream suppliers to compete with NVIDIA.

7.125 Given the Parties' vertical relationship, the CMA has considered whether the Merged Entity may have the ability and incentive to foreclose (through partial and/or total foreclosure) access to Arm's CPU IP, leading to a loss of competition in the supply of SoCs or SoC-based platforms for HP IoT (**HP IoT SoCs**) applications (**ToH 2**).

#### *Ability*

7.126 In order to assess whether the Merged Entity has the ability to foreclose competing suppliers of HP IoT SoCs, the CMA has considered:

- (a) the importance of Arm CPU IP and whether Arm has market power in relation to the supply of CPU IP for HP IoT SoCs, including by reference to the credibility of alternative CPU IP suppliers; and
- (b) the mechanisms that the Merged Entity could use to foreclose rival suppliers of HP IoT SoCs.

#### *Importance of Arm CPU IP as an input and whether Arm has market power*

7.127 The Parties submitted that the Merged Entity would have no ability to foreclose rivals because:<sup>224</sup>

- (a) Arm's position in CPU IP licensing for autonomous HP IoT is not indicative of market power, as Arm's CPU IP is not a differentiator, Jetson

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<sup>223</sup> A series of Arm internal email exchanges in October 2020 prepared for due diligence for NVIDIA show that 'Arm based solutions are making rapid growth in the 'Rich IoT' segment. Arm considers 'Rich IoT' to include industrial automation amongst others. See Re: NVIDIA regulatory filings: IoT Market Share; from: [REDACTED], 9 October 2020, original document name: Re: NVIDIA regulatory filings: IoT Market Share.msg, batch: CMA-002 - Batch 01. An Arm business plan in May 2020 indicates that Arm's IoT segment 'targets the industrial automation markets'; 'autonomous and industrial mobile robotics', both being described as solutions based on Cortex-A/R CPU IP. See Sparta Program, May 2020, original document name: Sparta Program - Overview.pdf, batch: CMA-002 - Batch 01. In an Automotive and IoT revenue plan for 2020-2024, Arm identifies a key focus of its IoT growth category as 'new customers in industrial, robotics, autonomous driving and delivery', 'targeting mid-to-high performance fixed Robotics, collaborative Bots and autonomous mobile robots'. See Automotive & IoT 2020-2024 Revenue Plan, 20 June 2020, original document name: Automotive & IoT.pptx, batch: CMA-002 - Batch 03. An Arm IPG (intellectual property group) strategic plan sets out one of its strategies for 2025 was to expand into autonomous, noting that Arm's 'safety grade cores are gaining traction in more markets from autonomous applications to industrial'. See IPG Strategic Plan, Work in Progress, 14 October 2020, original document name: IPG-Strategy-5YR-Plan-FY20.pptx, batch: CMA-002 - Batch 02\_v2.

<sup>224</sup> Final Merger Notice, paragraphs 688-710; the Parties' Issues Meeting presentation dated 16 June 2021, page 45. The CMA notes that the Parties' Issues Meeting presentation and following submissions on IoT largely repeated the Parties' previous submissions in the Final Merger Notice.

developers do not write their software for Arm ISA and Arm ISA does not have a significant software lock-in.

- (b) Customers can select from multiple alternative CPU IP licensors including RISC-V based suppliers (SiFive, StarFive, Andes Technology, Alibaba, InCore Semiconductor, MIPS) and Synopsys, or even develop in-house technologies.
- (c) Switching CPU ISA is straightforward for IoT applications and no existing CPU ISA used in IoT has a material advantage in IoT applications; customers for IoT SoCs can select from multiple alternatives, especially given the embedded nature of IoT computing.
- (d) NVIDIA's closest competitor, Intel, does not rely on Arm IP for its autonomous HP IoT solutions; Intel's use of x86-based in-house designs precludes any hypothetical attempt at foreclosure.

7.128 A CPU controls the SoC in an HP IoT device and, as noted above at paragraph 7.16, CPU IP forms the critical basis of the design of a CPU. Nearly all third parties who responded to the CMA regarding IoT said it is very important for HP IoT SoC suppliers (who are reliant on third party licensors) to license Arm CPU IP for HP IoT SoCs and for customers to be able to buy HP IoT SoCs based on the Arm CPU ISA. This is due to the power efficiency of Arm-based SoCs and Arm having a strong software ecosystem across IoT.<sup>225</sup> This indicates Arm's CPU IP plays an important role in shaping downstream competition.

7.129 Third parties did not see other CPU IP licensors as viable alternatives to Arm due to, amongst other factors, a lack of comparable software ecosystem and inferior performance:

- (a) MIPS was described as suffering from poorer performance, limited range, a lack of software ecosystem, as no longer developing independent IP and as having software that was not mature.
- (b) RISC-V was seen as lagging far behind Arm due to architectural gaps, and a lack of software ecosystem. Although it was seen as viable for LP IoT applications, it was not seen as viable for HP IoT applications and as being the basis for a low number of commercialised chips.

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<sup>225</sup> One respondent highlighted that Arm CPU IP is the 'de facto standard across computing ecosystems' because of its power efficiency and ease of integration and reasoned that Arm has, in IoT, the highest revenue and the most extensive product portfolio and software ecosystem, such that developers are familiar with Arm.

- (c) Synopsys was also seen as servicing LP IoT applications and suffering from a limited range of products and a lack of software ecosystem. It was described as 'lower-end', extremely limited in range and offering a weak software ecosystem.
- (d) SiFive's performance was seen as lagging too far behind Arm to be a viable alternative and as lacking a software ecosystem.

7.130 Arm's internal documents recognise competition from Intel and, to a lesser extent, emerging competition from RISC-V in the IoT segment.<sup>226</sup> However, such documents are not indicative of a strong constraint from RISC-V. No third parties mentioned any specific RISC-V suppliers identified by the Parties (StarFive, Andes Technology, Alibaba, InCore Semiconductor) as alternatives to Arm for CPU IP.

7.131 One of Arm's internal documents also indicates that Arm's share in the 'Rich IoT' market was [50-60]% in FY2020 and would increase to [60-70]% in the following five years, which suggests that Arm is the main CPU IP licensor in HP IoT and that its share is growing.<sup>227</sup>

7.132 With respect to the Parties' submissions on the constraint posed by Intel, the CMA notes that Intel is not an alternative for IoT SoC suppliers reliant on third-party licensors of CPU IP.<sup>228</sup> The CMA also believes that there are limitations to Intel's constraint for downstream customers of SoCs, based on third-party feedback which indicates that Intel-based SoCs are power and cost-inefficient for IoT applications generally. Further, the CMA notes that Intel uses Arm CPU IP for some of its products alongside its own x86 CPU and therefore relies at least to some extent on Arm.<sup>229</sup>

7.133 With respect to the Parties' view that switching CPU IP supplier is straightforward, all third parties that responded to the CMA's investigation in

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<sup>226</sup> Re: NVIDIA regulatory filings: IoT Market Share; from: [REDACTED], 9 October 2020, original document name: Re: NVIDIA regulatory filings: IoT Market Share.msg, batch: CMA-002 - Batch 01. Another Arm document relating to its IPG strategic plan states that 'market desire to shift away from Intel x86 in markets like Industrial automation, significant engagements underway to drive that shift', while 'RISC-V proliferation is a risk and could capture a foothold in start-ups and specific markets'. IPG Strategic Plan, Work in Progress, 14 October 2020, original document name: IPG-Strategy-5YR-Plan-FY20.pptx, batch: CMA-002 - Batch 02\_v2, slides 19-20.

<sup>227</sup> Re: NVIDIA regulatory filings: IoT Market Share; from: [REDACTED], 9 October 2020, original document name: Re: NVIDIA regulatory filings: IoT Market Share.msg, batch: CMA-002 - Batch 01. Arm describes the Rich IoT market as differentiated from LP IoT and including 'all the segments of IoT market that need Cortex A category of CPU and runs Linux or higher level Operating System, including 'industrial automation, IoT gateway, Retail compute devices such as point-of-sale units, Smart-camera/Surveillance, Smart City data aggregators/gateways etc'.

<sup>228</sup> The CMA's views on Intel's recent announcement to begin licensing IP to third parties are outlined at paragraphs 7.37-7.38.

<sup>229</sup> For example, see the List of Arm based Partner Products that compete with Nvidia, A&I, 9 October 2020, original document name: Nvidia Questions Oct20.pptx, batch: CMA-002 - Batch 01.

respect of IoT indicated that switching CPU IP supplier is difficult. The reasons provided include the view that this would entail expensive software rebuild, lack of ecosystem support, and more generally the time, effort and financial investment required to integrate products and transition with another CPU IP supplier or ISA.

7.134 On the basis of the above, the CMA considers that Arm's CPU IP is an important input to the supply of HP IoT applications, and such importance may grow as the Arm ecosystem further emerges. The CMA considers that Arm has market power given the lack of credible alternative suppliers of CPU IP, their limitations, and the difficulties for licensees to switch suppliers. As illustrated at paragraph 7.31 above, Arm also has a strong position in the supply of CPU IP overall worldwide. The CMA believes that the strength and existence of Arm's ecosystem across the CPU IP spectrum are interlinked to, and reinforce, Arm's market power in the narrower segmentation of CPU IP for HP IoT SoCs.

#### *Foreclosure mechanisms*

7.135 The Parties submitted that Arm's licensing model precludes any attempt at foreclosure, that Arm licensees are contractually protected against any foreclosure. They submitted that the general-purpose nature of most of Arm's products means Arm does not have full visibility of their intended use. The Parties submitted, therefore, that Arm could not selectively disadvantage any particular licensees with respect to IoT. The Parties further submitted that the Merged Entity will be constrained by the countervailing buyer power of Arm licensees, [REDACTED].<sup>230</sup>

7.136 The CMA has considered input foreclosure mechanisms through the restriction or degradation of Arm CPU IP similar to those explained in datacentres above, and other applications later on in this report, ie including both total and partial foreclosure mechanisms. Specifically to HP IoT, the CMA believes that it would be feasible for the Merged Entity to target foreclosure of competitors in the HP IoT segment, given Arm's internal documents referred to in paragraph 7.124 above show that HP IoT is a distinct target segment for which Arm is developing solutions. In addition, as explained in paragraph 7.60, several Arm licensees have told the CMA that they share with Arm for which field of application they use Arm's IP.

7.137 Given the importance of Arm's CPU IP as an input and the weakness of alternative CPU IP suppliers, the CMA does not believe buyer power and

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<sup>230</sup> Final Merger Notice, paragraphs 688-710; the Parties' Issues Meeting presentation dated 16 June 2021, page 45.

contractual protection to be sufficient to preclude foreclosure, especially with regards to smaller competitors and potential entrants which would not be protected by these options.

#### *Conclusion on ability*

7.138 The CMA considers that: (i) Arm's CPU IP is an important input to the supply of HP IoT SoCs; (ii) Arm has market power in the supply of CPU IP, including CPU IP used by HP IoT SoC suppliers due to the lack of credible alternatives and barriers to switching; and (iii) the Merged Entity has the ability to target foreclosure at rival suppliers of HP IoT SoCs.

#### *Incentive*

7.139 The Parties submitted that the Merged Entity would have no incentive to foreclose rivals because:<sup>231</sup>

- (a) NVIDIA is not observing [redacted] from companies moving in HP IoT devices.
- (b) Foreclosure would not be profitable as most of Arm's licensees are primarily active in LP IoT and HP IoT segments where NVIDIA is not present, and NVIDIA cannot selectively foreclose its autonomous HP IoT competitors.
- (c) NVIDIA would not capture most of these diverted sales downstream because [redacted] Intel does not rely on Arm IP and Arm-based potential competitors [redacted] tend to focus on different application areas than NVIDIA.
- (d) NVIDIA would be 'trading immediate licensing revenue and future royalties for Arm for [...] a hope that Arm's former customers would in several years' time lose downstream sales to NVIDIA'.
- (e) Foreclosure would risk retaliation from Arm's licensee 'partners'.

7.140 The evidence available to the CMA indicates that the Merged Entity may have an incentive to foreclose rivals in IoT.

7.141 First, the CMA notes that IoT (especially HP and autonomous HP IoT) is a nascent and growing area. This is confirmed by NVIDIA's [redacted]

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<sup>231</sup> Final Merger Notice, paragraphs 711-719; the Parties' RFI Submission of 2 July 2021, RFI 9, paragraph 1.1; the Parties' Issues Meeting presentation dated 16 June 2021, pages 45-46.

[REDACTED]. The same document also shows a [REDACTED].<sup>232</sup> The CMA considers that it shows NVIDIA has an incentive to capture growth across various HP IoT applications beyond just autonomous HP IoT, contrary to the Parties' suggestion that NVIDIA is only active in a 'small niche'.<sup>233</sup> Similarly, an Arm internal document shows that it expects 'the majority of the growth and innovation' will be happening in HP IoT.<sup>234</sup>

7.142 Second, the CMA considers that NVIDIA competes with Intel and other Arm-based suppliers in the supply of SoC products for HP IoT. As identified in Arm's internal document, the CMA believes that such rivals include a number of Arm licensees including NXP, Xilinx, Mediatek, Rockchip, Renesas, Qualcomm, and Intel (which uses Arm CPU IP for some of its products alongside its own x86 CPU).<sup>235</sup> In any event, irrespective of whether NVIDIA currently observes any current market threats, the CMA considers that NVIDIA will have an incentive to be the first-mover in a nascent market, positioning itself strongly in a high-growth market. The CMA also considers the Merged Entity would have, in the longer term, an incentive to raise barriers for potential competitors who would otherwise be able to enter using Arm technology and compete with NVIDIA, for similar reasons discussed above at paragraph 7.70.

7.143 Third, the CMA considers that the downstream profits are much greater than any potential upstream losses. [REDACTED].<sup>236</sup> By contrast, Arm's royalties are typically only a small percentage of the downstream product value, and any such upstream revenue losses would be small given the lack of alternatives and hence the inability of rivals to switch away from Arm. The CMA also considers that the Merged Entity can target foreclosure of specific competitors in IoT segments for reasons explained at paragraph 7.136 above. This implies the Merged Entity does not need to sacrifice upstream profit losses in segments such as LP IoT in which NVIDIA does not compete. This is also true in respect of a partial foreclosure strategy, where the Merged Entity would not need to sacrifice all licensing revenues immediately, as the Parties' submission on incentives suggest.

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<sup>232</sup> The Parties' response to the CMA RFI 1, Annex 63 – [REDACTED].

<sup>233</sup> Final Merger Notice, paragraph 390.

<sup>234</sup> Arm's internal document entitled 'Market Requirements Specification for Mainstream High Performance IoT 2021', 2020, original document name: Mainstream High Performance IoT Market Requirements 2021.pdf, batch: CMA-002 - Batch 03, page 9.

<sup>235</sup> For example, see the List of Arm based Partner Products that compete with Nvidia, A&I, 9 October 2020, original document name: Nvidia Questions Oct20.pptx, batch: CMA-002 - Batch 01.

<sup>236</sup> The Parties' response to the CMA RFI 1, Annex 63 – [REDACTED].

- 7.144 Further, the CMA believes that NVIDIA may have a wider strategic incentive to control an important input (ie Arm CPU IP) across various IoT segments in order to strengthen NVIDIA's position in other products or segments. Such concerns have been raised by third parties, including that 'NVIDIA could leverage its control of Arm [in IoT] to incentivise the AI workloads to run on NVIDIA's GPUs' and that 'NVIDIA could use its dominance in GPU and its SW ecosystem...strengthened with the acquisition of Arm to build a platform to strengthen its position in edge computing including Automotive and IoT'.
- 7.145 Finally, for the reasons outlined at paragraph 7.77 above, the CMA does not believe that any threat of retaliation would be effective to preclude the Merged Entity from foreclosing rivals.

### *Effect*

- 7.146 The Parties submitted that there is no likely harm to effective competition because existing and prospective entrants are not dependent on Arm's IP.<sup>237</sup>
- 7.147 The Parties further submitted that the Merger will spur innovation and provide stronger alternatives to x86, RISC-V, MIPS and others in the IoT space, as the Merged Entity will be able to: (i) create new embedded platforms for Autonomous HP IoT, and (ii) license design IP to chip companies to innovate and develop a rich variety of IoT solutions.<sup>238</sup>
- 7.148 Several third parties have raised such concerns in relation to IoT. As noted above, the CMA considers that Arm CPU IP is an important input which allows other competitors to enter and compete in the supply of HP IoT SoCs. The Merged Entity may restrict access to CPU IP by downstream competitors, including by Intel which does use Arm's CPU IP for some products, and also future competitors, across all IoT segments. Therefore, the CMA considers that the Merged Entity may engage in input foreclosure that would result in a substantial loss of competition and reduction in the degree of innovation in the downstream supply of HP IoT SoCs and related solutions for HP IoT applications. Several third parties have raised such concerns in relation to IoT. The CMA also notes that such loss of competition could be particularly significant as it may have a lasting effect on the development of a relatively nascent and increasingly important market. Further, the CMA notes that the Parties did not provide evidence to support their submission that the Merger will increase innovation in the IoT space (see paragraph 7.147 above).

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<sup>237</sup> Final Merger Notice, paragraph 720.

<sup>238</sup> The Parties' Issues Meeting presentation dated 16 June 2021, page 46.

## Conclusion on ToH 2

7.149 For the above reasons, the CMA believes that the Merged Entity would have the ability and incentive to engage in strategies to foreclose rival suppliers of SoCs for HP IoT applications. Accordingly, the CMA has found that the Merger gives rise to a realistic prospect of significant competition concerns as a result of vertical effects in relation to the supply of HP IoT SoCs and related solutions.

## Automotive

### Overview

7.150 The demand for sophisticated vehicle functionality such as autonomous driving has driven the growth of semiconductors for use in the automotive sector.<sup>239</sup> The Parties submit that autonomous driving is a ‘nascent and uncertain’ space where no supplier has managed to develop a safe technology.<sup>240</sup> The CMA’s competitive assessment has therefore focused on the Merger’s impact on these ongoing and future developments.

7.151 There are two broad applications within automotive where there is a vertical relationship between the Parties’ activities, namely: (i) ADAS; and (ii) infotainment:

(a) ‘ADAS’ encompasses a range of differentiated products, which are classified into ‘levels’ of assistance provided to the driver (L0-L5), ranging from no automation (L0) to functions such as parking assistance (L1) up to full autonomous driving (L5).<sup>241</sup> The Parties submit that ADAS solutions currently available are predominantly L0-L2 and that there are no widely commercially available solutions above L2.<sup>242</sup>

(b) Infotainment systems include navigation systems, WiFi, audio and video playback.<sup>243</sup> Infotainment solutions are differentiated. The next generation of infotainment systems are expected to include systems that display vehicle and driver information pertaining to safety, referred to as the digital cockpit.<sup>244</sup>

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<sup>239</sup> Automotive LoB – A&I LT, November 2020, original document name: A&I\_offsite\_NOV20\_[X]\_v1.0.pptx, batch: CMA-002 – Batch 01, pages 3-6.

<sup>240</sup> Final Merger Notice, paragraph 657.

<sup>241</sup> See: [US Department for Transportation ADAS levels](#), accessed by the CMA on 12 July 2021.

<sup>242</sup> Final Merger Notice, footnote 90, page 64.

<sup>243</sup> Final Merger Notice, paragraph 251.

<sup>244</sup> <https://community.arm.com/developer/ip-products/system/b/embedded-blog/posts/a-starters-guide-to-arm-processing-power-in-automotive>, accessed by the CMA on 12 July 2021.

7.152 Processors used for automotive applications are typically SoCs with CPU cores, as well as other hardware cores to perform graphics or acceleration functions, such as GPUs.<sup>245</sup> The competitive dynamics between ADAS and infotainment differ to an extent since there are some differences in competitor sets. Although a number of SoC suppliers are active in both segments, others are not (eg Intel-Mobileye is only active in ADAS). Similarly, as an upstream licensor, MIPS is active in ADAS but has limited activities in infotainment.

7.153 Higher levels of ADAS and digital cockpit require more powerful SoCs, so as to run the necessary software and software upgrades to perform advanced functionality. The focus of the Parties' vertical relationship in ADAS and infotainment is primarily on the high-end aspects of each.

(a) Arm is active in the upstream licensing of CPU, GPU, ISP and System IP to semiconductor suppliers for inclusion in SoCs in ADAS and infotainment applications. Arm licensees include MediaTek, NXP, Samsung, Qualcomm, Renesas.<sup>246</sup>

(b) NVIDIA supplies SoCs, SoC-based platforms,<sup>247</sup> discrete GPUs and software solutions to vehicle OEMs (eg Mercedes-Benz/Daimler,<sup>248</sup> Toyota and General Motors) and Tier 1 electronic suppliers (eg Bosch, Continental, and Harman)<sup>249</sup> for both ADAS and infotainment. NVIDIA continues to innovate in this space: it has developed a new SoC 'Orin' and announced the next-generation SoC, 'Atlan',<sup>250</sup> both of which target high-end, autonomous driving solutions in ADAS<sup>251</sup> and high-end infotainment; namely, AI-powered cockpit solutions for vehicles (**AI cockpit**).<sup>252</sup>

7.154 A significant number of third parties have raised concerns that the Merged Entity may engage in total or partial input foreclosure strategies, eg by restricting access to Arm's IP, degrading the quality of its service provision and/or increasing license fees. The CMA considered whether the Merger may give rise to vertical effects through foreclosure of rival suppliers of ADAS SoCs (**ToH 3a**) and infotainment SoCs (**ToH 3b**).

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<sup>245</sup> Final Merger Notice, paragraph 246.

<sup>246</sup> Final Merger Notice, paragraph 234.

<sup>247</sup> The Parties submitted that an SoC-based platform solution includes both an SoC and additional hardware/software and blueprint designs (RFI Submission of 2 July 2021, RFI 7, paragraph 18).

<sup>248</sup> Final Merger Notice, paragraph 225.

<sup>249</sup> Final Merger Notice, paragraph 522. The Parties submit that a Tier 1 supplier is one that provides system solutions and, in some instances, creates software for vehicle OEMs (Final Merger Notice, paragraph 209).

<sup>250</sup> <https://nvidianews.nvidia.com/news/nvidia-unveils-nvidia-drive-atlan-an-ai-data-center-on-wheels-for-next-gen-autonomous-vehicles>, accessed by the CMA on 9 July 2021.

<sup>251</sup> [REDACTED]

<sup>252</sup> Final Merger Notice, paragraph 194.

7.155 The CMA focussed primarily on input foreclosure through CPU IP. However, (i) some of NVIDIA's rival SoC suppliers use Arm's GPU,<sup>253</sup> ISP and/or System IP in addition to CPU IP, and (ii) a number of third parties voiced concerns in relation to these other forms of IP. Therefore, the CMA also considered foreclosure including these other forms of IP on suppliers of SoCs, together, within its assessment of foreclosure through CPU IP. The Parties did not provide separate submissions for these other forms of IP on the basis that the assessment would not materially differ from that CPU IP (noting Arm's ISP IP is relevant for ADAS but not infotainment applications).<sup>254</sup>

***Vertical effects through foreclosure of rival suppliers of SoCs for ADAS (ToH 3a) and infotainment (ToH 3b) applications***

*Ability*

7.156 In order to assess the ability to foreclose competing suppliers of: (i) ADAS SoCs; and (ii) infotainment SoCs, the CMA considered:

- (a) the extent to which Arm's IP is important for such suppliers and whether Arm has market power; and
- (b) the mechanisms that the Merged Entity could use to foreclose rival ADAS / infotainment SoC suppliers.

*Importance of Arm CPU IP and whether Arm has market power*

- *ADAS SoCs – CPU IP*

7.157 The Parties submitted that the Merged Entity has no ability to foreclose rival SoC suppliers in automotive (covering both ADAS and infotainment) as:

- (a) Arm's CPU IP is not an essential input for automotive applications,<sup>255</sup> and specifically for ADAS, Arm has no market power given its market share of

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<sup>253</sup> The CMA understands that Arm's Mali GPU IP can currently only be used for an integrated GPU in a SoC (and not as a discrete GPU). As detailed further in this section, the CMA has therefore focused on the effects of a foreclosure strategy through GPU IP for ADAS and infotainment applications on downstream SoC suppliers (rather than suppliers of discrete GPUs).

<sup>254</sup> The Parties justified this on the basis that 'almost all Arm GPU IP licensees are CPU IP licensees, as well. As a result, the competitive assessment provided for CPU IP apply mutatis mutandis to GPU IP. The same applies to Arm ISP IP. Arm ISP IP is only used in ADAS/autonomous driving for camera image sensor processing. Arm ISP IP customers are typically also CPU IP licensees. In any event, Arm ISP IP market share is below [5-10]%' (Final Merger Notice, paragraph 241). The Parties further described System IP for interconnect fabrics as 'ancillary' to its activities concerning CPU IP for use in automotive SoCs and did not provide a separate assessment to System IP (on, the CMA understands, the same basis as the other IP forms).

<sup>255</sup> Final Merger Notice, paragraphs 626-627.

[20-30]% (as an average of 2019-2020 volumes of downstream SoC sales, including non-licensed solutions).<sup>256</sup>

- (b) Arm's CPU IP is general-purpose and plays a limited role in the performance of automotive SoCs.<sup>257</sup> As such, Arm CPU IP is not a form of differentiation between NVIDIA and other options.<sup>258</sup>
- (c) There are multiple alternatives to Arm's CPU IP, including competing licensors (eg MIPS, Synopsys) and CPU IP based on open-source-licences (eg RISC-V).<sup>259</sup>
- (d) No ISA has an advantage in automotive applications, including ADAS, because SoCs do not need to be compatible with a large ecosystem of third-party software.<sup>260</sup> At the SoC customer level, the Parties submitted that Tier 1 suppliers and OEMs can port software between SoCs and, as a result, their choice of any future SoC is not conditioned by whether they have developed software for a particular vehicle/model.<sup>261</sup>
- (e) Leading robotaxi firms (the main vehicle types currently on the road operating at above ADAS L2+<sup>262</sup>) all use Intel's x86 ISA.<sup>263</sup>
- (f) The Merged Entity is constrained by significant buyer power.<sup>264</sup>

7.158 The Parties further submitted that, in automotive: (i) customers are losing confidence that Arm would ever be able to provide a competitive product, making them reluctant to use Arm's IP; and (ii) Arm faces competition from Intel, an 'entrenched' and 'well-resourced incumbent' that has established an offering of x86-based automotive products.<sup>265</sup>

7.159 As noted above at paragraph 7.16, third parties have indicated that CPU IP, which forms the basis of the design of a CPU, is an important input for any SoC product. One automotive SoC supplier told the CMA that a CPU is central to any automotive SoC supplier because it runs the host operating system and orchestrates its functions, and a CPU needs to function well with other parts of the SoC and external components. Therefore, the CMA

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<sup>256</sup> Final Merger Notice, paragraph 625.

<sup>257</sup> The Parties' presentation on automotive dated 31 March 2021, page 14.

<sup>258</sup> The Parties' Issues Meeting Presentation dated 16 June 2021, page 40.

<sup>259</sup> The Parties' presentation on automotive dated 31 March 2021, page 6; Final Merger Notice, paragraph 627; the Parties' Issues Meeting Presentation dated 16 June 2021, page 41.

<sup>260</sup> Final Merger Notice, paragraph 627.

<sup>261</sup> The Parties' RFI Submission of 2 July 2021, RFI 7, paragraph 6.15; the Parties' Issues Meeting presentation dated 16 June 2021, page 41.

<sup>262</sup> Final Merger Notice, footnote 90, page 64.

<sup>263</sup> Final Merger Notice, paragraph 634.

<sup>264</sup> Final Merger Notice, paragraph 623 *et seq.*; the Parties' Issues Meeting presentation dated 16 June 2021, page 41.

<sup>265</sup> Arm follow-up letter, page 6.

understands that the functioning and efficiency of the CPU is particularly important in high-end automotive products (whether ADAS or infotainment).

7.160 Third parties further indicated that Arm is an important supplier of CPU IP for suppliers to develop ADAS SoC products that meet advanced performance, safety and compatibility requirements of automotive Tier 1 and OEM customers. ADAS SoC suppliers that use Arm CPU IP include Renesas, Qualcomm, NXP, Xilinx and Huawei. The majority of third parties that made submissions to the CMA on automotive indicated that it was ‘very important’ for ADAS SoC suppliers to license CPU IP from Arm because of:

- (a) **Technical advantages of Arm’s CPU IP.** Contrary to the Parties’ submissions that Arm’s general-purpose CPU IP plays a limited role in automotive SoCs, Arm licenses CPU IP products specifically targeted to automotive applications; the automotive-enhanced, or ‘AE’ range. These CPU IP products are also specifically targeted to higher-end or lower-end uses within automotive.<sup>266</sup> Several third parties submitted that Arm is technically superior, and/or meets the performance requirements for ADAS SoCs, including power and cost. Two third parties further explained that Arm CPU IP is built for safety, or has certification of relevant safety standards, which is required by automotive Tier 1 and OEM customers. The CMA understands that such upstream input enables further investment and innovation downstream.
- (b) **The importance and strength of Arm’s ecosystem.** Contrary to the Parties’ submission that having a software ecosystem is not important in automotive, a range of third parties including ADAS SoC suppliers, OEMs and a robotaxi firm highlighted that Arm CPU IP has become a default, or ‘de facto standard’ for ADAS applications. Several others explained that they use Arm’s CPU IP because of the ecosystem (eg of software and tools), which is widely used by automotive Tier 1 and OEM customers.

7.161 The CMA notes that Intel-Mobileye competes with ADAS SoC suppliers that use Arm CPU IP. Mobileye SoCs use MIPS CPU IP rather than Intel’s proprietary x86 architecture. An internal Arm document also indicates that [redacted].<sup>267</sup>

7.162 Further, regarding the Parties’ submission that the leading robotaxi firms currently ‘all use x86 ISA’, a number of robotaxi firms submitted that they also

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<sup>266</sup> Automotive IP Roadmap, September 2020, original document name: Annex 54 - Automotive - Confidential.pdf, batch: Final annexes/Final annexes, page 4.

<sup>267</sup> Arm’s internal document entitled ‘Automotive & IoT 2020-2024 Revenue Plan’, 2020, original document name: Automotive & IoT.pptx, batch: CMA-002 – Batch 03, page 27.

use Arm's CPU IP, and not exclusively x86. One said it 'relies extensively' on Arm CPU IP as it purchases chips from Arm-based SoC suppliers. This firm submitted that Intel's chips are not suitable for low power consumption applications and are also more expensive than Arm-based chips. Another submitted that, in addition to x86 CPUs for processing, it also uses some low/medium-end Arm CPU cores for control and management functions. This firm submitted that Arm's CPU IP is a very important input for future ADAS solutions.

7.163 The CMA considers, in line with its assessment at paragraphs 7.25-7.26 above, that static share of supply estimates for ADAS SoCs<sup>268</sup> (which are based on 2018-2020 sales of ADAS SoCs operating at L0-L2) do not provide a good indicator for future market competitive conditions. This is because future competition will increasingly focus on higher levels of ADAS, particularly autonomous driving. The CMA considers that these shares understate Arm's current and potential future strength in CPU IP for the following reasons:

- (a) Contrary to the Parties' submission that customers are losing confidence in Arm, and are reluctant to use their IP, the CMA notes that aside from Intel-Mobileye, all major ADAS SoC suppliers use Arm CPU IP. These suppliers include Qualcomm, Xilinx,<sup>269</sup> and Renesas,<sup>270</sup> [✂] autonomous driving.
- (b) These shares materially underestimate Arm's strength in CPU IP used for SoCs performing powerful functions required at L2+ ADAS solutions. One third party submitted to the CMA that NVIDIA's ADAS SoCs based on Arm's CPU IP have more than a 50% share in ADAS SoCs used for central computing functions. An internal Arm document also indicates that Arm has a share of supply of more than [80-90]% for CPU IP used for '360 view or surround view camera', which will be required at ADAS levels above L2+.<sup>271</sup>
- (c) Arm's own forecasts show an expectation that its shares for all levels of ADAS will increase significantly.<sup>272</sup> Arm expects its revenue share for ADAS L0-L3 (based on SoCs using Arm CPU IP for the primary CPU) to increase from [50-60]% in 2018 to [60-70]% in 2029, and its share for ADAS L4

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<sup>268</sup> Final Merger Notice, Table 23. The Parties refer to Arm's share of [20-30]% in 2018-2020 by proxy of downstream sales volumes.

<sup>269</sup> Final Merger Notice, paragraph 234.

<sup>270</sup> Final Merger Notice, footnotes 249 and 250, page 146.

<sup>271</sup> Market Requirements Specification for ADAS (L2/L2+) and Autonomous (L3/L4/L5) solutions in 2022/2023, April 2020, original document name: ADAS 2022 MRS.docx, batch: CMA-002 – Batch 01, page 9.

<sup>272</sup> The Parties did not challenge the validity of these Arm forecasts in respect of automotive applications.

and L5 to increase from [50-60]% in 2023 to [70-80]% in 2029.<sup>273</sup> Arm also expects its royalty revenue from L4/L5 to increase from US\$[ ] in 2023 to US\$[ ] in 2030.<sup>274</sup>

- (d) The shares provided by the Parties do not capture revenue from ADAS SoC suppliers who are developing (but have not yet sold) products [ ] between 2018 and 2020.

7.164 Third party feedback and Arm internal documents also indicate that other licensors, namely MIPS, RISC-V (and suppliers based on this ISA) and Synopsys are, at most, weak alternatives to Arm for ADAS SoC suppliers:

- (a) **MIPS.** [ ]. Most third parties submitted that MIPS is not an alternative, or a weak alternative to Arm, primarily because it lacks ecosystem support and/or a software ecosystem. Specific observations included that ‘the [MIPS] ISA is on the decline’, and ‘effectively obsolete’. [ ]. An internal Arm CPU IP competitive monitoring document references MIPS but [ ].<sup>275</sup> Moreover, as noted at paragraph 7.42 above, Arm’s competitor reports indicate that [ ].
- (b) **RISC-V.** Nearly all third parties who responded to the CMA submitted that RISC-V (and suppliers based on this ISA) are either not currently an alternative, or a weak alternative to Arm CPU IP. Reasons include a lack of ecosystem support, weak technical performance, a limited product portfolio and roadmap and the RISC-V ISA being untested in the automotive context. However, there is some evidence that RISC-V may become a more competitive alternative to Arm in future. One respondent submitted that RISC-V is 5-10 years away from being a viable architecture in ADAS. [ ]. Internal Arm documents also indicate that [ ].<sup>276, 277</sup>
- (c) **Synopsys.** Nearly all third parties that responded to the CMA submitted that Synopsys is either not an alternative, or is a weak alternative to Arm CPU IP, for reasons including weak technical performance, no IP product

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<sup>273</sup> Automotive LoB – A&I LT, November 2020, original document name: A&I\_offsite\_NOV20\_[ ]\_v1.0.pptx, batch: CMA-002 – Batch 01, page 8.

<sup>274</sup> Market Requirements Specification for ADAS (L2/L2+) and Autonomous (L3/L4/L5) solutions in 2022/2023, April 2020, original document name: ADAS 2022 MRS.docx, batch: CMA-002 – Batch 01, page 24.

<sup>275</sup> Synopsys – the automotive challenge, June 2020, original document name: Counter SNPS 6172020.pptx, batch: CMA-002- Batch01, page 4.

<sup>276</sup> Competitive Strategy report W40 – 02-Oct-20, July 2018, original document name: Competitor Reports - by date.pdf, batch: AXON\_CMA\_20201124, page 52.

<sup>277</sup> A&I briefing Q3 Sales Update Auto, November 2020, original document name: Auto Sales Update - Nov 2020 - NA&EMEA1.pdf, batch: CMA-002 - Batch 01, page 16.

roadmaps, and no ecosystem support. Two third parties noted that Synopsys CPU IP cannot be used for cores performing the main processing tasks in ADAS solutions. Consistent with this, an internal Arm competitive monitoring document, in which Arm evaluates the potential threat of Synopsys, shows that Arm [REDACTED].<sup>278</sup>

7.165 In relation to self-supply, third parties indicated that developing proprietary CPU IP is not an alternative to Arm, noting technical challenges, cost and lack of ecosystem support. [REDACTED]. One third party indicated that any proprietary CPU designs it may develop in future would remain Arm-based. Another noted that proprietary designs may be a substitute for Arm's Cortex-R CPU IP, but not for Cortex-A equivalent.

7.166 There are also barriers for ADAS SoC suppliers to switch CPU IP supplier, primarily due to incompatibility of existing software with alternative ISAs and/or new SoCs, and difficulty of porting software to new SoCs.<sup>279</sup> A large proportion of third parties responding to the CMA's questionnaire submitted that the existing software ecosystem is a barrier to switching CPU IP suppliers. One third party submitted that the software used in ADAS platforms is specific to the architecture of the processor core. Another submitted that Tier 1 suppliers and automotive OEMs have many software assets specific to the Arm architecture. One third party said switching CPU IP suppliers would mean significant extra costs. Third parties also said in general that it is either not possible, or very difficult and/or costly, for vehicle OEMs and Tier 1 suppliers to port software to any new hardware/SoCs. Specific drivers of the cost include development and verification, and performance-optimisation. An external research report also indicates that reusing software is important for vehicle OEMs and Tier 1 suppliers and suggests that, particularly at higher levels of ADAS, software costs need to be optimised – [REDACTED].<sup>280</sup>

7.167 In this regard, the CMA notes that Arm is developing its software to work with its CPU IP for automotive applications. Arm's 'Sparta' program has developed the 'Kronos' strand for autonomous vehicles.<sup>281</sup> This program provides

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<sup>278</sup> Synopsys – the automotive challenge, June 2020, original document name: Counter SNPS 6172020.pptx, batch: CMA-002- Batch01, page 6 and 20.

<sup>279</sup> A few third parties submitted that there are also significant technical barriers for an ADAS SoC supplier to switch CPU IP core; one third party submitted that this would require a redesign of the entire SoC and could take several years.

<sup>280</sup> IHS Markit: Autonomous driving and infotainment disrupt classic car electronics, January 2019, original document name: Q3 - from-silicon-to-mobility-autonomous-driving-and-infotainment-disrupt-classic-car-electronics-2019.pdf, batch: NVDIA Section 109 – Batch 1, pages 13-14.

<sup>281</sup> Sparta Program, May 2020, original document name: Sparta Program - EMEA Sales 1 July 2020.pptx, batch: CMA-002 – Batch 01, page 3.

automotive customers with a base software stack, a developer platform, and a system architecture blueprint,<sup>282</sup> which enable Arm to define standards to unlock software portability across Arm-based solutions.<sup>283</sup> The CMA considers that this programme indicates that while software portability is feasible across Arm-based suppliers, this does not imply it would be plausible to port software from an Arm to a non-Arm ISA.

7.168 Arm documents also indicated that Arm's strategy includes encouraging customer stickiness.<sup>284</sup> For example, a document dated February 2020 sets out that 'automotive socket wins' at OEMs create long-term stickiness of Arm architecture at OEMs.<sup>285</sup>

- *ADAS SoCs – other IP*

7.169 The Parties submitted that:<sup>286</sup>

- (a) When Arm GPU IP is incorporated in ADAS SoCs it is used for basic graphics rendering, and not for autonomous driving<sup>287</sup> or AI capabilities,<sup>288</sup> and that most of NVIDIA's ADAS SoC competitors are not dependent on Arm's GPU IP.<sup>289</sup>
- (b) Arm's ISP IP is used for camera image sensor processing,<sup>290</sup> and that NVIDIA's ADAS SoC competitors do not rely on Arm's ISP IP as many have in-house capabilities.<sup>291</sup>
- (c) Arm's System IP in automotive serves to connect the Arm CPU core to the peripherals and other processors included in the SoC.<sup>292</sup>

7.170 Generally, third parties indicated that Arm's GPU, ISP and System IP is important to some extent for ADAS SoC suppliers, with some saying it is 'very important'. They noted that System IP goes together with and is ancillary to CPU products, and some highlighted a lack of alternatives to Arm. A few third

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<sup>282</sup> The system architecture blueprint is split into 'Kronos' for ADAS and 'Ithaca' for digital cockpit/infotainment.

<sup>283</sup> Kronos Solution Business Model Discussion, July 2020, original document name: Kronos Business Model Discussion-27 July 2020.pptx, batch: CMA-002 – Batch 01, page 8.

<sup>284</sup> Synopsys – the automotive challenge, June 2020, original document name: Counter SNPS 6172020.pptx, batch: CMA-002- Batch01, page 6.

<sup>285</sup> [IPG Board Update, 20 February 2020, original document name: IPG Plan - February 2020 - As presented.pdf, batch: AXON\\_CMA\\_20201124](#), page 86.

<sup>286</sup> The Parties also submitted that, as with CPUs, it is easier to port ADAS software to a new GPU or ISP than it is to port software of general-purpose computers, due to the embedded nature.

<sup>287</sup> Final Merger Notice, paragraph 234.; The Parties' Issues Meeting Presentation dated 16 June 2021, page 40.

<sup>288</sup> The Parties' Issues Meeting Presentation dated 16 June 2021, page 40.

<sup>289</sup> Final Merger Notice, footnote 451, page 237.

<sup>290</sup> Final Merger Notice, paragraph 234; the Parties' Issues Meeting Presentation dated 16 June 2021, page 40.

<sup>291</sup> Final Merger Notice, footnote 451, page 237; the Parties' Issues Meeting Presentation dated 16 June 2021, page 40.

<sup>292</sup> Final Merger Notice, paragraph 234.

parties [REDACTED] generally submitted that Arm's IP was less important. One third party submitted that both Arm's GPU and ISP IP was 'very important' for reasons of functionality, a lack of alternatives and barriers to switching.

7.171 Evidence is mixed on the availability and suitability of alternatives to Arm.

- (a) For GPU IP, around half of respondents submitted that Imagination Technologies is a strong alternative to Arm and is technically comparable or superior. However, the other half viewed it as a weak or medium alternative, lacking ecosystem support, performance and low power consumption. Arm documents indicate that Arm identifies Imagination Technologies as a competitor in GPU IP for ADAS SoCs but considers its product weaker than Arm's.<sup>293</sup>
- (b) For ISP IP, although a small number of third parties submitted that in-house proprietary solutions are an alternative, a similar number of others submitted this was not an option and that they relied on Arm's ISP IP. One third party identified VeriSilicon, while another identified videantis and Synopsys as non-proprietary alternatives to Arm. Internal Arm documents identify Imagination Technologies as a similar competitor to Arm in ISP IP.<sup>294</sup>
- (c) For System IP, several third parties submitted that Arteris is a strong alternative to Arm for System IP for ADAS. However, a small number viewed Arteris as a weak alternative to Arm on the basis that it does not offer some critical System IP, has insufficient technical performance / automotive-grade, and has no ecosystem support. A small number of ADAS SoC suppliers indicated that they develop proprietary System IP, but that it is used *alongside* Arm's System IP. Internal Arm documents indicate that Arm identifies Synopsys and Imagination Technologies as competitors in 'physical IP', and assesses [REDACTED].<sup>295</sup>

7.172 Several third parties indicated barriers to switching GPU and/or ISP provider, albeit generally lower than barriers to switching CPU IP. Barriers include the cost of migrating software, acquiring knowledge of the new IP and persuading customers to migrate to the new technology, entailing considerable time and resources. One third party indicated that it would take a minimum of [REDACTED]

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<sup>293</sup> Synopsys – the automotive challenge, June 2020, original document name: Counter SNPS 6172020.pptx, batch: CMA-002- Batch01, page 3.

<sup>294</sup> Synopsys – the automotive challenge, June 2020, original document name: Counter SNPS 6172020.pptx, batch: CMA-002- Batch01, page 3. [REDACTED].

<sup>295</sup> Synopsys – the automotive challenge, June 2020, original document name: Counter SNPS 6172020.pptx, batch: CMA-002- Batch01, page 3.

switch GPU and ISP provider and cost in the region of [X]. Several third parties submitted that there would be relatively high barriers to switching System IP provider noting the close links with CPU IP, the absence of alternatives to Arm, and the impact of having to migrate software.

- *ADAS SoCs – CMA’s conclusion on importance of Arm IP and market power*

7.173 For the reasons outlined above, the CMA considers that Arm’s CPU IP is an important input into the supply of ADAS SoCs and that Arm has market power given the lack of credible alternative suppliers and difficulties in switching. Contrary to the Parties’ submission, the CMA considers that Arm CPU IP would be a point of differentiation between NVIDIA and potential foreclosed rivals, due to the importance of the existing Arm ecosystem, and the technical advantages of Arm’s CPU IP. As illustrated previously at paragraph 7.31 above, Arm also has a strong position in the supply of CPU IP overall worldwide. The CMA believes that the strength and existence of Arm’s ecosystem across the CPU IP spectrum are interlinked to, and reinforce, Arm’s market power in the narrower segmentations of CPU IP for ADAS SoCs.

7.174 While the evidence received regarding the importance of Arm’s GPU, ISP and System IP is more mixed, for some ADAS SoC suppliers, the evidence indicates that Arm’s input is important, and they have limited alternatives. The CMA therefore considers that, in respect of certain customers, the importance of Arm’s GPU, ISP and/or System IP may have an augmenting effect as regards foreclosure primarily in relation to CPU IP.

7.175 In relation to the Parties’ submission on the Merged Entity being constrained by Arm’s licensees’, OEMs’ and Tier 1 suppliers’ buyer power, the CMA considers that, as discussed at paragraph 7.65 above, these third parties’ buyer power depends on the availability of good alternatives to which third parties can switch. The CMA considers that the limited alternatives to Arm discussed at paragraphs 7.129-7.134 above will undermine any buyer power (and any contractual protection) that licensees may have, particularly in relation to CPU IP. Moreover, even if some larger Arm licensees, OEMs and Tier 1 suppliers had a degree of buyer power, smaller licensees would not have the same degree of buyer power. Accordingly, any such buyer power is insufficient to mitigate the Merged Entity’s ability to engage in foreclosure.<sup>296</sup>

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<sup>296</sup> As set out in detail at paragraph o, the CMA does not consider that the ability of Arm licensees to negotiate and/or secure any concessions from Arm is not sufficient to demonstrate buyer power.

- *Infotainment SoCs – CPU IP*

7.176 The Parties submitted that Arm does not have market power in the licensing of CPU IP for infotainment SoCs for the following reasons:

(a) There are multiple alternatives to Arm’s CPU IP, to which infotainment SoC suppliers could switch.<sup>297</sup>

(b) Arm is constrained by a declining demand for infotainment SoCs.<sup>298</sup>

7.177 The CMA considers that CPU IP is an important input for any infotainment SoC products. This is for the same reasons as set out at paragraph 7.159 above in relation to ADAS SoC products and the third-party submissions set out at paragraph 7.160 (relating to the importance of Arm’s CPU IP in ADAS SoCs, also submitted in relation to infotainment SoCs). Two additional responses were received for infotainment SoCs, further confirming that Arm’s CPU IP is very important because there is no feasible alternative.

7.178 As for ADAS SoCs (outlined at paragraph 7.163 above), the CMA considers the Parties’ static share of supply estimates for all infotainment SoCs do not provide a good indicator for current or future market competitive conditions.<sup>299</sup> In particular, these may understate Arm’s current and potential future strength for high-end infotainment SoCs (ie digital cockpit functions). An internal Arm document indicates that Arm has a roadmap of products specifically designed for a range of cockpit products including ‘premium to high-end’.<sup>300</sup> Another internal Arm document forecasts sales of Arm-based cockpit domain controller SoCs to increase from [X] units in 2020 to [X] units in 2025. The same document estimates the share of cockpit domain controllers that have an Arm-based primary CPU to be [80-90]% in 2020, and forecasts that this will be [80-90]% by 2025.<sup>301</sup>

7.179 Regarding the Parties’ submission [X] the evidence – from both internal Arm forecasts and external research reports – indicates that the total addressable market for infotainment

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<sup>297</sup> The Parties’ submissions relating to alternative suppliers, ease of switching and buyer power are common to those made for ADAS and are set out at paragraph 7.157.

<sup>298</sup> Final Merger Notice, paragraphs 628-629; the Parties’ Issues Meeting Presentation dated 16 June 2021, page 41. The Parties submit Apple’s CarPlay and Google’s Android Auto allow mobile phones to power in-car screens, competing with dedicated in-car infotainment systems. Consumers prefer mobile-phone based solutions, and automakers and Tier 1 suppliers are realising they do not need to invest in an expensive, dedicated in-vehicle SoC.

<sup>299</sup> Final Merger Notice, Tables 27 and 29. The Parties’ submitted figures estimate Arm’s market share in 2019 by volume and value was [10-20]% and [50-60]%, respectively.

<sup>300</sup> Automotive IP Roadmap, September 2020, original document name: Annex 54 - Automotive - Confidential.pdf, batch: Final annexes/Final annexes, pages 3-4.

<sup>301</sup> Market Requirements Specification for Digital Cockpit, February 2020, original document name: Digital Cockpit MRS - 2023 - 14.02.20201(DE).pdf, batch: CMA-002- Batch 01, page 15.

SoCs is growing.<sup>302</sup> Additionally, evidence indicates that this may be driven by increased demand for SoCs for high-end cockpit infotainment products,<sup>303</sup> which both NVIDIA and Arm are targeting.<sup>304</sup>

7.180 The evidence also indicates limited competitive alternatives to Arm's CPU IP for infotainment SoCs, particularly for cockpit solutions. In particular:

- (a) Third parties submitted similar views on alternatives to Arm in CPU IP for infotainment SoCs as for ADAS SoCs – as set out at paragraphs 7.164-7.165, RISC-V, MIPS and Synopsys were at most seen as weak alternatives to Arm in CPU IP by all respondents, for reasons including weak ecosystems, limited support, and lack of performance and/or technical features. One third party noted that RISC-V has potential but is weak currently. As with ADAS, third parties did not consider proprietary solutions to be an alternative to Arm CPU IP.
- (b) An internal Arm document indicates that Arm does not currently view RISC-V or Synopsys as competitors for digital cockpit. This document sets out that (i) RISC-V does not provide application class processing required by a cockpit domain controller;<sup>305</sup> (ii) Synopsys has not been used for infotainment; and (iii) Arm is stronger than any competitor in automotive digital cockpit solutions because of its extensive application ecosystem.<sup>306</sup>

7.181 The CMA found significant barriers for infotainment SoC suppliers to switch their CPU IP supplier. Third parties submitted the same, or similar responses relating to ease of switching infotainment SoC CPU IP supplier as for switching their ADAS SoC CPU IP supplier, as outlined at paragraph 7.166. In addition, specifically in relation to infotainment, third parties submitted

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<sup>302</sup> For example: Automotive LoB – A&I LT, November 2020, original document name: A&I\_offsite\_NOV20\_[]\_v1.0.pptx, batch: CMA-002 – Batch 01, page 9. Arm projects the total addressable market for 'IVI and Digital Cockpit' to increase from US\$[] in 2020 to US\$[] in 2030. An external research report [] also projects infotainment SoC revenue to increase between 2020 and 2030.

<sup>303</sup> See for example - IHS Markit: Autonomous driving and infotainment disrupt classic car electronics, January 2019, original document name: Q3 - from-silicon-to-mobility-autonomous-driving-and-infotainment-disrupt-classic-car-electronics-2019.pdf, batch: NVIDIA Section 109 – Batch 1, pages 7-8. IHS Markit project growth of cockpit domain controllers, which contain powerful SoCs.

<sup>304</sup> See paragraph 7.153(b): NVIDIA's infotainment product is a high-end AI cockpit. Internal Arm documents (see for example, Automotive LoB – A&I LT, November 2020, original document name: A&I\_offsite\_NOV20\_[]\_v1.0.pptx, batch: CMA-002 – Batch 01, page 5) indicate that its focus within infotainment is on digital cockpit.

<sup>305</sup> The CMA understands that cockpit domain controllers are used primarily in digital cockpit solutions.

<sup>306</sup> Market Requirements Specification for Digital Cockpit, February 2020, original document name: Digital Cockpit MRS - 2023 - 14.02.20201(DE).pdf, batch: CMA-002- Batch 01, page 20.

performance and a software ecosystem, and lack of suitable alternatives to Arm as barriers to switching.

- *Infotainment SoCs – other IP (GPU IP and System IP)*

7.182 Most third-party submissions made in relation to ADAS SoCs (discussed at paragraphs 7.170-7.171) were also made in relation to infotainment SoCs. The CMA received additional third-party submissions relating only to infotainment:

- (a) Access to Arm's GPU IP is considered important or very important for infotainment SoC suppliers. Vivante is viewed a weak alternative to Arm in GPU IP. However, although the CMA notes an internal Arm document indicates that Arm may view Imagination Technologies [X],<sup>307</sup> views on Imagination Technologies were mixed.
- (b) The CMA received limited evidence as regards System IP. One third party submitted that there was no alternative to Arm. Another viewed Arteris System IP as a weak alternative. Views on proprietary System IP were mixed.

- *Infotainment SoCs: CMA's conclusion on importance of ARM CPU IP and market power*

7.183 For the reasons outlined above, the CMA considers that Arm's CPU IP is an important input into infotainment SoCs and that Arm has market power, given the lack of credible alternative suppliers and difficulties in switching. As illustrated previously at paragraph 7.31 above, Arm also has a strong position in the supply of CPU IP overall worldwide. The CMA believes that the strength and existence of Arm's ecosystem across the CPU IP spectrum are interlinked to, and reinforce, Arm's market power in the narrower segmentations of CPU IP for infotainment SoCs.

7.184 The evidence received regarding the importance of Arm's GPU and System IP is more mixed and limited. The CMA considers that, for some infotainment SoC suppliers, these are important inputs, particularly as regards GPU IP, and they have limited alternatives to which they can easily switch. The CMA considers that, in respect of certain customers, the importance of Arm's GPU, and/or System IP may have an augmenting effect as regards foreclosure primarily in relation to CPU IP.

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<sup>307</sup> Arm's internal document entitled 'A&I briefing Q3 Sales Update Auto', November 2020, original document name: Auto Sales Update - Nov 2020 - NA&EMEA1.pdf, batch: CMA-002 - Batch 01, page 17.

7.185 The CMA's assessment on the constraint that would be placed on the Merged Entity from buyer power is outlined at paragraph 7.175.

*Mechanisms the Merged Entity could use to achieve foreclosure*

7.186 The Parties submitted that foreclosure of ADAS and infotainment SoC competitors would not be possible for largely the same reasons as those in relation to datacentre at paragraph 7.53 (contractual protection of Arm licensees, inability to target foreclosure at automotive rivals and constraints from competitors' and customers' countervailing buyer power).<sup>308</sup> The Parties additionally submitted that: (i) customers can and do license Arm's 'AE' IP outside automotive,<sup>309</sup> and (ii) the Merged Entity would not have the ability to target specific use cases within automotive.<sup>310</sup>

7.187 The CMA has considered whether the Merged Entity could harm ADAS SoC and infotainment SoC suppliers by engaging in total and/or partial foreclosure strategies. This relates primarily to the possible foreclosure of CPU IP, but also to possible foreclosure of GPU IP, ISP IP (for ADAS), and System IP alongside CPU IP foreclosure.

7.188 A large number of third parties raised concerns that the Merged Entity could engage in partial and total foreclosure of Arm's IP with respect to ADAS and infotainment applications. Most of these concerns were common across all applications in which architectural and implementation licensees, (and those licensees that are both), are active and are summarised and assessed in full in the datacentre section.<sup>311</sup>

7.189 In relation to the Parties' submission that Arm's 'AE' range is also used by licensees for non-automotive applications, the CMA notes that this range is also marketed for industrial automation (as outlined at footnote 49). However, the Parties have not provided evidence on the prevalence of this practise. The CMA's analysis of an internal Arm document indicates that, while Arm is targeting a limited number of current and pipeline 'AE' CPU IP products at

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<sup>308</sup> Final Merger Notice, paragraphs 635-643.

<sup>309</sup> The Parties' Issues Meeting presentation dated 16 June 2021, page 22.

<sup>310</sup> Final Merger Notice, paragraph 651; the Parties' Issues Meeting presentation dated 16 June 2021, page 42.

<sup>311</sup> Concerns relating to total foreclosure are summarised at paragraph 7.57, and partial foreclosure at paragraph 7.58. Licensees active in automotive indicated that they share commercially sensitive information with Arm, relating to the field of application, specific end-products and R&D plans. These concerns are set out in full at paragraph 7.60. As set out at in detail at paragraph 7.64, the CMA does not consider contractual protections will prevent foreclosure and that, for similar reasons explained in paragraphs 7.71-7.62, the Merged Entity can target foreclosure against specific rivals and types of rivals.

high-performance IoT devices,<sup>312</sup> there are many more current and pipeline<sup>313</sup> products in Arm's 'AE' range (Cortex-A and Cortex-R CPU IP, GPU IP, ISP IP and System IP) that appear targeted to automotive uses.<sup>314</sup> The CMA also considers that the name of this range ('automotive-enhanced') indicates that it is targeted heavily towards automotive applications, and notes that this range is specifically marketed for use in autonomous driving and IVI/digital cockpit applications.<sup>315</sup> For this reason, the CMA considers that the 'AE' range provides an effective mechanism for the Merged Entity to target foreclosure of its automotive competitors.

7.190 Additionally, the CMA considers that the Merged Entity can target rivals that use Arm IP for specific use-cases, including for different levels of ADAS and types of infotainment. This is evidenced by internal Arm documents which indicate that Arm's different 'AE' IP products are targeted to high-end, or 'high performance' uses within automotive, such as 'autonomous, high-end ADAS and premium cockpit', versus 'ADAS, gateway and cockpit'.<sup>316</sup> A number of third parties told the CMA that their choice of Arm CPU IP products does vary depending on the level of ADAS or the type of infotainment the IP is used for.

#### *Conclusion on ability*

7.191 For the reasons set out above, the CMA considers that: (i) Arm's CPU IP is an important input to the supply of ADAS and infotainment SoCs; (ii) Arm has market power in the supply of CPU IP, including for ADAS and infotainment SoCs, due to the lack of credible alternatives and the barriers to switching; and (iii) the Merged Entity has the ability to target foreclosure at rival SoC suppliers for each. Additionally, the CMA considers that the reliance of some ADAS and infotainment SoC rivals on Arm's GPU, ISP and System IP may strengthen the Merged Entity's ability to foreclose rival suppliers of ADAS and infotainment SoCs through CPU IP.

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<sup>312</sup> Specifically, 3 'AE' products from Arm's Cortex-R CPU IP range. See Arm Group Products, Technology and Engineering Management Presentation', 11 August 2020, original document name: 4c-7 Arm Group Products, Technology and Engineering MP.pdf, batch: NVIDIA-CMA-001, page 89.

<sup>313</sup> The CMA notes that this internal Arm document indicates that Arm is investing in/developing new automotive grade (AE) GPU, ISP and System IP, which will contain specific automotive features, including safety packages.

<sup>314</sup> Automotive IP Roadmap, September 2020, original document name: Annex 54 - Automotive - Confidential.pdf, batch: Final annexes/Final annexes, pages 4, 5, 8, 9, 10.

<sup>315</sup> <https://www.arm.com/products/silicon-ip-cpu/cortex-a/cortex-a78ae>, accessed by the CMA on 9 July 2021.

<sup>316</sup> Automotive IP Roadmap, September 2020, original document name: Annex 54 - Automotive - Confidential.pdf, batch: Final annexes/Final annexes, page 4.

## *Incentive to foreclose*

7.192 The Parties submitted that the Merged Entity would have no foreclosure incentive, because:

- (a) Foreclosure would reduce the chance of a successful autonomous driving solution emerging and would prevent NVIDIA from diversifying its risk.<sup>317</sup>
- (b) The Merged Entity would lose: (i) significant, guaranteed revenues and profits in the upstream market immediately, but would not recoup any (potential, uncertain) downstream profits for several years, due to the long time period between the licensing of IP and SoC marketisation;<sup>318,319</sup> and (ii) lower-end (L1-L2) ADAS revenues, because it could not target specific levels of automation (eg L3-L5).<sup>320,321</sup>
- (c) The Parties also submitted that the Merged Entity would have no incentive to foreclose [X] specifically, because [X]'s success creates a strong competitive pressure on Tier 1 suppliers and OEMs to look for competing solutions, driving demand for NVIDIA's products.<sup>322</sup>
- (d) NVIDIA is reliant on its competitors in automotive for components used in automotive SoCs (eg [X]), and attempts at foreclosure would face retaliation.<sup>323</sup>

7.193 The CMA considers the Merger may create incentives to change Arm's open business model in the ADAS and infotainment applications for the following reasons.

7.194 First, the addressable markets for both ADAS and infotainment SoCs are growing, particularly for higher levels of ADAS (ie autonomous driving):

- (a) An external research report suggests that revenue for ADAS SoCs will grow from around US\$[5-10] billion by 2024 to around US\$[10-15] billion by

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<sup>317</sup> Final Merger Notice, paragraph 654; the Parties' Issues Meeting Presentation dated 16 June 2021, page 42.

<sup>318</sup> Final Merger Notice paragraphs 646-651.

<sup>319</sup> The Parties additionally submitted that foreclosed licensees would have time to find alternatives, as foreclosure is not immediate (the Parties' Issues Meeting presentation dated 16 June 2021, page 8). The CMA considers that this relies on the availability of competitive alternatives to foreclosed licensees, third party views on which are set out at paragraph 7.164.

<sup>320</sup> Final Merger Notice, paragraph 651.

<sup>321</sup> The Parties submit that this is because: (i) L1-L5 ADAS solutions use the same Arm CPU IP, and (ii) NVIDIA's downstream competitors who license Arm IP for L0-L2 ADAS SoCs are the same licensees that are or will be developing L3-L5 SoCs.

<sup>322</sup> Final Merger Notice, paragraphs 665-667; the Parties' Issues Meeting presentation dated 16 June 2021, page 42.

<sup>323</sup> Final Merger Notice, paragraph 662-664; the Parties' Issues Meeting presentation dated 16 June 2021, page 42.

2030.<sup>324</sup> Internal Arm documents also indicate that the total addressable market for ADAS will increase [REDACTED] between 2020 and 2030,<sup>325</sup> and that SoCs and MCUs for L4-L5 specifically will grow quickly from 2025.<sup>326</sup>

- (b) An external research report suggests that market revenue for infotainment SoCs will be around US\$[0-5] billion by 2024 and over US\$[0-5] billion by 2030.<sup>327</sup>

7.195 Second, NVIDIA is well-placed to capture these growth opportunities given the Merged Entity's ability to weaken downstream ADAS and infotainment SoC suppliers as it can target foreclosure against these suppliers (see paragraphs 7.187-7.189).

- (a) Controlling the development, availability, and timing of the licensing of Arm CPU IP (and any related GPU, ISP or System IP) to ADAS/infotainment SoC suppliers could give NVIDIA a substantial time-to-market advantage on new products and winning contracts. Several third parties active in ADAS/infotainment raised concerns that the Merged Entity would, post-Merger, be able to withhold access to specific innovations to Arm's IP and/or reduce the reliability of Arm's product roadmap or restrict critical technical service and support.
- (b) As high-end ADAS and infotainment SoC segments in particular remain nascent, suppliers are competing to develop new, more advanced technologies. The Merged Entity therefore may have the incentive to foreclose rivals to ensure it can acquire a greater scale and accumulate experience more quickly than its rivals. One third party submitted that there are several features of the automotive SoC market that would make such strategies particularly harmful to NVIDIA's rivals, such as that SoC suppliers' contracts with automotive OEMs are high value, incorporating the SoC suppliers' products into hundreds of millions of vehicles, and that automotive OEMs require scalable, durable SoCs, with a long product lifespan. This third-party said that these factors mean that by winning a few tenders to supply SoCs for ADAS or infotainment, NVIDIA would be

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<sup>324</sup> [REDACTED]

<sup>325</sup> Automotive LoB – A&I LT, November 2020, original document name: A&I\_offsite\_NOV20\_[REDACTED]\_v1.0.pptx, batch: CMA-002 – Batch 01, page 9.

<sup>326</sup> Market Requirements Specification for ADAS (L2/L2+) and Autonomous (L3/L4/L5) solutions in 2022/2023, April 2020, original document name: ADAS 2022 MRS.docx, batch: CMA-002 – Batch 01, page 24.

<sup>327</sup> [REDACTED]

able to build up experience and generate significant revenues for further investment, tipping the sector in its favour.

- (c) NVIDIA is well-placed to capture growth opportunities in high-end ADAS and infotainment SoCs in particular. Specifically:
- (i) Several ADAS SoC suppliers that license CPU IP from Arm indicated [REDACTED]<sup>328</sup>. The majority of these suppliers are active in, or targeting, ADAS L3 and above. NVIDIA has a leading position in high-end ADAS, which makes it well-placed to succeed in capturing these growth opportunities from foreclosed rivals. An external research report indicates the current market leader is NVIDIA, followed by Qualcomm and Intel-Mobileye.<sup>329</sup> The Parties' forecasts also indicate that NVIDIA's market share by volume is expected to be higher in future for ADAS L4 and L5 solutions ([20-30]% by 2025).<sup>330</sup>
  - (ii) A small number of infotainment SoC suppliers indicated that [REDACTED]. Additionally, the Parties submitted that between 2018-2020, NVIDIA's share of MPUs<sup>331</sup> for mid/premium-high tier infotainment was [5-10]% by volume ([40-50]% by value),<sup>332</sup> significantly higher than NVIDIA's share of supply for infotainment as a whole ([0-5]% by volume, [10-20]% by value over this time period).<sup>333</sup> The Parties did not submit a forecast of NVIDIA's future share of supply in AI cockpit solutions on the grounds that the segment is nascent and there is a limited number of offers currently available, but did estimate that their sales of AI cockpit solutions would [REDACTED] between 2021 and 2025.<sup>334</sup>
  - (iii) The CMA also notes, in response to the Parties' submission that foreclosure would reduce the chance of a successful autonomous driving solution emerging, that NVIDIA's documents indicate it is currently marketing a solution in which the hardware is already capable of 'scaling from Level 2+ to Level 5'.<sup>335</sup> Additionally, NVIDIA

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328 [REDACTED].  
329 [REDACTED].

330 The Parties' RFI Submission of 2 July 2021, RFI 7, Table 25, page 58.

331 The CMA understands from footnote 66, page 51 in the Parties' RFI Submission of 2 July 2021, RFI 7 that these shares are indicative of the shares of supply for SoCs for mid/premium-high tier infotainment ('The market size in value and volume is estimated using Strategy Analytics' third-party report on the Infotainment SoC market size').

332 The Parties' RFI Submission of 2 July 2021, RFI 7, Tables 16 and 17, page 52.

333 Final Merger Notice, Tables 30 and 31, pages 152-153.

334 The Parties' RFI Submission of 2 July 2021, RFI 7, Table 20, page 56.

335 <https://developer.nvidia.com/sites/default/files/akamai/drive/drive-product-brief.pdf>, accessed by the CMA on 09 July 2021.

has secured a deal with Daimler in which NVIDIA's DRIVE solution will be rolled out across the fleet of next-generation Mercedes-Benz vehicles from 2024, 'enabling them with upgradable automated driving functions'.<sup>336</sup>

(d) The success of NVIDIA could further strengthen Arm's ecosystem, making it more difficult for customers to switch to non-Arm-based alternatives such as Intel/Mobileye, thereby limiting their constraints. As explained at paragraph 7.160(b) above, several third parties submitted that Arm is now the default option, or *de facto* standard in automotive SoCs.

7.196 Third, the CMA considers that the costs of foreclosure upstream to Arm's ecosystem are likely to be limited. As explained above, the importance of Arm's CPU IP for ADAS and infotainment SoC suppliers and customers (and, to some extent, its importance in the other related forms of IP) indicates that Arm's ecosystem would continue to grow in the future. By contrast, the limitations of alternative CPU IP (and, to some extent, related IP) suppliers indicate that the risk of Arm licensees switching to alternative ISAs and an alternative competing ecosystem in the foreseeable future is limited.

7.197 The CMA also notes that Arm's upstream revenues represent a small fraction of the downstream value of finished ADAS and infotainment SoCs. Third parties indicated that Arm captures between [0-5]% of downstream revenue for ADAS and infotainment SoCs, noting that this depends on the product generation. An internal Arm document also indicates that Arm earns around [X]% royalties on ADAS SoCs incorporating their IP.<sup>337</sup> Downstream margins are significantly higher than Arm's upstream revenues. [X].<sup>338, 339</sup> [X].<sup>340</sup> Third parties also indicated that downstream margins are [30-70]%, depending on the product generation.

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<sup>336</sup> <https://nvidianews.nvidia.com/news/mercedes-benz-and-nvidia-to-build-software-defined-computing-architecture-for-automated-driving-across-future-fleet>, accessed by the CMA on 09 July 2021.

<sup>337</sup> Market Requirements Specification for ADAS (L2/L2+) and Autonomous (L3/L4/L5) solutions in 2022/2023, April 2020, original document name: ADAS 2022 MRS.docx, batch: CMA-002 – Batch 01, page 24.

<sup>338</sup> [X]

<sup>339</sup> [X]

<sup>340</sup> [X]

- 7.198 With regard the Parties' submission that the Merged Entity could not foreclose competitors in higher levels of ADAS without also losing revenues in lower levels of ADAS, the CMA considers that Arm has specific IP products targeted to higher-end uses (see paragraph 7.160(a), and receives information from licensees regarding the specific application end-use of this IP (see paragraph 7.60). Therefore this risk appears limited and any lost revenue would likely be small compared to revenue earned from capturing growth opportunities in high-end ADAS (see paragraphs 7.194-7.199 above).
- 7.199 With regard the Parties' submission that the Merged Entity would have no incentive to foreclose Tesla, the CMA considers that Tesla is an important customer in the automotive sector. The CMA considers that NVIDIA has a strong incentive to increase its chance of winning opportunities to supply SoCs to Tesla, potentially by foreclosing other competitors.<sup>341</sup>
- 7.200 Finally, the CMA has not received evidence to suggest that a threat of retaliation would likely preclude NVIDIA from foreclosing rivals. In any event, as outlined with respect to datacentre (paragraph 7.77), the CMA considers that the option of retaliation is not available to all licensees.

#### *Conclusion on incentive*

- 7.201 For the above reasons, the CMA considers that the Merged Entity would have the incentive to foreclose competing suppliers of ADAS and infotainment SoCs. The medium to long-term benefits to the Merged Entity of foreclosure may be substantial, particularly those deriving from capturing sales of the fast-growing area of autonomous driving SoCs.

#### *Effect*

- 7.202 The Parties submitted that a foreclosure strategy would not harm effective competition, because existing and potential entrants are not dependent on Arm IP, and that they can use rival IP or develop in-house technologies swiftly.<sup>342</sup> The CMA's assessment of alternatives to Arm is set out in the Ability section above.

- 7.203 Additionally, the Parties submitted that:

(a) Competition for ADAS SoCs is driven by Intel-Mobileye (which uses MIPS CPU IP) and is expected to intensify,<sup>343</sup> that the Merger will allow NVIDIA

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<sup>341</sup> The CMA understands that Tesla [redacted] (Final Merger Notice, paragraphs 208 and 641).

<sup>342</sup> Final Merger Notice, paragraph 668.

<sup>343</sup> The Parties' presentation on automotive dated 31 March 2021, page 16.

to innovate to compete effectively with Intel;<sup>344</sup> and in relation to both ADAS and infotainment, that AMD is entering, and Qualcomm has acquired Nuvia to leverage its expertise in automotive.<sup>345</sup>

(b) Barriers to entry for autonomous driving SoCs are relatively low, because SoCs can be easily adapted from use in eg mobile or console to be suitable for use in autonomous driving.<sup>346</sup>

7.204 The CMA notes that, other than Intel-Mobileye, all major ADAS SoC suppliers rely on Arm CPU IP and hence they are potentially subject to foreclosure. While Intel-Mobileye currently has the largest position in the supply of ADAS SoCs and it uses MIPS CPU IP, it relies on Arm on other IP and hence it can also be foreclosed to some degree. As outlined at paragraph 7.161, the CMA also notes that [REDACTED]. The CMA therefore considers that there remain limits to the constraint Intel-Mobileye poses on NVIDIA SoCs, and that there is potential for this to decrease [REDACTED].<sup>347</sup>

7.205 The CMA is not aware of any competitors to NVIDIA in SoCs for infotainment that do not use Arm's CPU IP. The CMA therefore considers that there is limited competitive constraint from non-Arm based infotainment SoC competitors, especially in the high-end segment.

7.206 In relation to the Parties' submission on barriers to entry, and that SoCs for other applications can easily be adapted, the CMA considers it likely Arm would also be an important input to those SoCs. The CMA notes Arm's persistently strong position in CPU IP for SoCs for mobile and other Android and iOS devices in 2019.<sup>348</sup> Therefore, the CMA considers that competitive constraint posed by new entrants is limited.

7.207 The CMA considers the threat of foreclosure may lead to reduced ability and incentive for ADAS and infotainment SoC competitors to innovate. One third party submitted that partial foreclosure strategies would not be detected by Arm licensees competing with NVIDIA until a relatively late stage of SoC product development, when investment costs are significant and sunk.

7.208 The CMA therefore considers that the effects of ToH 3a and 3b would substantially reduce competition in each of the downstream frames of

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<sup>344</sup> The Parties' presentation on automotive dated 31 March 2021, page 17.

<sup>345</sup> The Parties' presentation on automotive dated 31 March 2021, page 16.

<sup>346</sup> Final Merger Notice, paragraphs 201-202.

<sup>347</sup> [REDACTED]

<sup>348</sup> Final Merger Notice, table 48, page 159.

reference, particularly in relation to the high-end ADAS and cockpit products that NVIDIA is targeting.

### *Conclusion on ToH 3*

7.209 For the above reasons, the CMA believes that the Merged Entity would have the ability and incentive to engage in strategies to foreclose rival suppliers of ADAS SoCs and infotainment SoCs. Accordingly, the CMA has found that the Merger gives rise to a realistic prospect of significant competition concerns as a result of vertical effects in relation to the supply of ADAS SoCs and infotainment SoCs for automotive applications.

## **Gaming consoles**

### ***Overview***

7.210 A variety of devices can run videogames (**gaming**), including personal computers such as laptops and desktops, mobile phones, tablets, high-end videogame consoles (**consoles**), streaming devices, and virtual reality headsets. Consoles, as well as high-end gaming PCs, are devices that have been designed for dedicated high-end gaming.<sup>349</sup>

7.211 Consoles are typically powered by SoCs that are customised for a specific console (ie, Console SoCs).<sup>350</sup> NVIDIA is active in the downstream supply of Console SoCs, while Arm is active in the upstream supply of CPU IP used as an input for CPUs that are integrated into these Console SoCs. The Parties therefore have a vertical relationship. There are three major consoles currently on the market: Microsoft Xbox, Sony PlayStation, Nintendo Switch.

7.212 Nintendo's consoles use NVIDIA's semi-custom Tegra SoC, which is based on Arm's CPU IP. The Parties estimate that NVIDIA had a [40-50]% share in the supply of Console SoCs by volume in 2019, reflective of the market presence of Nintendo.<sup>351</sup>

7.213 Xbox and PlayStation deploy SoCs supplied by AMD, using AMD's proprietary x86-based CPUs.<sup>352</sup> AMD accounts for the remainder of Console SoC sales, excluding NVIDIA.

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<sup>349</sup> Final Merger Notice, paragraphs 253-254.

<sup>350</sup> Final Merger Notice, paragraph 266; the Parties' Issues Meeting presentation dated 16 June 2021, page 48.

<sup>351</sup> Final Merger Notice, Table 42, page 156.

<sup>352</sup> Final Merger Notice, paragraph 429.

7.214 The CMA notes that the existing suppliers and their historical or static shares of supply may not reflect the extent to which Console SoC suppliers compete for new generations of consoles in future. In addition to these existing Console SoC suppliers, there are third parties that may begin supplying Console SoCs by using Arm CPU IP as an input. Arm's internal documents<sup>353</sup> and third-party evidence indicate that new generations of consoles are released approximately every five to seven years. Many years in advance of a console release, console OEMs would typically issue an invitation to tender and/or engage in discussions with SoC suppliers. Third-party evidence indicates that, while there are high barriers to switching to a different Console SoC / CPU IP supplier 'within-generation', competition opportunities may arise for each release of the OEM's next generation console.

***Vertical effects through foreclosure of rival suppliers of Console SoCs from accessing Arm CPU IP***

7.215 In light of the vertical relationship between the Parties in respect of CPU IP and Console SoCs, the CMA considered whether the Merged Entity may have the ability and incentive to foreclose access to Arm's CPU IP, leading to a loss of competition in the supply of Console SoCs. The CMA considered foreclosure in relation to existing and future SoC suppliers who may begin supplying Console SoCs using Arm's CPU IP. The CMA considered partial foreclosure, through raised costs or reduced quality of CPU IP and associated support, and total foreclosure by denying access to CPU IP in respect of new licences, for example when future generations of consoles are released.

*Ability*

7.216 In order to assess ability, the CMA considered:

- (a) The importance of Arm CPU IP and whether Arm has market power in relation to the supply of CPU IP, including by reference to the credibility of alternative CPU IP suppliers.
- (b) the mechanisms that the Merged Entity could use to foreclose rival suppliers of Console SoCs.

*Importance of CPU IP input and Arm's market power*

7.217 The Parties submitted that there are no actual or potential Console SoC competitors that rely on Arm CPU IP that the Merged Entity could realistically

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353 [353]

foreclose, noting that AMD does not rely on Arm.<sup>354</sup> Additionally, the Parties submitted that Arm's CPU IP is general-purpose and not designed for high-end gaming consoles, and that high-performance GPU technology, not CPU IP, drives competition in consoles.<sup>355</sup>

7.218 The CMA notes that AMD does not license CPU IP from Arm for Console SoCs. However, third-party evidence received by the CMA indicates that third parties actively or potentially competing in the supply of Console SoCs are dependent on Arm for the necessary CPU IP, and that Arm's CPU IP is an important input:

- (a) Console OEMs require Console SoCs that provide performance and high power, and can manage high consumption balanced against costs. One third party told the CMA that Arm's CPU IP is perceived as industry-leading due to its particular power efficiency benefits which is a critical feature for gaming.
- (b) Console OEMs may require a high degree of trust in the CPU element of an SoC, owing to the long production cycles for next generation consoles and the importance of the CPU, as well as the risks associated with switching fundamental CPU architectures away from Arm or x86.

7.219 Contrary to the Parties' submission that the CPU IP used in consoles is general-purpose and not designed for high-end consoles,<sup>356</sup> the CMA notes the Parties' prior submission that 'CPUs used in...Consoles tend to be more powerful than CPUs used in general-purpose devices'.<sup>357</sup>

7.220 Based on the evidence received from third parties, the CMA considers that AMD's proprietary (x86) IP is not available to third parties and that other theoretical CPU IP providers are not suitable for Console SoCs. In particular, third parties have told the CMA that:

- (a) RISC-V is not a substitute for compute-intensive or complex use applications, such as consoles, because it does not provide the requisite performance, has undeveloped hardware and software components, and an immature developer support system. Third party evidence indicates that RISC-V may not be a viable alternative for an additional five to 10 years.

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<sup>354</sup> Final Merger Notice, paragraph 54; the Parties' Issues Meeting presentation dated 16 June 2021, page 49.

<sup>355</sup> The Parties' Issues Meeting presentation dated 16 June 2021, page 48.

<sup>356</sup> The Parties' Issues Meeting presentation dated 16 June 2021, page 48.

<sup>357</sup> Final Merger Notice, paragraph 263.

- (b) MIPS is not an alternative for consoles, being more present in the lower cost, lower function microcontroller segment.
- (c) Synopsys and Alibaba do not provide the necessary CPU IP technology in terms of performance, efficiency, size, and ecosystem/tools to meet the demands of consoles.

7.221 As noted above, third-party evidence also indicates that there are high barriers to switching to a different Console SoC / CPU IP supplier 'within-generation'.

7.222 The CMA therefore believes that Arm's CPU IP is an important input into the supply of Console SoCs and that Arm has market power, given the lack of credible alternative suppliers and barriers to switching. As illustrated previously at paragraph 7.31 above, Arm also has a strong position in the supply of CPU IP overall worldwide. The CMA believes that the strength and existence of Arm's ecosystem across the CPU IP spectrum are interlinked to, and reinforce, Arm's market power in the narrower segmentations of CPU IP for Console SoCs.

#### *Foreclosure mechanisms*

7.223 The Parties submitted that they could not foreclose a rival in the supply of Console SoCs because Arm only supplies general purpose CPU IP and often does not know the exact end use of that CPU IP.<sup>358</sup> Additionally, the Parties submitted that Arm does not negotiate with console suppliers, and that Arm was not aware that NVIDIA was working on a console SoC at the time NVIDIA partnered with Nintendo.<sup>359</sup>

7.224 The CMA has received evidence to indicate concerns regarding the Merged Entity's ability to foreclose future rivals in the supply of Console SoCs. Concerns focused on partial input foreclosure, including that the Merged Entity's control over the Arm ISA could lead to raised fees for access to Arm's IP, and NVIDIA-only features or other forms of self-preferencing that could hinder a third party's access to CPU IP for use in Console SoCs.

7.225 The CMA also understands that Console SoCs are semi-customised versions of SoCs used for other applications, and that rival potential or actual suppliers in Console SoCs are therefore also active in other areas.

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<sup>358</sup> Final Merger Notice, paragraph 596 ('When a customer licenses Arm IP, Arm has little insight into the end use').

<sup>359</sup> The Parties' Issues Meeting presentation dated 16 June 2021, page 49.

7.226 For the reasons outlined above at paragraph 7.60, relating to the information Arm licensees share with Arm, the CMA considers that the Merged Entity has the ability to target input foreclosure to specific rivals. Foreclosure could be partial, through mechanisms raised by third parties at paragraph 7.224, or through total foreclosure by denying access to Arm's CPU IP. The CMA also considers that conduct by the Merged Entity affecting specific rivals, who may be active in a number of applications, could affect these rivals' ability to compete in Console SoCs, regardless of whether their activities or planned activities in console specifically are known to the Merged Entity.

7.227 In addition, the CMA considers that the process for customising a Console SoC may provide a further mechanism for targeting specific rivals. Considerable investment is required to customise SoCs for use in consoles.<sup>360</sup> Internal documents suggest that Arm does play an important role in the collaboration process with the OEM or otherwise contributes to the Console SoC supplier's engagement with the OEM.<sup>361</sup> Third party evidence also supports the view that the development of a customised Console SoC requires extensive collaboration and information sharing between Arm and the Console SoC supplier. The CMA considers that the need for customisation and for collaboration with Arm implies the Merged Entity has the ability to target specific future Console SoC competitors.

7.228 The CMA considers that these mechanisms could be used to foreclose both rivals intending to compete in Arm-based Console SoCs and, in future, rivals who have secured contracts to supply Console SoCs.

#### *Conclusion on ability*

7.229 The CMA considers that: (i) Arm's CPU IP is an important input for the supply of Console SoCs; (ii) Arm has market power in the supply of CPU IP, including CPU IP used by current and potential future Console SoC suppliers who do not have access to the x86 ISA, due to the lack of credible alternatives and barriers to switching; and (ii) the Merged Entity has ability to target foreclosure at potential rival suppliers of Console SoCs other than AMD.

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<sup>360</sup> Final Merger Notice, footnote 137, page 87. ('It took NVIDIA over a year to make a semi-custom SoC for a Console such as the Switch. The variant of Tegra SoC supplied to Nintendo is not an off-the-shelf product and its non-recurring costs are significant. The OEM hires a partner to design a chip, and the final SoC is highly customized.')

<sup>361</sup> NVIDIA/Nintendo Switch High End Platform royalty request, January 2020, original document name: Nintendo switch overview.pptx, batch: CMA-002 - Batch 03, page 3.

## *Incentive*

7.230 The Parties submitted that any attempt at input foreclosure would stunt Arm's ecosystem growth and 'cripple' NVIDIA's ability to generate additional revenues.<sup>362</sup>

7.231 The CMA considers that, by foreclosing an entrant in the supply of Console SoCs:

- (a) the Merged Entity would not sacrifice immediate Arm console royalty earnings, but would only sacrifice future royalties – in the event that a rival Console SoC supplier won a future OEM bid; and
- (b) if successful in protecting NVIDIA's relationship with Nintendo and winning new relationships with another OEM or new console models, the Merged Entity would gain from both CPU IP and Console SoC supply – and would secure that position for a considerable period of time (eg, until the next generation release).

7.232 The evidence indicates that the downstream revenue opportunities are substantially greater than any potential future loss of Arm licensing revenues upstream.

- (a) An internal Arm document indicates that Arm's upstream royalty revenue from Nintendo Switch was US\$[REDACTED] in FY2019.<sup>363</sup> By contrast, NVIDIA's downstream revenue [REDACTED]. The total market revenue for semi-custom Console SoCs in 2019 was US\$[REDACTED]billion.<sup>364</sup> [REDACTED].<sup>365</sup>
- (b) The same internal Arm document indicates that the average sale price for the Console SoCs [REDACTED], and Arm's royalty revenue was approximately US \$[REDACTED]per unit.<sup>366</sup> Another internal Arm document also

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<sup>362</sup> The Parties' Issues Meeting presentation dated 16 June 2021, page 49.

<sup>363</sup> Client Line of Business, Quarterly Royalty Report and Forecast FY2019Q4 (CY2020Q1), July 2020, original document name: Client Quarterly Report (FY19Q4).pptx, batch: CMA-002 - Batch 01, page 29.

<sup>364</sup> Final Merger Notice, Table 43, page 156.

<sup>365</sup> [REDACTED].

<sup>366</sup> Client Line of Business, Quarterly Royalty Report and Forecast FY2019Q4 (CY2020Q1), July 2020, original document name: Client Quarterly Report (FY19Q4).pptx, batch: CMA-002 - Batch 01, page 29.

indicates that Arm earns between [REDACTED]% and [REDACTED]% of the average sale price of the Console SoC.<sup>367</sup>

- 7.233 Further, NVIDIA has [REDACTED].<sup>368</sup> The CMA considers that, while AMD may continue to compete for these customers, the Merged Entity would have an incentive to increase its likelihood of success in future by foreclosing rivals who would otherwise be able to enter using Arm's CPU IP.
- 7.234 The CMA also considers that the costs of foreclosure upstream to Arm's ecosystem are likely to be limited. As explained above, evidence indicates that Arm's CPU IP is important to Console SoC suppliers who do not have access to x86 and customers, indicating that Arm's ecosystem may grow in future. The limitations of alternative CPU IP suppliers indicate that the risk of Arm licensees switching to alternative ISAs and an alternative competing ecosystem in the foreseeable future is limited.
- 7.235 Based on the evidence above, the CMA considers that the Merged Entity's potential gains downstream would be much greater than the potential revenues it would forego upstream by denying Arm CPU IP to new entrants. Therefore, the CMA considers that the Merged Entity has the incentive to engage in input foreclosure strategies so as to prevent or deter new Console SoC suppliers from competing with NVIDIA for new generations of consoles, and protecting NVIDIA's current profitability and incumbent position with Nintendo. The CMA considers that such a strategy is consistent with NVIDIA's intention to invest and seek to expand in gaming.

### *Effects*

- 7.236 The CMA considers that, since NVIDIA has a significant presence in the supply of Console SoCs (deploying Arm CPU IP), a strategy to foreclose access to Arm's CPU IP would likely reduce competition from any potential future Arm licensees, largely limiting competition to that between AMD and NVIDIA. A number of third parties raised the prospect that the Merger would give the Merged Entity the ability and incentive to harm future Console SoC suppliers' ability to compete.
- 7.237 As noted above, the CMA considers that Arm is an important supplier of CPU IP and NVIDIA currently has a strong presence in SoCs for consoles, through

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<sup>367</sup> [REDACTED]

<sup>368</sup> [REDACTED]

its relationship with Nintendo – matched only by AMD. Therefore, should the Merger lead to the foreclosure of a new entrant, this would represent a significant loss of competition in a concentrated area where specific market features such as long time periods between console releases act as barriers to entry. Such foreclosure could have lasting effects especially in the reduction of choice and innovation that other SoC suppliers can offer based on Arm’s CPU IP. Accordingly, the CMA does not believe that the loss of competition would be sufficiently mitigated by the indirect constraint provided through x86 (AMD), including downstream self-supply for Console SoCs, or by any future out-licensing of IP by Intel.

#### *Conclusion on ToH 4*

7.238 For the above reasons, the CMA believes that the Merged Entity would have the ability and incentive to engage in strategies to foreclose rival suppliers of Console SoCs. Accordingly, the CMA has found that the Merger gives rise to a realistic prospect of significant competition concerns as a result of vertical effects in relation to the supply of Console SoCs.

## **8. Third-party views**

8.1 Most third-party views received during the CMA’s investigation regarding the Merger’s impact on competition related to the datacentre, HP IoT, ADAS and/or infotainment, and gaming console applications, and have already been discussed in the competitive assessment above.

8.2 The Parties submitted that third parties have expressed concerns about the Merger because: (i) large strategic companies benefit from a weak Arm and do now want Arm to ‘enable’ other third parties to compete; and (ii) smaller companies are happy with the status quo and do not want to see changes in the supply chain.<sup>369</sup> The Parties also submitted that, as recently as 26 June 2021 three important Arm customers – namely, Broadcom, MediaTek, and Marvell – have publicly stated their support for the Merger.<sup>370</sup>

8.3 In its competitive assessment, the CMA has taken into account the context of third-party submissions and considered all evidence in the round. With regards to the alleged support for the Merger cited by the Parties, the CMA notes that the comments included references to the need for assurances and safeguards to address concerns raised regarding the Merger. Overall, the

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<sup>369</sup> The Parties’ Issues Meeting presentation dated 16 June 2021, page 10.

<sup>370</sup> NVIDIA’s letter of 28<sup>th</sup> of June 2021 ‘Re NVIDIA/Arm-Undertakings in Lieu of Reference’, citing <https://www.thetimes.co.uk/article/nvidias-swoop-on-40bn-arm-wins-over-chip-titans-bl0xdlvmm>.

CMA has received a large volume of reasoned concerns from third parties, including customers and competitors, as discussed in this report.

## General-purpose PCs

- 8.4 One area in which third party views received did not relate to those applications already discussed in this report is general-purpose PCs.<sup>371</sup> The vast majority of third parties that responded to the CMA's investigation in relation to general-purpose PCs also raised CPU IP foreclosure concerns.
- 8.5 The CMA has received very limited information from the Parties regarding their activities in general-purpose PCs. The Parties submitted at a late stage of the CMA's merger investigation in the Issues Meeting that Arm does not have market power in relation to general-purpose PCs as (i) Intel and AMD's x86 ISA is dominant with over 95% share and a supporting ecosystem; (ii) RISC-V and other ISAs are available alternative options.<sup>372</sup>
- 8.6 The CMA understands that Arm's CPU IP is used by semiconductor suppliers and/or OEMs to design and supply CPUs for use in general-purpose PCs. NVIDIA submitted that it does not offer CPU, integrated GPU, or SoC technology (eg Tegra SoCs) for general-purpose PCs,<sup>373</sup> but noted [REDACTED].<sup>374</sup> [REDACTED].<sup>375</sup>
- The CMA notes that third-party submissions in relation to general-purpose PC echo the concerns expressed in respect of datacentre. These submissions indicated that Arm CPU IP is very important to licensees and their customers,
- 8.7 that Arm has a strong market position, that licensees typically have no

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<sup>371</sup> A small number of third parties raised concerns in relation to mobile citing Arm's importance, uncertainty around the Merger's impact on Arm's open licensing model, and concerns the Merged Entity may seek to foreclose mobile licensees with whom NVIDIA competes elsewhere.

<sup>372</sup> The Parties' Issues Meeting presentation dated 16 June 2021, pages 5, 9 and 11.

<sup>373</sup> Final Merger Notice, paragraph 288. NVIDIA further submitted that its discrete GPUs were 'not actively marketed' for general purpose PCs.

<sup>374</sup> [REDACTED]

<sup>375</sup> [REDACTED].

alternatives or no comparable alternatives to Arm CPU IP, and that switching away from Arm would be high risk and costly. One third party noted an increasing shift towards Arm-based CPUs from x86. Third parties indicated that licensees of Arm's CPU IP are also rivals of NVIDIA, potentially across a number of applications. One third party indicated that they considered NVIDIA could expand its activities into general-purpose PC, and pointed to an increasing convergence between datacentres, cloud computing and PC as a reason for concern.

- 8.8 The CMA believes that third-party views relating to general-purpose PCs discussed at paragraphs 8.7 – 8.7 above are generally consistent with, and analogous to, the vertical input foreclosure strategies discussed in ToHs 1 – 4, thereby raising potential concerns. However, within the constraints of the phase 1 process and limits on the information made available to the CMA at this stage, the CMA has not been able to investigate this area sufficiently to come to a conclusion as to whether there is a realistic prospect of an SLC. The CMA believes that this is an area which may warrant further examination in any phase 2 investigation.

## **9. Countervailing factors**

### **Entry and expansion**

- 9.1 In its competitive assessment, the CMA may take into account entry and/or expansion plans of rivals who will enter or expand irrespective of whether the merger proceeds. The CMA considers the possibility of entry and/or expansion as a countervailing measure to what might otherwise be an SLC finding. The CMA considers that entry and/or expansion preventing an SLC from arising would be rare.<sup>376</sup>
- 9.2 The Parties submitted that there have been a range of recent new entrants in the development and supply of semiconductor IP generally.<sup>377</sup> The Parties further submitted that some semiconductor suppliers develop CPU IP in-house,<sup>378</sup> and that customers can develop IP in-house using a free, open-source ISA such as RISC-V.<sup>379</sup> Moreover, the Parties submitted that Intel's

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<sup>376</sup> Merger Assessment Guidelines, paragraphs 8.28-8.29. As explained in the Merger Assessment Guidelines, in assessing whether entry or expansion might prevent a substantial lessening of competition, the CMA considers whether such entry or expansion would be timely, likely and sufficient to prevent an SLC. Typically, entry or expansion being effective within two years of an SLC arising would be considered by.

<sup>377</sup> Alibaba, AMD, Intel (licensing x86 cores and other IP broadly to customers of Intel foundries), Microchip, Nuclei, Qualcomm, Seagate Corporation, StarFive, Western Digital Corporation, Syntacore (YADRO) (Final Merger Notice, Table 60).

<sup>378</sup> Such as, for example, Intel/AMD, Renesas, and TI, and NXP (Final Merger Notice, paragraph 787).

<sup>379</sup> Final Merger Notice, paragraph 797.

recent decision to expand into out-licensing IP is an example of entry creating a significant threat to Arm.<sup>380</sup>

- 9.3 As discussed in the competitive assessments above, the evidence received by the CMA indicates that a large number of Arm licensees rely on Arm CPU IP and do not consider other suppliers to provide now or within the next five years a credible alternative to Arm IP. The evidence also suggests, that across all applications, turning towards developing in-house solutions is not considered as a realistic alternative to Arm CPU IP by many third parties.<sup>381</sup> For example, one respondent explained that CPU core development requires significant re-engineering efforts in terms of time and investment. The evidence also indicates that no supplier of semiconductor IP, other than Arm, has so far succeeded in expanding sufficiently after entry.
- 9.4 Further, as discussed in the competitive assessments above, the CMA considers that third-party evidence indicates that there are significant barriers to switching IP supplier as a result of software portability issues, which require considerable time and investment to address.
- 9.5 Therefore, the CMA does not consider that entry or expansion (including self-supply) will be timely, likely or sufficient to mitigate any SLC.

## Efficiencies

- 9.6 The CMA's framework for assessing merger efficiencies is whether they enhance rivalry in the supply of those products where an SLC may otherwise arise, are timely, likely and sufficient, are merger-specific and will benefit customers in the UK.<sup>382</sup> The greater the expected adverse effect of a merger, the greater the expected efficiencies must be.<sup>383</sup> The CMA will consider whether, even if the Merger does give rise to efficiencies, the Merged Entity would have the incentive to allow customers in the UK to benefit from the efficiencies.<sup>384</sup> At phase 1, the evidence must be sufficient to satisfy the CMA within the time available in an initial investigation that efficiencies would prevent the realistic prospect of an SLC.<sup>385</sup>

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<sup>380</sup> Final Merger Notice, paragraph 796.

<sup>381</sup> See eg paragraphs 7.17, 7.40 and 7.165.

<sup>382</sup> Merger Assessment Guidelines, paragraph 8.8 *et seq.*

<sup>383</sup> Merger Assessment Guidelines, paragraph 8.14.

<sup>384</sup> Merger Assessment Guidelines, paragraph 8.20.

<sup>385</sup> Merger Assessment Guidelines, paragraph 8.15.

- 9.7 The Parties submitted<sup>386</sup> that the Merger would give rise to efficiencies by (i) creating a worldwide ISA able to effectively compete with x86 in datacentres and PC (by combining the necessary resources, knowledge and motivation to do so); (ii) generating synergies in mobile, automotive, and IoT, enabling the Merged Entity to be more competitive and innovative and meet the growing demands of the AI era; and (iii) generating additional cost savings, through fixed-cost savings and internalising royalty payments.<sup>387</sup> The Parties submitted further that, without the Merger, NVIDIA would not have the incentive to invest in Arm as this would result in significant sunk costs that NVIDIA would not be able to recover as a licensee.<sup>388</sup>
- 9.8 The Parties have not provided the CMA with sufficient verifiable evidence that the Merger will lead to efficiencies that will be timely, likely and sufficient to prevent an SLC from arising.<sup>389</sup> Nor has the CMA received evidence to indicate that any efficiencies would be Merger-specific. In relation to the Parties' submission that efficiencies would arise from faster deployment of autonomous driving technologies through the licensing of NVIDIA's GPU and AI technology through Arm's licensing channels, the CMA notes that the Parties have not provided verifiable evidence in this regard. It also notes its current assessment of the Merged Entity's post-Merger incentives in relation to the ADAS application discussed at paragraphs 7.192-7.201. The CMA has also not received evidence to indicate that there are significant difficulties preventing investments from being achieved by alternative means of other than by NVIDIA.<sup>390</sup>
- 9.9 In relation to the claimed synergies and cost savings, the CMA has not received verifiable supporting evidence of these savings or how they would be passed on to customers.<sup>391</sup>
- 9.10 Finally, and in the light of the competitive assessment above, the CMA has received no substantiated or verifiable evidence that customers can be expected to benefit from any of any claimed efficiencies.

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<sup>386</sup> Merger Assessment Guidelines, paragraphs 8.44-9.24. Paper by Compass Lexecon, Stimulating Investment Along the Vertical Chain to Increase Datacenter Competition: The Economics of the NVIDIA-Arm Transaction, including Annex II, 12 May 2021; the Parties' Issues Meeting presentation dated 16 June 2021, pages 18-20.

<sup>387</sup> In particular, the Parties submitted that the Merger would create a more competitive and innovative computing business better equipped to help Arm's licensees challenge x86 ISA (Intel and AMD). The Parties submitted that stronger competition between x86 and Arm would increase innovation and lower prices of semiconductors to OEMs and, ultimately, end consumers. Final Merger Notice, paragraphs 846, 857.

<sup>388</sup> Final Merger Notice, paragraph 892, 896-897.

<sup>389</sup> Merger Assessment Guidelines, paragraph 8.13.

<sup>390</sup> Merger Assessment Guidelines, paragraph 8.16.

<sup>391</sup> Merger Assessment Guidelines, paragraph 8.7. In relation to fixed cost savings in particular, the CMA notes that it generally views reductions in merger firms' marginal or variable costs as being more likely to result in an incentive to reduce price or make short-run improvements in quality than reductions in fixed costs; Merger Assessment Guidelines, paragraph 8.10.

## 10. Conclusion on substantial lessening of competition

10.1 Based on the evidence set out above, the CMA believes that it is or may be the case that the Merger may be expected to result in an SLC in the following markets:

- (a) the supply of Datacentre CPUs on a global basis;
- (b) the supply of SmartNICs on a global basis;
- (c) the supply of Datacentre GPUs on a global basis;
- (d) the supply of SoCs for HP IoT applications on a global basis;
- (e) the supply of SoCs for automotive applications on a global basis, and specifically in respect of:
  - (i) ADAS applications, and
  - (ii) infotainment applications; and
- (f) the supply of SoCs for gaming consoles on a global basis.

10.2 The CMA believes that the foreclosure effects in the above markets would variously reinforce each other in light of the interaction and inter-relatedness of: (i) these different downstream product types with each other within and across applications; (ii) the customers and suppliers in these markets, many of whom are active across multiple of these markets; (iii) the ecosystem dynamics of each market; and (iv) the technological trends driving changes in each of these markets in the AI era.

## 11. Public Interest Consideration

### Summary of interested parties

11.1 Section 44(3)(b) of the Act requires the CMA to provide a summary of representations it has received (i) which relate to the public interest consideration in question (in this case, national security) and (ii) which are or may be relevant to the Secretary of State's decision as to whether to make a reference for a phase 2 assessment under section 45 of the Act.

### **DCMS**

11.2 The Department for Digital, Culture, Media and Sport (**DCMS**) is preparing advice for the Secretary of State on the national security risks arising from the

Merger, coordinating input from a range of government departments. That advice will include a report from the National Cyber Security Centre (**NCSC**) on the potential for the transaction to negatively impact the cyber security of the UK in a manner contrary to the UK's national security.

### ***Third parties***

11.3 The CMA received representations from six third parties. Third-party views provided to the CMA relate to the following overarching themes:

- (a) first, that Arm's technology is used in various sectors that are crucial for the UK's national security; and, in the light of this,
- (b) concerns that the Merger would reduce the UK's sovereignty, ie the UK's ability to act independently from other countries, including pertaining to:
  - (i) the Merged Entity becoming subject to the US export regime;
  - (ii) remedies that may be imposed by foreign regulators that could introduce risk to the UK's national security; and
- (c) concerns that the Merged Entity would become a 'single gatekeeper' of the core components for critical computing infrastructure, the effect of which would give rise to risks as regards:
  - (i) downstream distortion of competition in relation to the supply of technology used in datacentre, 'edge' and 'cloud' related applications, which are critical for the UK's national security; and
  - (ii) risk of the Merged Entity becoming an increased target for a potential attack.

### ***Importance of the applications in which the Parties' technology is used***

11.4 Several third parties referred to the strategic significance of the applications in which the Parties' technology is used. For example, one third party noted that Arm licenses its technology to crucial suppliers across different sectors such as automobile, mobile and datacentre. It submitted that Arm's licensees provide (directly or indirectly) goods and services to the UK's Critical National Infrastructure sectors of chemicals, civil nuclear, communication, defence, emergency services, energy, finance, food, government, health, space, transport, and water. Referring to NCSC's Annual Review 2020, it noted that certain licensees of Arm were critical to the UK's response to COVID-19 pandemic. It submitted that science and technology, diversity of supply and the protection of the UK's R&D capabilities are important for the UK's national

security. It submitted that 'computing power and innovation is necessary for the work of the UK armed forces, intelligence services and in the provision of national public and private services like the NHS, transport network, banking network, and communications network'.

- 11.5 Similarly, third parties referred to the fact that CPUs and GPUs are the core components of critical computing infrastructure, edge, artificial intelligence and digital security, and are therefore essential for the UK's national security. One noted that the Merger would harm Europe's sovereignty in relation to the 'particularly sensitive and important area' of exascale supercomputers. Another commented that Arm is one of the most critical and strategic companies for the UK and Europe, comparable to companies such as Airbus, Rolls Royce, Volkswagen and ASML.

#### *UK's sovereignty and overseas influence*

- 11.6 Several third parties raised an issue of sovereignty or the risks associated with increased overseas influence on the development of products which are of critical importance to the UK's national security, as summarised above. One third party considered that the Merger affects 'technology sovereignty' of the UK, describing Arm as the UK's 'sole remaining bargaining chip in the struggle for Technology Sovereignty'. It argued that technology sovereignty is achieved when a country controls the IT infrastructure required for the country's economy and for the government to act with independence. Another third party submitted that the Merger could leave the UK open to manipulation and control by foreign countries threatening the UK with 'shortages, unjustifiable cost increases, and even threatening our infrastructure and government'.
- 11.7 Specifically in relation to the US, three third parties commented on the fact that the Merger would entail a US company owning Arm, which would increase the UK's dependency on the US, and would increase the US' influence over the UK's IT infrastructure. Two third parties submitted that the Merged Entity would have to adhere to US export regulations and that, therefore, the US government instead of the UK government would decide on export matters, which could render the UK's national security more vulnerable. One third party warned that export restrictions could extend to the UK companies that incorporate Arm technology in their products, requiring the UK companies to apply and compete against US companies for restricted US export licences, further risking the UK's national security. Lastly, another third party submitted that the Merger could have potential political ramifications, particularly for the Chinese technology industry, as it would lead to an almost monopoly by the US over ISAs.

- 11.8 One third party submitted that potential remedies imposed by foreign regulators on the Parties could raise concerns for the UK's national security. It noted that these remedies may include the grant of rights or a level of control over Arm's technology to foreign governments or foreign public companies which could have an impact on the UK's national security, should the UK's national security review be concluded without considering all potential remedies imposed by foreign regulators.

#### *Concentration of influence over the supply chain*

- 11.9 One third party submitted that the Merger would make the Merged Entity the dominant computing company, and a 'single gatekeeper' of AI technology, which is key for the UK's national security. This third party submitted that this concentration of influence would allow the Merged Entity to control the downstream development and use of CPUs and GPUs (which are the core components of critical computing infrastructure, and are essential for the UK's national security). It submitted that, in the medium-term, the Merger would distort CPU competition in the datacentre sector, which is a critical input for the UK's national security. It submitted that foreclosure of competitors would have a detrimental impact on diversity of suppliers for critical national infrastructure in the UK. It also submitted that, in the long-term, the Merger would provide the Merged Entity with the ability and incentive to impede edge computing, lessening current and future competition in and between the edge and cloud applications – to the detriment of the UK's national security. It submitted that, in future, processing can be performed either in the cloud or edge and, absent the Merger, datacentre companies (eg NVIDIA, Marvell, Fujitsu) will compete against edge processing companies (eg Qualcomm, Apple, Samsung). This third party further submitted that 5G mobile communications technology makes convergence between the cloud and edge important for many critical sectors such as industrial IoT, road safety, automotive, and boundless extended reality (XR) in education and healthcare.
- 11.10 One third party additionally submitted that the UK's national security would be vulnerable because there would be a 'single point of failure risk', ie that there would be no alternatives in the UK to the Merged Entity's products. It noted that, as a single gatekeeper for cloud and edge computing, the Merged Entity would be 'an easy and clear target for any potential attack'.

#### *Other concerns*

- 11.11 In addition to the above concerns, one third party submitted that it would only have concerns if Government Communications Headquarters (**GCHQ**) were to have access to Arm ISA, which allows the UK to utilise Arm architecture for

national security purposes. It suggested that, should this be the case, post-Merger GCHQ could lose the access to or influence over Arm ISA which could result in a national security risk.

- 11.12 Consistent with section 44(2) and 44(3) of the Act the CMA does not provide in this report advice or recommendations on the national security public interest consideration under section 44(6) of the Act.<sup>392</sup>

## 12. Remedies – Undertakings in Lieu

### Introduction

- 12.1 Where competition concerns have been identified, the CMA is required to report to the Secretary of State on its decision as to whether, for the purpose of remedying, mitigating or preventing the SLC concerned or any adverse effect which may be expected to result from it, it would be appropriate to accept undertakings in lieu of making a reference.<sup>393</sup>
- 12.2 To be acceptable, remedies proposed in phase 1 investigations must be clear-cut and capable of ready implementation. This means, amongst other things, that (i) the CMA must be confident that, if the UILs are accepted, there is no material doubt about their overall effectiveness; and (ii) all potential competition concerns that have been identified in its investigation would be resolved by means of the UILs without the need for further investigation.<sup>394</sup>
- 12.3 The CMA shall in particular have regard to the need to achieve as comprehensive a solution to the SLC (and any adverse effects resulting from it) as is reasonable and practicable. The CMA considers that, at phase 1, it is appropriate to seek to remedy or prevent competition concerns rather than mitigate concerns. Accordingly, the CMA's starting point is to seek an outcome that restores competition to the level that would have prevailed absent the merger.<sup>395</sup>
- 12.4 The more extensive the competition concerns, in terms of magnitude of potential customer harm, the more significant the error costs of an ineffective remedy, and hence the greater the belief must be that the UILs will comprehensively resolve those concerns. In cases where the potential

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<sup>392</sup> Guidance on the CMA's jurisdiction and procedure, paragraph 16.7 d).

<sup>393</sup> Section 44(4)(f) of the Act requires the CMA to include in its report its decision as to whether it believes that it is or may be the case that it would be appropriate to deal with the matter (disregarding any public interest considerations mentioned in the intervention notice concerned) by way of undertakings under paragraph 3 of Schedule 7 to the Act.

<sup>394</sup> [CMA guidance on Merger Remedies, 13 December 2018](#) (CMA 87) (**Merger Remedies**), paragraph 3.27.

<sup>395</sup> Merger Remedies, paragraphs 3.3, 3.30 and 3.31.

magnitude of harm is large, the CMA will be particularly cautious in its approach to UILs.<sup>396</sup>

- 12.5 At phase 1, the CMA is generally unlikely to consider behavioural undertakings sufficiently clear-cut to address the identified competition concerns. Whereas structural remedies deal with the concern at source, behavioural undertakings bring a number of risks which can reduce their effectiveness or create competition concerns elsewhere, and can be difficult to monitor and enforce.<sup>397</sup> Complex behavioural remedies that create continuing economic links and dependencies are unlikely to recreate the pre-merger competitive intensity of the market, can raise significant circumvention risks, and can become outdated as market conditions change. In some circumstances they can also distort the natural development of the market.<sup>398</sup> This is underscored further by the increasing complexity of dynamic markets and the need to undertake forward-looking assessments.
- 12.6 [In practice, this means that in most instances where remedies are required, the CMA has selected structural remedies with behavioural remedies sometimes playing a supporting role.<sup>399</sup>

### ***The Undertakings offered to remedy the competition concerns identified***

- 12.7 NVIDIA proposed behavioural undertakings to the CMA (the **Proposed Undertakings**) on the basis of the theories of harm which had been outlined in the CMA's issues paper sent to the Parties.<sup>400</sup> The Proposed Undertakings are for a five-year term,<sup>401</sup> and comprise the following:
- (a) Preserving Arm's open licensing program, engineering, maintenance and technical support, and offering any interested parties licences consistent with Arm's current practices; and honouring all Arm licences for the duration of their term (for both existing licences and any new licences issued during the 5 year period) (the **Open Licensing Undertaking**);
  - (b) Providing equal access to Arm technology for all Arm licensees, including access to all Arm technology that NVIDIA receives, publishing the Arm ISA instruction, consistent with Arm's current practices, and not reserving

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<sup>396</sup> Merger Remedies, paragraph 3.28 (a).

<sup>397</sup> Merger Remedies, paragraphs 3.32 and 7.4, in particular: specification, distortion, circumvention, and monitoring and enforcement risks.

<sup>398</sup> [Joint statement by the Competition and Markets Authority, Bundeskartellamt, and Australian Competition and Consumer Commission on merger control](#), 20 April 2021. See also Merger Remedies, paragraph 7.4.

<sup>399</sup> Merger Remedies, paragraph 3.47.

<sup>400</sup> NVIDIA's letter of 28<sup>th</sup> of June 2021 'Re NVIDIA/Arm-Undertakings in Lieu of Reference' and 'NVIDIA Arm UILs Final' attachment. This offer was made without prejudice to NVIDIA's position that there is no realistic prospect of an SLC on any relevant frame of reference.

<sup>401</sup> Commencing one working day after completion of the Merger.

Arm IP or creating proprietary version of the Arm ISA for NVIDIA (the **Equal Access Undertaking**);

- (c) Providing early access to Arm technology for any interested Arm architectural or implementation licensee, and providing every Arm architectural licensee the opportunity to participate in the Arm Technical Advisory Board consistent with Arm's current practices (the **Early Access Undertaking**);<sup>402</sup>
- (d) Delivering Arm IP to Arm implementation licensees without any restriction on interoperability, consistent with Arm's current practices, and ensuring that any future Arm implementation licences shall not preclude or restrict any product incorporating Arm implementation IP from interoperating with any other third-party component, software, or system (the **Interoperability Undertaking**);
- (e) Honouring all existing Arm non-disclosure agreements (**NDA**s) and offering all Arm licensees the opportunity to enter into new or updated NDAs to protect any confidential Arm customer information and restrict its use to only specified staff and for the purposes specified in the NDA (the **Confidentiality Undertaking**); and
- (f) Appointing a monitoring trustee to oversee the above. The monitoring trustee would also be provided with access to a contracts database, which NVIDIA would maintain and keep up-to-date, as well as keeping its contents confidential.

### ***The Expansion of UK Origin IP Undertaking***

12.8 In addition to the Proposed Undertakings, the Parties have offered to: (i) increase Arm's R&D expenditure in the UK; (ii) create a new Arm R&D team in the UK to create CPU IP for datacentre and PC products, and make that IP

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<sup>402</sup> This comprises giving access [redacted].

available to all Arm Licensees; (iii) retain Arm's roadmap for all IP developed in the UK and Europe; and (iv) build and staff two artificial intelligence centres in the UK as well as a supercomputer to support research collaborations with the UK community (the **Expansion of UK Origin IP Undertaking**).

- 12.9 The Expansion of UK Origin IP Undertaking is not expressed as addressing the competition concerns identified by the CMA. Rather, NVIDIA submitted that it is included to reflect its ongoing discussions with DCMS as regards the public interest considerations in question. For completeness, in accordance with section 44(3)(a) of the Act, the CMA provides its views as regards this undertaking below, as these may also be relevant to the Secretary of State's decision as to whether to make a reference under section 45 of the Act.

## **Assessment of the Proposed Undertakings**

### ***Effectiveness of the Proposed Undertakings to address the identified SLC***

- 12.10 For the reasons set out below, the CMA does not consider that the Proposed Undertakings would effectively remedy the competition concerns identified in this report to the requisite standard.

### *Overall concern as to suitability of behavioural remedies in this case*

- 12.11 The CMA has an overall and significant concern that the conduct required to address the competition concerns and their adverse effects cannot be specified with sufficient clarity, to provide an effective basis for a lasting remedy that is capable of effective monitoring and enforcement. This risk is significant in this case, having regard to (i) the complex and evolving nature of the contracts and markets involved, (ii) the magnitude of the concerns identified, spanning a number of markets and applications, and (iii) the breadth and technically specialist nature of the Proposed Undertakings. The CMA considers that the Proposed Undertakings give rise to significant uncertainty and therefore doubt as to their effectiveness.

### *Specific remedy risk concerns*

- 12.12 The CMA considers that a five-year commitment falls manifestly short of the time period required to remedy the concerns identified by the CMA in this report, which are lasting in nature, and pertain to long development cycles. However, even with a longer duration, the CMA does not consider the Proposed Undertakings offer a clear-cut remedy in light of the overall concern described above, and the specific risks relating to the remedy design identified below.

### *Specification and circumvention risk*

- 12.13 Open Licensing Undertaking: The CMA has specification concerns in respect of the ability to ensure that terms and fees offered are not unattractive such that they act to prohibit or limit access. Whilst the monitoring trustee may have access to a contracts database, competitors will not and, therefore, will not be able to benchmark whether these terms are reasonable. The CMA also doubts the ability to ensure levels of technical and engineering support are provided at pre-Merger levels.<sup>403</sup>
- 12.14 Early Access Undertaking: The CMA has circumvention concerns in respect of the direction, design and timing of the available R&D. The CMA has serious doubts that this undertaking can prevent the overall strategic direction and focus of R&D research from being directed towards NVIDIA's needs. The CMA is concerned that, through the iterative R&D process, NVIDIA would continue to have an opportunity to influence Arm's internal decision-making. The CMA also considers there to be an internal stage of technology development before Arm releases it to customers<sup>404</sup>, such that NVIDIA could gain a first-mover advantage.
- 12.15 Interoperability Undertaking: The CMA has specification and circumvention concerns that this undertaking may not prevent technical or other *de facto* restrictions on interoperability being introduced (or better interoperability for NVIDIA to the detriment of competitors).
- 12.16 Confidentiality Undertaking: The CMA has significant concerns about the effectiveness of the proposed NDAs to sufficiently protect confidential information. For example, there is a circumvention risk of Arm staff collaborating or moving between divisions within the organisations, and applying their experience from working on other competitors' products.

### *Overall monitoring and enforcement risk*

- 12.17 The risks identified above point to a significant monitoring and enforcement risk. In particular, even with a monitoring trustee appointed, there is an inherent reliance on third parties bringing suspected breaches to the attention of the monitoring trustee. This imposes a cost on competitors, including financial and staff resources, as well as time and opportunity costs which could be significant in the relevant sectors in this case. The CMA also has considerable concerns relating to the complexity of the information and

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<sup>403</sup> In particular, in ensuring that NVIDIA is not favoured in terms of resource prioritisation, staff quality and ongoing staff training to support its ecosystem.

<sup>404</sup> Eg before [X], which are some of the stages at which NVIDIA proposes to provide access for Arm licensees.

understanding required to evaluate compliance, including by the monitoring trustee. In the light of asymmetries of information, the CMA has serious doubts as to how third parties, in conjunction with the monitoring trustee, would be able to (i) identify a breach of the Proposed Undertakings in a timely way, and/or (ii) obtain the evidence required to pursue it effectively.

### ***Expansion of UK Origin IP Undertaking***

12.18 While the Expansion of UK Origin IP Undertaking does not directly relate to the competition concerns identified, the CMA makes the following observations that may be relevant to the Secretary of State's decision as to whether to make a reference under section 45 of the Act:

- (a) The five-year term is very short, and does not offer a lasting solution to the any concerns identified; and
- (b) The considerable specification, circumvention, monitoring and enforcement risks identified above, also are relevant to this undertaking.

### **Decision**

12.19 For the reasons set out above, after careful examination, the CMA does not believe that it would be appropriate to accept the Proposed Undertakings. Further, based on the concerns identified as regards the Proposed Undertakings and the magnitude of the competition concerns identified, the CMA does not believe there to be a modified form of behavioural remedy sufficient to address the competition concerns identified to the phase 1 standard.

12.20 The Parties have not offered structural remedies. However, the CMA would not be confident that a remedy involving the partial divestment of Arm's IP business(es) would be sufficiently clear-cut and comprehensive for phase 1, as a result of risks relating to severability, and the potential loss of scale and synergies.

12.21 The CMA therefore considers that it would not be appropriate to deal with the competition concerns arising from the merger situation by way of undertakings under paragraph 3 of Schedule 7 to the Act.

## **13. Assessment and Advice to the Secretary of State**

13.1 The CMA produces this report to the Secretary of State pursuant to its duty under section 44(2) of the Act, following investigations carried out under section 44(7).

- 13.2 This report contains advice on considerations relevant to the making of a reference under section 33 of the Act which are also relevant to the Secretary of State's decision as to whether to make a reference under section 45 of the Act, namely that the CMA believes that 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;
  - (b) the creation of that merger situation may be expected to result in an SLC within a market or markets in the UK for goods or services; and
  - (c) it would not be appropriate to accept undertakings in lieu of a reference to a phase 2 inquiry.<sup>405</sup>
- 13.3 This report also contains a summary of the representations about the case which it has received which relate to the national security public interest consideration mentioned in the Notice.
- 13.4 This report does not contain advice or recommendations on the public interest consideration under section 44(6) of the Act.

**Andrea Coscelli, Chief Executive, CMA**

**20 July 2021**

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<sup>405</sup> Pursuant to section 44(4) of the Act, the CMA does not believe it is or may be the case that (i) the market or markets concerned would be of insufficient importance to justify the making of a reference; (ii) the arrangements are insufficiently far advanced, or insufficiently likely to proceed, to justify the making of such a reference; or (iii) any relevant customer benefits in relation to the creation of the relevant merger situation concerned outweigh the substantial lessening of competition and any adverse effects of the substantial lessening of competition.