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EUROPEAN COMMISSION  
DG Competition

***Case M.7772 - WESTERN DIGITAL / SANDISK***

Only the English text is available and authentic.

**REGULATION (EC) No 139/2004  
MERGER PROCEDURE**

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Article 6(1)(b) NON-OPPOSITION  
Date: 04/02/2016

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## EUROPEAN COMMISSION

Brussels, 4.2.2016  
C(2016) 766 final

In the published version of this decision, some information has been omitted pursuant to Article 17(2) of Council Regulation (EC) No 139/2004 concerning non-disclosure of business secrets and other confidential information. The omissions are shown thus [...]. Where possible the information omitted has been replaced by ranges of figures or a general description.

MERGER PROCEDURE

PUBLIC VERSION

### **To the notifying party:**

Dear Sir/Madam,

**Subject: Case M.7772 – Western Digital / SanDisk  
Commission decision pursuant to Article 6(1)(b) of Council Regulation No 139/2004<sup>1</sup> and Article 57 of the Agreement on the European Economic Area<sup>2</sup>**

- (1) On 22 December 2015, the European Commission received notification of a proposed concentration pursuant to Article 4 of the Merger Regulation by which Western Digital Corporation ("Western Digital", USA, hereinafter referred to as the "Notifying Party") acquires within the meaning of Article 3(1)(b) of the Merger Regulation sole control of the whole of SanDisk Corporation ("SanDisk", USA) by way of purchase of shares (the "Transaction").<sup>3</sup> Western Digital and SanDisk are hereinafter referred to together as the "Parties".

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<sup>1</sup> OJ L 24, 29.1.2004, p. 1 ('the Merger Regulation'). With effect from 1 December 2009, the Treaty on the Functioning of the European Union ('TFEU') has introduced certain changes, such as the replacement of 'Community' by 'Union' and 'common market' by 'internal market'. The terminology of the TFEU will be used throughout this decision.

<sup>2</sup> OJ L 1, 3.1.1994, p.3 ('the EEA Agreement').

<sup>3</sup> Publication in the Official Journal of the European Union No C 3, 7.1.2016, p. 7.

## **1. THE PARTIES AND THE TRANSACTION**

- (2) Western Digital produces hard disk drives ("HDDs") for a number of uses including personal computers, consumer electronics, cloud computing and datacentre applications, enterprise class solid state drives ("enterprise SSDs"), and hybrid drives. Western Digital also produces certain external storage, business storage solutions, as well as storage solution software.
- (3) SanDisk is a digital storage producer that specializes in flash memory solutions such as flash storage solutions, including enterprise SSDs and SSDs for consumer-operated devices ("client SSDs"), as well as removable cards, USB flash drives and embedded flash products for mobile and connected applications and consumer electronics. SanDisk is also active in software and consumer products, as well as flash storage solutions, including SSDs, for enterprise data centres and client computing platforms.
- (4) Pursuant to an Agreement and Plan of Merger signed by the Parties on 21 October 2015, Western Digital will acquire 100% of the shares and control of SanDisk. The Transaction therefore constitutes a concentration within the meaning of Article 3(1)(b) of the Merger Regulation.
- (5) The Notifying Party submits that the main rationale of the transaction is for Western Digital to gain access to in-house production of NAND flash memory<sup>4</sup> (an essential input for the production of SSDs), which will reduce margin stacking<sup>5</sup> and ensure continued supply. Further, the Transaction would combine the Parties' complementary product ranges, customer bases and know-how.

## **2. EU DIMENSION**

- (6) The undertakings concerned have a combined aggregate world-wide turnover of more than EUR 5 000 million<sup>6</sup> (Western Digital: EUR 13 722 million; SanDisk: EUR 4 989 million). Each of them has an EU-wide turnover in excess of EUR 250 million (Western Digital: EUR [...] million; SanDisk: EUR [...] million), but they do not achieve more than two-thirds of their aggregate EU-wide turnover within one and the same Member State. The Transaction therefore has an EU dimension under Article 1(2) of the Merger Regulation.

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<sup>4</sup> Flash memory is a type of non-volatile storage technology that stores data in transistors and that does not require power to retain data. There are two types of flash memory, NAND and NOR. The names refer to the type of logic gate used in each memory cell ("Negative AND" and "Negative OR"). Contents of NOR memory can be read more rapidly than the contents of NAND, while data can be written to NAND more rapidly than to NOR. NAND-based flash memory is used for high capacity storage such as SSDs because it is more durable, less expensive and its write/erase operations are faster relative to NOR-based flash memory.

<sup>5</sup> Margin stacking refers to the cost or profit margin that each member of the supply chain (i.e. components supplier, manufacturer, vendor, reseller, etc.) adds to bring a product to the end user and the final cost includes these "stacked" margins.

<sup>6</sup> Turnover calculated in accordance with Article 5 of the Merger Regulation and the Commission Consolidated Jurisdictional Notice (OJ C 95, 16.4.2008, p. 1).

### 3. MARKET DEFINITION

#### 3.1. Introduction to data storage

- (7) The Transaction relates to data storage solutions. Storage solutions allow for the creation, management and preservation of digital content and are used in a variety of information technology (“IT”) devices and applications such as personal computers, servers, and other business storage systems, as well as in industrial and consumer electronic applications, such as digital video recorders, gaming devices and automotive applications. Storage solutions used in these devices and applications include HDDs, SSDs, memory cards, USB flash drives and embedded flash storage.
- (8) An HDD is a storage solution that uses one or more rotating metal or glass disks with magnetic surfaces to store and allow access to data. A read/write head on a moving actuator arm accesses the data while the disk is spinning.

**Figure 1: a hard disk drive (HDD)**



- (9) An SSD is a storage solution that uses NAND flash memory to store digital data. The NAND flash memory is a key input for SSDs. The other main components of an SSD are the controller and the interface. The controller is a chip that directs memory reading, writing, and certain other functions (in other words, it manages how and where data is stored on the memory chips within the SSDs). The interface is the connection between the storage unit and the computer or system where it is inserted. It consists of a physical layer, the physical interconnector, and a logical layer, the protocol used to structure the communication.

**Figure 2: a solid state drive (SSD) and its main components**

- (10) A memory card is a flash memory storage solution which is used in portable electronic devices such as digital cameras, mobile phones, tablets, laptops and gaming consoles.
- (11) Similar to a memory card, a USB flash drive is a flash memory storage solution. The USB flash drive has an integrated USB interface through which it can be connected to various types of hardware, including PCs and laptops.
- (12) Embedded flash storage is a flash memory storage solution that is permanently integrated into the devices that use it. Those devices comprise, for instance, mobile phones, car electronics and industrial equipment.
- (13) Another type of storage solution built around flash memory is a so-called all flash array ("AFA"). An AFA may employ SSDs (SSD-based AFA) or use NAND flash memory modules supplemented with additional hardware that enables the reading and writing of that NAND flash memory (NAND-based AFA).
- (14) Storage solutions vary in terms of storage capacity (the amount of data that can be stored), latency or performance (how quickly data is stored and accessed), reliability (the likelihood of a system failure) and endurance (the total amount of write activity to the product before it becomes unreliable). These parameters have an impact on the price of the storage product. Storage solutions also vary in terms of physical size and the type of interface that is used to connect the storage to the system in which it is used. Several different interfaces have been defined as industry standards, for example SATA<sup>7</sup>, SAS<sup>8</sup>, PCIe<sup>9</sup> and USB<sup>10</sup>.
- (15) As indicated in paragraphs (2) and (3), Western Digital and SanDisk develop and manufacture a number of storage solutions. While Western Digital produces both HDDs and flash memory based storage solutions, SanDisk focuses only on flash memory based storage solutions.
- (16) In relation to flash memory based storage solutions, and in particular enterprise SSDs, which are at the heart of the Commission's investigation in the present case, the Parties compete with a number of large and sophisticated IT companies such as Samsung, Intel, Toshiba and Micron. Those companies produce SSDs and sell them on to their customers.
- (17) The main input for enterprise SSDs is NAND flash memory (see paragraph (9)). NAND flash memory is also used in other storage solutions, such as memory cards and USB flash drives. There is a merchant market for NAND flash memory. However, a number of manufacturers of enterprise SSDs also produce NAND flash memory and are thus able to satisfy all or at least part of their demand for NAND flash memory in-house. This is also the case for San Disk. The largest producers of NAND flash memory are Samsung, Toshiba, Micron, SanDisk and SK Hynix.

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<sup>7</sup> Serial Advanced Technology Attachment.

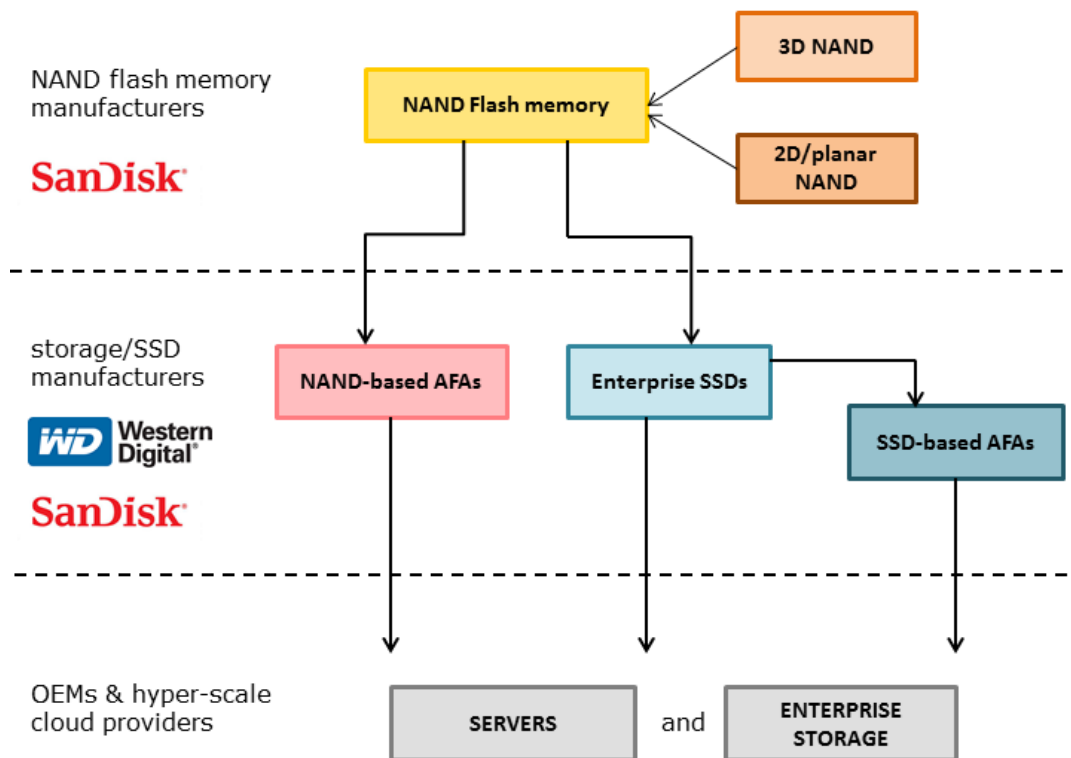
<sup>8</sup> Serial Attached SCSI, where SCSI stands for Small Computer System Interface.

<sup>9</sup> Peripheral Component Interconnect Express.

<sup>10</sup> Universal Serial Bus.

- (18) There are several types of customers for enterprise SSDs. First, Original Equipment Manufacturers (or “OEMs”, such as Dell, IBM and EMC) use enterprise SSDs to build enterprise storage solutions. OEMs typically use high-performance, high-reliability enterprise SSDs for active use in servers, as well as high-capacity, lower-cost SSDs for generic storage use. Second, “Hyper-scale” cloud service providers (such as Facebook, Google and Amazon Web Services) buy lower-cost enterprise SSDs to incorporate them into server farms and datacentres. Third, several emerging OEMs, value added resellers and system integrators make and sell AFA solutions which may be built using SSDs. Finally, distributors on-sell a range of solid state storage and other electronic products to smaller or specialized enterprises.

Figure 3: the NAND flash memory-based storage value chain



### 3.2. Relevant product markets

- (19) In the following sections, the Commission discusses the product markets for storage solutions.
- (20) First, the Commission distinguishes between storage solutions for enterprise use and for client use (section 3.2.1), and between HDDs and SSDs (section 3.2.2). The Parties' activities neither overlap in the production of HDDs (where only Western Digital is active), nor in the production of SSDs for client use (where only SanDisk is active). The Parties activities mainly overlap in relation to SSDs used in

enterprise applications. Therefore, sections 3.2.3 to 3.2.5 will discuss enterprise solid state storage<sup>11</sup> and possible segmentations of this market.

- (21) Finally, section 3.2.6 will discuss the possible product market for NAND flash memory. There is a vertical link between the upstream market for NAND flash memory, where SanDisk is active, and the possible downstream markets for solid state storage where both SanDisk and Western Digital are active.

### 3.2.1. *Storage – segmentation based on intended use (enterprise vs. client storage)*

#### 3.2.1.1. Previous Commission decisions

- (22) In its previous decisions, the Commission has found that HDDs for use in enterprise applications are not substitutable with HDDs for client applications because of differences in technical features required by the different end-use applications.<sup>12</sup> There is no Commission precedent to date dealing with this possible segmentation in relation to solid state storage solutions.

#### 3.2.1.2. Notifying Party's view

- (23) The Notifying Party submits that storage is generally categorized as either: (i) enterprise storage (storage for servers and storage solutions in high workload environments, such as corporate datacentres); (ii) client storage (storage for lower workload environments that are usually for use by individual consumers, such as personal computers and portable electronic devices); or (iii) embedded flash storage (fixed storage for mobile phones, car electronics, industrial equipment, etc.), and that enterprise storage and client storage belong to two separate product markets.

#### 3.2.1.3. The Commission's assessment

- (24) The majority of respondents to the market investigation agree that data storage solutions can be distinguished between enterprise storage, client storage and embedded storage. While some respondents noted that customers may use client-grade SSDs for enterprise storage in applications that do not require a high workload, the overall results of the market investigation support a distinction between enterprise and client storage as enterprise storage in general requires higher performance and superior endurance than client storage.<sup>13</sup>
- (25) Consistent with its past decisional practice, and in light of the results of the market investigation, the Commission considers that enterprise storage and client storage belong to two separate product markets.

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<sup>11</sup> Solid state storage are storage solutions that are based on flash memory, including SSDs and NAND-based AFAs.

<sup>12</sup> Commission decision of 19 October 2011 in Case M.6214 – *Seagate Technology/The HDD Business of Samsung Electronics*, recitals 260-262; and Commission decision of 23 November 2011 in Case M.6203 – *Western Digital Ireland/Viviti Technologies*, recitals 366-368.

<sup>13</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 9, and questionnaire to competitors Q2 of 4 January 2016, question 7.

### 3.2.2. Storage – segmentation based on technology (HDDs vs. SSDs)

#### 3.2.2.1. Previous Commission decisions

- (26) In its previous decisions<sup>14</sup>, the Commission found that SSDs and HDDs do not belong to the same relevant product markets, neither for client use nor for enterprise use, due to the significant price difference between the two technologies and the limited storage capacity of SSDs relative to HDDs.

#### 3.2.2.2. Notifying Party's view

- (27) The Notifying Party submits that the main types of enterprise storage solutions used today are HDDs and SSDs. The Notifying Party further submits that since the latest Commission decisions regarding HDDs, SSDs have rapidly expanded in both client and enterprise applications, at the expense of HDDs, thus increasing the competitive interaction between these two types of storage. On the demand side, SSDs have been exerting a competitive constraint on HDDs, and customers have been substituting to SSDs in applications where HDDs were previously used. According to the Notifying Party, the competitive interaction between HDDs and SSDs appears to be asymmetric, in the sense that substitution seems to go primarily in the direction of SSDs replacing HDDs. On the supply side, substitution would appear to be more limited, as the production processes for HDDs and SSDs differ.

#### 3.2.2.3. The Commission's assessment

- (28) The results of the market investigation are in line with the Notifying Party's view. According to the majority of respondents to the market investigation, HDDs and SSDs are the main types of enterprise storage used today and the use of other storage media, such as tape, is very limited.<sup>15</sup>
- (29) Internal documents of the Parties indicate that enterprise SSDs [...] enterprise HDDs, [...].<sup>16</sup> The results of the market investigation also indicate that SSDs and HDDs may be substitutes for some enterprise applications. For example, some respondents point out that low-performance SSDs may be interchangeable with high-performance HDDs.<sup>17</sup>
- (30) Overall, however, the results of the market investigation show that there are still significant differences between enterprise HDDs and enterprise SSDs.
- (31) A majority of the respondents to the market investigation consider that enterprise SSDs and enterprise HDDs are not comparable in terms of product characteristics,

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<sup>14</sup> Commission decision of 19 October 2011 in Case M.6214 – *Seagate Technology/The HDD Business of Samsung Electronics*, recitals 256-259; and Commission decision of 23 November 2011 in Case M.6203 – *Western Digital Ireland/Viviti Technologies*, recitals 362-365.

<sup>15</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 10, and questionnaire to competitors Q2 of 4 January 2016, question 8.

<sup>16</sup> Form CO, Annex 4.7, [Reference to Parties' internal business document]

<sup>17</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 26.



such as performance, efficiency, latency and capacity.<sup>18</sup> The respondents state that SSDs in general have higher performance characteristics than HDDs, with lower latency (i.e. faster access to data), lower power consumption, and better tolerance against vibrations than HDDs, as they have no moving parts.

- (32) As regards the price difference between HDDs and SSDs, data submitted by the Notifying Party show that while the price per gigabyte of storage for enterprise SSDs has fallen considerably since the Commission's decisions regarding HDDs in 2011, the price per gigabyte of storage for enterprise SSDs is still significantly higher than the price per gigabyte of storage for enterprise HDDs.<sup>19</sup>
- (33) In the market investigation, the Commission asked customers of the Parties to what extent they would switch from using enterprise SSDs to using enterprise HDDs in case the price of enterprise SSDs increased by 5-10%, while prices of enterprise HDDs would remain constant. A clear majority of the responding customers say they would not change their purchasing pattern as a result of such a price increase.<sup>20</sup>
- (34) As for the client market, data submitted by the Notifying Party show that the price per gigabyte of storage has fallen also for client SSDs, but is still significantly higher than the price per gigabyte of storage for client HDDs.<sup>21</sup> [...] internal documents of the Parties indicate that the adoption of SSDs [...].<sup>22</sup>
- (35) In light of the results of the market investigation the Commission considers that, while there appears to be a long term trend whereby HDDs, to some extent and with respect to certain uses (such as client applications), are slowly being substituted by SSDs, at present, HDDs and SSDs are not sufficiently substitutable due to the differences in terms of technical characteristics and prices. Consistent with its past decisional practice, the Commission therefore concludes, for the purpose of the present decision, that enterprise HDDs and enterprise SSDs belong to separate product markets. The question whether client HDDs and client SSDs belong to the same product market or to separate product markets can be left open as this would not change the outcome of the competitive assessment in this case.

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<sup>18</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 27, and Replies to the Commission questionnaire to competitors Q2 of 4 January 2016, question 26.

<sup>19</sup> Form CO, page 46, Figure 13.

<sup>20</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 28.

<sup>21</sup> Form CO, page 46, Figure 13.

<sup>22</sup> Form CO, Annex 4.7, [Reference to Parties' internal business document]; Form CO, Annex 4.18, [Reference to Parties' internal business document]; The Notifying Party's response to the Commission's request for information of 16 December 2015 (RFI 3), Annex 2, page 4.

### 3.2.3. *Enterprise solid state storage*<sup>23</sup>

#### 3.2.3.1. Notifying Party's view

- (36) The Notifying Party claims that enterprise SSDs belong to a separate product market for enterprise solid state storage comprising at least SSDs and NAND-based AFAs. According to the Notifying Party, NAND-based AFA solutions constitute alternatives to AFAs that use SSDs, and competitive constraints on enterprise SSD providers arise not just from other enterprise SSDs, but also from NAND-based AFAs.

#### 3.2.3.2. The Commission's assessment

- (37) While some customers who responded to the market investigation indicated that they produce solid state storage solutions, such as all flash arrays, in house,<sup>24</sup> the replies to the market investigation did not provide clear evidence on the extent to which such alternatives constitute competitive constraints on enterprise SSD providers.
- (38) However, the Commission considers that, for the purpose of this decision, the question whether NAND-based AFAs belong to the same relevant product market as enterprise SSDs can be left open as this would not change the outcome of the competitive assessment in this case.

### 3.2.4. *Enterprise solid state storage – segmentation based on interface*

#### 3.2.4.1. Previous Commission decisions

- (39) In its previous decisions regarding HDDs, the Commission considered the different interfaces of HDDs to be relevant in the definition of the relevant product markets. In *Hitachi/IBM Harddisk Business* and *Seagate/Maxtor*, the Commission noted that the choice of the interface affects the data transfer speed and that different interfaces were used for different end-use applications. The precise market definition was left open.<sup>25</sup> In its more recent decisions regarding HDDs, the Commission took into account differences in interfaces used when it distinguished business critical HDDs from desktop HDDs, and mission critical enterprise HDDs from HDDs intended for other end-uses (including business critical enterprise HDDs).<sup>26</sup>

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<sup>23</sup> The following sections focus on storage solutions for enterprise use that are based on flash memory (solid state storage), which are the segments in which the Parties' activities overlap.

<sup>24</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 3.

<sup>25</sup> Commission decision of 2 August 2002 in case M.2821 – *Hitachi/IBM Harddisk Business*, paragraphs 9-11; Commission decision of 27 April 2006 in case M.4100 – *Seagate/Maxtor*, paragraphs 9-18.

<sup>26</sup> Commission decision of 19 October 2011 in Case M.6214 – *Seagate Technology/The HDD Business of Samsung Electronics*, recitals 33, 105, 174 and 223-225 and ; and Commission decision of 23 November 2011 in Case M.6203 – *Western Digital Ireland/Viviti Technologies*, recitals 151, 258 and 327-328

#### 3.2.4.2. Notifying Party's view

- (40) The Notifying Party submits that the three most common interfaces used for enterprise SSDs are SATA, SAS and PCIe. The type of interface influences certain characteristics of the enterprise SSDs such as performance and reliability. According to the Notifying Party, these three interfaces have the following features.
- (41) SATA is a relatively inexpensive interface but typically has higher latency (slower data access speed) and lower reliability (relatively higher probability of failure) than SAS and PCIe.
- (42) SAS was introduced on the market after SATA and is characterised by fast data access and transfer speed (low latency) and high reliability. SAS power consumption, however, is higher than the one of the SATA interface and its production costs are similar to those of comparable PCIe enterprise SSDs.
- (43) PCIe has, in general, low latency and high performance, and owing to its scalability in terms of number of lanes, PCIe can be used both for lower-cost mainstream performance purposes and for higher-cost, higher-performance purposes. The Notifying Party claims that, over time, PCIe enterprise SSDs are likely to outperform and replace SATA and at least a portion of SAS enterprise SSDs.
- (44) The Notifying Party submits that segmentation by interface of SSDs is not appropriate because of (i) the high level of substitutability of the three main interfaces for the same end use; (ii) the flexibility of the enterprise SSD customers in choosing between the different interfaces; and (iii) the existence of interoperability solutions such as SATA to SAS interposers<sup>27</sup> or the U.2 universal backplane connector allowing the integration of all three interface types into one system. The Notifying Party further submits that supply-side considerations also show that a possible segmentation by interface is not relevant as manufacturers of enterprise SSDs can produce SATA, SAS and PCIe enterprise SSDs using the same equipment and assembly lines,<sup>28</sup> and switching production between SATA, SAS or PCIe SSDs does not require significant effort or expense.
- (45) The Notifying Party finally submits that if the Commission were to determine that a segmentation of enterprise SSDs by interface would be appropriate, NAND-based AFAs should be considered to belong to the same market as SAS enterprise SSDs, thus forming a broader SAS enterprise solid state storage segment, because NAND-based AFAs are geared towards the same performance specifications as SAS enterprise SSD-based arrays.

#### 3.2.4.3. The Commission's assessment

- (46) The results of the market investigation and Commission's assessment indicate that a further segmentation of enterprise SSDs by interface could be appropriate.

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<sup>27</sup> An interposer (also called a dongle) is a piece of equipment, either a card or a bridge chip which enables SATA SSDs to be used in SAS systems.

<sup>28</sup> The Notifying Party claims that interface components and controllers (different interfaces require different controllers) are accessible from third parties or can be designed and manufactured in-house.

- (47) First, according to the majority of the respondents to the market investigation, enterprise SSDs with SATA, SAS and PCIe interfaces have different endurance, reliability, latency and price.<sup>29</sup> A clear majority of the respondents to the market investigation say that each of these three interfaces for enterprise SSDs is not interchangeable with another interface.<sup>30</sup> Several respondents point out that it is not always the interface itself, or the interface alone, that determines the characteristics and price of the enterprise SSDs. Respondents also point out that there can be differences also among SSDs with the same interface. However, the results of the market investigation indicate that, overall, there are differences in characteristics between SSDs with different interfaces, and in particular that SAS enterprise SSDs have lower latency and are more expensive.
- (48) Second, according to the majority of the respondents to the market investigation, enterprise SSDs with SATA, SAS and PCIe interfaces are used for different end-uses and applications.<sup>31</sup> In general, the SATA interface appears to be used more in server applications, while the SAS interface is preferred in storage applications.<sup>32</sup>
- (49) Third, a majority of the customers responding to the market investigation consider that switching from enterprise SSDs with one type of interface to enterprise SSDs with another type of interface involves cost and takes time. They explain that switching involves changes in the production process of the devices using SSDs and investments in new equipment, e.g. for testing of SSDs.<sup>33</sup> Switching interface also requires time for certification and validation.<sup>34</sup> A majority of responding customers say that they have not switched between different interfaces of enterprise SSDs for the same application and end-uses.<sup>35</sup> The majority of responding customers estimate that it would take more than one year to switch from one particular interface of enterprise SSDs to another interface.<sup>36</sup>
- (50) As regards the question whether the existence of adaptors makes a distinction between different interfaces unjustified, the results of the market investigation were mixed. While a majority of the respondents acknowledge that the U.2 universal backplane connector can be used to allow different interfaces to be incorporated interchangeably, the majority also acknowledge that the use of adaptors would affect the performance of the enterprise SSDs concerned.<sup>37</sup>

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<sup>29</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 11; and Replies to the Commission questionnaire to competitors Q2 of 4 January 2016, question 9.

<sup>30</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, questions 17(a)-(c); and Replies to the Commission questionnaire to competitors Q2 of 4 January 2016, question 15.

<sup>31</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 11.5; and Replies to the Commission questionnaire to competitors Q2 of 4 January 2016, question 9.5.

<sup>32</sup> See also Form CO, Annex 4.18, [Reference to Parties' internal business document].

<sup>33</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, questions 14 and 16.

<sup>34</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 16.3.

<sup>35</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 13.

<sup>36</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 15.

<sup>37</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, questions 23-25; and Replies to the Commission questionnaire to competitors Q2 of 4 January 2016, questions 22-24.

- (51) As regards supply-side substitutability, respondents to the market investigation indicate that switching from producing one particular interface of enterprise SSDs to another interface requires time (more than six months) and – in case a supplier does not already produce enterprise SSDs with a certain interface – also involves certification of the new product with customers.<sup>38</sup> Thus, the effects of supply-side substitution appear to be insufficient to be taken into account for the purpose of market definition.<sup>39</sup>
- (52) The Commission also investigated a possible further segmentation of PCIe enterprise SSDs based on protocol. The protocols used to manage the PCIe interface were originally proprietary (both SanDisk/Fusion-io<sup>40</sup> and LSI/Seagate<sup>41</sup> developed such a protocol), but in 2011 a standardized protocol called Non-Volatile Memory Express ("NVMe") was developed under the leadership of Intel.
- (53) As regards a further segmentation of PCIe enterprise SSDs based on protocol, i.e. a distinction between PCIe using a proprietary protocol and PCIe using the standardised NVMe protocol, the results of the market investigation did not provide strong evidence that such a distinction should be made. A majority of the customers responding to the market investigation say that, depending on the application, it is possible to substitute PCIe enterprise SSDs using proprietary protocols with PCIe enterprise SSDs using the standardized NVMe.<sup>42</sup> While such substitution may involve costs and additional work, switching between different PCIe products appears to be easier than switching between different interfaces.
- (54) In light of the above, the Commission considers that a segmentation of enterprise SSDs according to the interfaces SATA, SAS and PCIe could be justified. However, the Commission considers that, for the purpose of this decision, the question whether distinct markets for enterprise SSDs with each of these interfaces exist can be left open as this would not change the outcome of the competitive assessment in this case.
- (55) With respect to the possible further segmentation of the possible market of enterprise solid state storage (comprising enterprise SSDs and NAND-based AFAs) based on interface, the Commission notes that SAS is the type of interface used predominantly for SSD-based AFAs, while NAND-based AFAs do not use any of the primary SSD interfaces (i.e. SAS, SATA or PCIe) as an external interface to communicate with other storage systems, servers and networks. Thus, only a possible market for SAS enterprise solid state storage could be plausibly delineated.<sup>43</sup> However, the question whether NAND-based AFAs should be

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<sup>38</sup> Replies to the Commission questionnaire to competitors Q2 of 4 January 2016, questions 11-12.

<sup>39</sup> See Commission notice on the definition of relevant market for the purpose of Community competition law (97/C 372/03), paragraph 20.

<sup>40</sup> Fusion-io has been acquired by SanDisk in 2014.

<sup>41</sup> Seagate acquired LSI's flash storage business from Avago Technologies in 2014.

<sup>42</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 17(d).

<sup>43</sup> Around 70% (by revenue and by capacity measured in terabytes) of SSD-based AFAs use SAS as an internal interface. The SATA interface is used internally in SSD-based AFAs to a much lesser extent (approximately 30%) while PCIe is only marginally used for SSD-based AFAs. NAND-based AFAs on the other hand use a different set of external interfaces such as Fibre Channel, Infiniband and

considered to belong to the same possible market as SAS enterprise SSDs, forming a possible market for SAS enterprise solid state storage, can be left open as this would not change the outcome of the competitive assessment in this case.

### 3.2.5. *Enterprise solid state storage – other possible segmentations*

#### 3.2.5.1. Previous Commission decisions

(56) In its previous decisions regarding HDDs, the Commission considered that HDDs could be distinguished by form factor, i.e. the physical size in the disks.<sup>44</sup> The Commission also took into account differences in reliability and performance when it distinguished between HDDs for consumer electronics, desktops and enterprise use.<sup>45</sup>

#### 3.2.5.2. Notifying Party's view

(57) The Notifying Party submits that segmentation by form factor is not plausible for enterprise SSDs as the form factor plays no role for enterprise SSDs. The Notifying Party does not take a position on a possible segmentation by performance.

#### 3.2.5.3. The Commission's assessment

(58) The results of the market investigation did not provide strong indications that enterprise SSDs should be distinguished on the basis of form factor. Half of the respondents consider that such a distinction should be made and the other half considers that such a distinction should not be made.<sup>46</sup> One respondent points out that currently the majority of enterprise SSDs has the 2.5-inch form factor, and another respondent says that in many cases, the differences in form factors reflect the different interfaces, with SAS products having the 2.5-inch and 3.5-inch form factors, and SATA and PCIe products having additional form factors such as M.2 form factors.<sup>47</sup>

(59) The Commission also investigated whether enterprise SSDs could be distinguished in two different markets for high-performance, high-reliability enterprise SSDs, on the one hand, and high-capacity, lower performance SSDs on the other hand. While the majority of respondents agree that enterprise SSDs vary in performance and reliability, several respondents point out that the variety of enterprise SSDs is more

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Ethernet. Both NAND-based and SSD-based AFAs often offer more than one of these interfaces in a single system.

<sup>44</sup> Commission decision of 19 October 2011 in Case M.6214 – *Seagate Technology/The HDD Business of Samsung Electronics*, recital 141; and Commission decision of 23 November 2011 in Case M.6203 – *Western Digital Ireland/Viviti Technologies*, recital 200.

<sup>45</sup> Commission decision of 19 October 2011 in Case M.6214 – *Seagate Technology/The HDD Business of Samsung Electronics*, recitals 98-99 and 102-103; and Commission decision of 23 November 2011 in Case M.6203 – *Western Digital Ireland/Viviti Technologies*, recitals 143-144 and 148-149.

<sup>46</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 22; and Replies to the Commission questionnaire to competitors Q2 of 4 January 2016, question 21.

<sup>47</sup> The M.2 specification for SSDs features a connector that supports both SATA and PCIe interfaces, and allows for a variety of physical sizes.

complex and that enterprise SSDs cannot be categorized simply as either high performance/high reliability or high capacity/low performance.<sup>48</sup>

- (60) The Commission notes that the distinction between client and enterprise storage solutions discussed in Section 3.2.1, and the segmentation based on interface discussed in Section 3.2.3, also reflect differences in form factor and performance characteristics of enterprise SSDs. The Commission therefore considers that, for the purpose of the present case, it is not necessary to segment the market for enterprise storage also based on these latter parameters.

### 3.2.6. *NAND flash memory*

#### 3.2.6.1. Previous Commission decisions

- (61) The Commission has considered previously<sup>49</sup> whether a separate market for flash memory exists, with alternative market definition according to NOR or NAND type of memory, and/or by intensity/density factors of the flash memory end applications. The Commission ultimately left the market definition open.

#### 3.2.6.2. Notifying Party's view

- (62) The Notifying Party claims that, if there were to be a separate market for flash memory, the appropriate market would be the one for NAND flash memory with both 2D and 3D NAND<sup>50</sup> competing on the same market.

#### 3.2.6.3. The Commission's assessment

- (63) The majority of respondents to the market investigation consider that NAND flash memory should be distinguished from other flash memory.<sup>51</sup> Respondents state that NAND and NOR flash memory have different characteristics and are used in different applications.
- (64) In light of the differences between NAND and NOR flash memory, and given that NAND is the type of flash memory used in SSDs, the Commission considers, for the purpose of assessing the Transaction, NAND flash memory to be the relevant product market.

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<sup>48</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 18; and Replies to the Commission questionnaire to competitors Q2 of 4 January 2016, question 16.

<sup>49</sup> Commission decision of 10 August 2007 in Case M.4751 – *STM/Intel/JV*, paragraphs 16 and 20; and Commission decision of 30 March 2010 in Case M.5804 – *Samsung Electronics/Samsung Digital Imaging*, paragraphs 20-23.

<sup>50</sup> The difference between 2D (or planar) NAND and 3D NAND is the way the memory cells are laid out: the memory cells in 2D NAND are laid out on a two-dimensional plane while 3D NAND is composed of memory cells laid out in three-dimensional stacks or dies (which allows a significantly higher density of memory cells thus improving performance and reliability).

<sup>51</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 29; and Replies to the Commission questionnaire to competitors Q2 of 4 January 2016, question 28.

- (65) As regards a possible distinction between 2D NAND and 3D NAND, the majority of respondents to the market investigation consider that such a distinction should be made. Respondents point to differences in technology, price and capacity.<sup>52</sup>
- (66) The Commission considers that, for the purpose of this decision, the question whether a 2D and 3D NAND belong to separate product markets can be left open as this would not change the outcome of the competitive assessment in this case.

### **3.3. Relevant geographic markets**

#### *3.3.1. Previous Commission decisions*

- (67) In its previous decisions, the Commission has found that the relevant geographic market for HDDs (excluding external HDDs) was worldwide in scope.<sup>53</sup>
- (68) As regards flash memory, the Commission concluded that the relevant geographic market can be considered to be at least EEA-wide or wider but ultimately left the precise delineation open.<sup>54</sup>

#### *3.3.2. Notifying Party's view*

- (69) As regards geographic market definitions, the Notifying Party submits that the different product markets for storage, including (enterprise) HDDs and SSDs, and the product market for NAND flash memory, are all worldwide in scope, because (i) transport costs do not play a significant role; (ii) there are no significant barriers to trade; and (iii) prices do not typically differ by region.

#### *3.3.3. The Commission's assessment*

- (70) The majority of respondents to the market investigation consider that the product markets for storage solutions, including SSDs and HDDs, are all worldwide in scope. Customers said that transport costs and barriers to trade are low, and that the products are sold on a worldwide basis with no or small variations in prices.<sup>55</sup>
- (71) As for NAND flash memory, the results of the market investigation provided no indications that the geographic market is narrower than worldwide in scope.
- (72) The Commission therefore considers that the relevant geographic market for all the relevant product markets is worldwide in scope.

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<sup>52</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 30, and questionnaire to competitors Q2 of 4 January 2016, question 29.

<sup>53</sup> Commission decision of 19 October 2011 in Case M.6214 – *Seagate Technology/The HDD Business of Samsung Electronics*, recital 281; and Commission decision of 23 November 2011 in Case M.6203 – *Western Digital Ireland/Viviti Technologies*, recital 389.

<sup>54</sup> Commission decision of 10 August 2007 in Case M.4751 – *STM/Intel/JV*, paragraph 22; and Commission decision of 30 March 2010 in Case M.5804 – *Samsung Electronics/Samsung Digital Imaging*, paragraph 26.

<sup>55</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 31, and questionnaire to competitors Q2 of 4 January 2016, question 30.



### **3.4. Conclusion on relevant markets**

- (73) In light of the elements referred to in sections (15) and 3.3, the Commission finds that for the purpose of this decision the relevant markets can be defined as follows.
- (74) Enterprise storage solutions belong to a market separate from that of client storage solutions.
- (75) Enterprise SSDs belong to a market separate from that of enterprise HDDs.
- (76) The question whether client HDDs and client SSDs belong to the same product market for client storage or to separate product markets can be left open as this would not change the outcome of the competitive assessment in this case.
- (77) The question whether NAND-based AFAs are part of the same relevant market as enterprise SSDs, forming a broader market for enterprise solid state storage, can also be left open as this does not alter the competitive assessment in this case.
- (78) Within the possible market for enterprise SSDs, there are indications that a further distinction can be made according to the interface of the SSD. However, the question whether enterprise SSDs with SATA, SAS and PCIe interfaces constitute separate product markets can be left open, as the Transaction raises no competition concerns under either market definition.
- (79) The question whether NAND-based AFAs should be considered to belong to the same possible market as SAS enterprise SSDs, forming a possible market for SAS enterprise solid state storage, can also be left open as this would not change the outcome of the competitive assessment in this case.
- (80) NAND flash memory belongs to a relevant market separate from that of NOR flash memory. The question whether a distinction should be made between 2D and 3D NAND flash memory can be left open as this would not change the outcome of the competitive assessment in this case.
- (81) The relevant geographic market for all the relevant product markets is worldwide in scope.

## **4. COMPETITIVE ASSESSMENT**

- (82) As explained in further detail in section 1, Western Digital and SanDisk supply a variety of enterprise and client storage solutions. Western Digital supplies both SSDs and HDDs whereas SanDisk only supplies SSDs. In addition, SanDisk supplies NAND flash memory, one of the key inputs for solid state storage solutions (see paragraph (9)). The Parties' activities overlap in relation to a number of possible market delineations on the markets for enterprise solid state storage solutions as well as on the possible market for client storage encompassing both client HDDs and client SSDs. In addition, given SanDisk's vertical integration into NAND flash memory, and given Western Digital's presence on the downstream markets for enterprise solid state storage solutions there is a vertical relationship between the upstream market for NAND flash memory and the downstream markets for enterprise solid state storage solutions. Finally, the different markets for enterprise solid state storage are closely related markets. Also, the markets for HDDs, client SSDs and embedded flash storage on the one hand and the markets

for enterprise solid state storage on the other hand are closely related markets. There are thus also conglomerate relationships between the Parties' activities.

- (83) In the following, the Commission will assess the horizontal overlaps (section 4.1) and the vertical and conglomerate relationships between the activities of the parties (sections 4.2 and 4.3 respectively).

#### **4.1. Horizontal overlaps**

- (84) The Parties' activities overlap in relation to the following possible markets: (a) enterprise solid state storage; (b) enterprise SSDs; (c) SAS enterprise solid state storage; (d) SAS enterprise SSDs; (e) PCIe enterprise SSDs and (f) client storage (client HDDs and client SSDs).

- (85) The Parties also hold a number of patents relating to enterprise SSDs and NAND flash memory. [Statement of the Parties relating to Standard Essential Patents with respect to SAS and PCI based enterprise SSDs and NAND flash memory (including 3D NAND)]. Second, although SanDisk's patent portfolio is heavily focused on NAND flash memory and other non-volatile types of memory (out of the total SanDisk's [...] patents and [...] applications nearly [...] patents are worldwide patents relating to NAND), the increment brought by the Transaction is small (Western Digital has [...] worldwide NAND-related patents) and other major competitors such as Samsung, Micron and Toshiba have much larger patent portfolios.<sup>56</sup> The Transaction therefore will not alter the Parties' patent strength relative to other competitors.

- (86) Furthermore, the market investigation did not provide indications that the Transaction would result in any changes of the licensing policy of Western Digital and SanDisk as a result of the Transaction.<sup>57</sup>

- (87) In the light of the above, the Commission considers that the Transaction does not raise serious doubts with regards to its compatibility with the internal market with respect to patents aggregations.

##### *4.1.1. Enterprise solid state storage and enterprise SSDs*

###### *4.1.1.1. The Notifying Party's view*

- (88) The Notifying Party submits that the Transaction would not lead to any competition concerns on the markets for enterprise solid state storage and enterprise SSDs because, first, the merged entity would face intense competition from strong and well-resourced players such as Intel, Samsung, Micron and Toshiba.

- (89) Second, in the Notifying Party's view, the Parties are not close competitors as they focus on different types of solutions. Western Digital focuses on mixed-use and

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<sup>56</sup> According to information submitted by the Notifying Party, Micron has [...] patents and [...] applications (of which [...] patents are related to NAND flash memory), Samsung has a portfolio of [...] worldwide NAND flash memory patents and Toshiba's total portfolio encompasses 81 000 patents and [...] applications (of which [...] NAND flash memory patents).

<sup>57</sup> Replies to the Commission questionnaire to competitors Q2 of 4 January 2016, question 54.

write intensive enterprise SSD solutions that require sophisticated controllers which it develops in-house and combines with NAND memory components from third parties. SanDisk is particularly strong in read-intensive enterprise SSD solutions, using its in-house NAND flash memory components and a combination of in-house and merchant controllers. Even where they serve the same customers, the Parties address different requirements and needs.

- (90) Third, the Notifying Party submits that they will be constrained by competitors that are more advanced than the Parties in the development of new memory technologies such as 3D NAND. The on-going innovation results in a dynamic market with volatile positions of the active companies.
- (91) Fourth, irrespective of the exact scope of the relevant product market, NAND-based AFAs and other solid state storage solutions, which customers of the Parties, and notably Original Equipment Manufacturers ("OEMs") are able to produce in-house, would impose a competitive constraint on the merged entity.
- (92) Fifth, the affected markets are by and large bidding markets, which, according to the Parties, relativises the relevance of historical market shares.
- (93) Sixth, the merged entity would be constrained by the threat of entry and expansion as the affected markets are growing and characterised by a high degree of innovation. Indeed, a number of companies, including Samsung, SK Hynix, Lite-on and Kingston are named as recent successful market entrants.
- (94) Seventh, customers exercise a high degree of countervailing buyer power. The Parties' main storage solution customers are large OEMs or distributors with significant technical understanding and expertise such as [...], as well as hyperscale cloud service providers such as [...]. Post-transaction those companies will continue to have a number of suppliers to choose from during their respective tender processes and will continue to be able to switch supplier. They are in a position to sponsor entry or to start producing storage solutions such as NAND-based AFAs in-house. In addition, customers purchase a variety of products from the Parties. This would further constrain the merged entity from e.g. raising prices in relation to one product.
- (95) Finally, the Notifying Party submits that the vertical integration brought about by the Transaction, that is to say the fact that the merged entity would have access to NAND flash memory at competitive pricing, would allow the merged entity to lower prices and step up innovation.

#### 4.1.1.2. Competitive landscape and Commission's assessment

- (96) Table 1 below illustrates the market shares of the Parties and their competitors on the possible markets for enterprise solid state storage and enterprise SSDs.

**Table 1: Market shares on the markets for enterprise solid state storage and enterprise SSDs.**

		2014		2015 Q1-Q3	
		Revenue %	Volume %	Revenue %	Volume %
<b>Enterprise solid state storage (SSDs and AFAs)<sup>58</sup></b>	Western Digital	[10-20]%	n/a	[10-20]%	n/a
	SanDisk	[10-20]%	n/a	[10-20]%	n/a
	<b>Combined</b>	<b>[30-40]%</b>	<b>n/a</b>	<b>[20-30]%</b>	<b>n/a</b>
	<i>Intel</i>	[20-30]%	n/a	[20-30]%	n/a
	<i>Samsung</i>	[10-20]%	n/a	[20-30]%	n/a
	<i>Micron</i>	[5-10]%	n/a	[0-5]%	n/a
	<i>Toshiba</i>	[0-5]%	n/a	[0-5]%	n/a
	<i>LSI/Seagate</i>	[0-5]%	n/a	[0-5]%	n/a
<b>Enterprise SSDs</b>	Western Digital	[10-20]%	[5-10]%	[10-20]%	[5-10]%
	SanDisk	[20-30]%	[5-10]%	[10-20]%	[5-10]%
	<b>Combined</b>	<b>[30-40]%</b>	<b>[10-20]%</b>	<b>[30-40]%</b>	<b>[10-20]%</b>
	<i>Intel</i>	[30-40]%	[40-50]%	[20-30]%	[40-50]%
	<i>Samsung</i>	[10-20]%	[10-20]%	[20-30]%	[20-30]%
	<i>Micron</i>	[5-10]%	[10-20]%	[0-5]%	[5-10]%
	<i>Toshiba</i>	[0-5]%	[0-5]%	[5-10]%	[0-5]%

- (97) As regards the possible market for enterprise solid state storage, the Parties' combined market shares are moderate, amounting to [30-40]% in terms of revenues in 2014 and [20-30]% in terms of revenues for the first three quarters of 2015. The largest competitor in that market with a market presence similar to the merged entity's market share is Intel, with a revenue based market share of [20-30]% in 2014 and [20-30]% in the first three quarters of 2015. Other competitors include Samsung ([10-20] / [20-30]%), Micron ([5-10] / [0-5]%), Toshiba ([0-5] / [0-5]%) and LSI/Seagate ([0-5] / [0-5]%).
- (98) The Parties' combined market shares on the possible market for enterprise SSDs are slightly higher, amounting to [30-40]% in terms of revenues in 2014 and [30-40]% in terms of revenues for the first three quarters of 2015. Also in this possible market, Intel is the largest competitor, with a revenue based market share of [30-40]% in 2014 and [20-30]% in the first three quarters of 2015. Other competitors include Samsung ([10-20] / [20-30]%), Micron ([5-10] / [0-5]%) and Toshiba ([0-5] / [0-5]%).
- (99) First, based on the above, the Commission notes that the possible markets for enterprise solid state storage and for enterprise SSDs are characterised by the presence of a sufficient number of competitors that will remain active post-transaction ensuring effective competition.
- (100) Intel offers SSDs with the SATA and PCIe interfaces as well as other NAND flash memory solutions manufactured in cooperation with Micron. Intel's main source of NAND flash is through a joint venture with Micron.
- (101) Samsung is another established player in the markets for enterprise solid state storage and enterprise SSDs and has been steadily growing its share on these markets since its entry in late 2010: from [5-10]% market share by revenue in 2013 to [10-20]% in 2014 and [20-30]% in the first three quarters of 2015. Samsung offers enterprise SSDs with all three interfaces (SATA, SAS and PCIe) and is

<sup>58</sup> Market shares for enterprise solid state storage, available only by revenue, include equivalent SSD sales of NAND-based AFAs and exclude own-use SSDs.

vertically integrated into the production of NAND flash memory. In addition Samsung was the first supplier to introduce the next-generation NAND technology, 3D NAND, in 2013. Samsung has a significant head start in 3D NAND ahead of its competitors and thanks to its technological position is considered to be well placed to compete vigorously on the enterprise SSDs markets.

- (102) Toshiba also offers enterprise SSDs with all three interfaces and has managed to increase its market presence from [0-5]% by revenue in 2013 to [0-5]% by revenue in 2014. Toshiba is vertically integrated as well and is a major producer of NAND flash memory, which it originally invented.
- (103) Micron, active in the provision of SSDs with all available interfaces is another established, although smaller competitor. Micron also manufactures NAND flash memory, some of which is developed and produced in cooperation with Intel. In 2015, Micron and Seagate joined forces under a strategic cooperation agreement to work together on enterprise NAND flash based storage technologies, beginning with SAS enterprise SSDs.<sup>59</sup>
- (104) Seagate is also active in the enterprise solid state storage space where it offers enterprise SSDs with SAS and PCIe interfaces.
- (105) In addition to the above mentioned competitors, the Parties will face also competition from a number of NAND-based AFA producers: IBM, Violin Memory and Hitachi Data Systems ("HDS"), as well as from smaller enterprise solid state storage competitors such as SK Hynix (SATA enterprise SSDs), Kingston (SATA enterprise SSDs) and Lite-On (SATA and PCIe enterprise SSDs).
- (106) The majority of respondents also consider that post-merger there will be a sufficient number of suppliers of enterprise SSD solutions to maintain a competitive environment.<sup>60</sup>
- (107) Customers seem to have the ability to switch suppliers by shifting quantities ordered between their different qualified suppliers and by disqualifying an existing or qualifying a new supplier. While large customers tend to multi-source from two or more suppliers to ensure security of supply, it appears that customers believe that their purchasing strategies will continue to be effective post-transaction, given the sufficient number of remaining suppliers.
- (108) Second, based on the information provided by the Parties and based on the replies from market participants, the Commission also considers that the Parties are not close competitors.
- (109) Contrary to SanDisk, Western Digital does not produce SATA enterprise SSDs. The Parties therefore only compete in relation to (i) PCIe based SSDs where, as explained in further detail in paragraph (154), Western Digital is a very small player with a revenue based market share of [5-10]% in the first three quarters of

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<sup>59</sup> <http://www.seagate.com/de/de/about-seagate/news/new-sas-solid-state-drive-first-product-from-seagate-micron-alliance-master-pr/>

<sup>60</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 51 and Replies to the Commission questionnaire to competitors Q2 of 4 January 2016, question 47.

2015; and (ii) in the SAS enterprise space where each of Western Digital and SanDisk have important market positions.

- (110) Even in relation to the SAS enterprise space the Parties' customers only overlap to a limited extent. In the first two quarters of 2015, the [...] customers accounting for a considerable share of each of the Parties' revenues were [...]. As regards [...] the Parties submit that they sell predominantly to different business units. [...].<sup>61</sup> In relation to [...], internal documents of Western Digital show that SanDisk is not perceived to be a close competitor neither by Western Digital nor by [...].<sup>62</sup>
- (111) Beyond that, the market investigation did not provide any further indications as to the closeness of competition between the Parties on the possible broader markets for enterprise SSDs and enterprise solid state storage.
- (112) Third, based on the information provided by the Parties and based on the replies from market participants, the Commission further considers that the way in which customers source enterprise SSDs and enterprise solid state storage is likely to further constrain the Parties' behaviour on those markets post-transaction.
- (113) Most large customers of enterprise SSDs and enterprise solid state storage engage in some sort of qualification process for their suppliers before entering into any sales agreement for a certain type of enterprise SSD or solid state storage solution. The customers' replies to the market investigation suggest that the qualification processes in place is rather complex and sophisticated as customers take into account a number of parameters such as price, product quality and reliability, product roadmap as well as time to market.<sup>63</sup> While the duration of the qualification process varies widely across customers, it spans between 3 and 12 months in general.
- (114) The vast majority of customers confirm having at least two suppliers per product. Once a supplier of enterprise SSDs is qualified, customers can place purchase orders negotiating the exact price and quantities to be delivered for every purchase order separately. Thus, the shares of actual supply from each qualified supplier could vary greatly over time depending on the negotiated price and corresponding quantities.<sup>64</sup>
- (115) Customers also explain that they regularly engage in qualification processes as new products are released on the market and changes in the prices occur. However, the cost associated with the qualification process can significantly limit the number of suppliers included in the qualification process as well as the frequency of such qualification processes. Nevertheless, the majority of the customers that replied to the market investigation express the view that it is very important to have multiple suppliers because of price and stability of supply considerations; as explained by

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<sup>61</sup> [Document submitted by Western Digital to the FTC].

<sup>62</sup> [Document submitted by Western Digital to the FTC].

<sup>63</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 35 and Replies to the Commission questionnaire to competitors Q2 of 4 January 2016, question 34.

<sup>64</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 36.

one customer, multi-sourcing (sourcing from more than one supplier) is perceived as a "*common practice to mitigate supply risk and provide competitive tension*".<sup>65</sup>

- (116) Finally, as regards their bargaining power vis-à-vis suppliers of enterprise SSDs, the majority of customers consider that, at present, a balanced relationship exists between customers and suppliers of enterprise SSDs.<sup>66</sup> The large majority of customers also consider that the Transaction will not have an impact on their current bargaining position vis-à-vis their respective enterprise SSD suppliers.<sup>67</sup>

#### 4.1.1.3. Conclusion on Enterprise solid state storage and enterprise SSDs

- (117) In light of the above, and in particular in view of the moderate combined market share of the Parties as well as the important number of competitors of varying size that will remain active post-merger, the Commission considers that the Transaction does not give rise to serious doubts as to its compatibility with the internal market with respect to the possible markets for enterprise SSDs and enterprise solid state storage.

#### 4.1.2. SAS enterprise solid state storage and SAS enterprise SSDs

##### 4.1.2.1. The Notifying Party's view

- (118) The Notifying Party submits that the Transaction would not give rise to any competition concerns on the possible markets for SAS enterprise solid state storage and SAS enterprise SSDs for the following reasons.
- (119) First, the Parties will continue to face intense competition on these possible markets from strong and well-resourced competitors such as Samsung, Toshiba, Micron and Seagate who will discipline the commercial behaviour of the merged entity post-transaction. On the possible market for SAS enterprise storage solutions, in particular NAND-based AFA manufacturers like IBM, Violin Memory and HDS will also exert competitive pressure on the merged entity.
- (120) Second, the Notifying Party submits that the Parties are not close competitors given that Western Digital focuses on mixed-use and write intensive SAS enterprise SSDs where the Notifying Party considers Samsung and Toshiba to be its closest competitors while SanDisk is particularly strong in read-intensive SAS enterprise SSDs.
- (121) Third, following the increasing interoperability between interfaces and the flexibility of customers who constantly seek storage solutions that better address their needs, the Parties will be constraint by suppliers of SATA and PCIe storage solutions. In the context of the constantly evolving interfaces landscape the Notifying Party considers that PCIe in particular has an important growth potential and will be a valid constraint on SAS enterprise SSDs and SAS solid state storage solutions.

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<sup>65</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 42.

<sup>66</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 47.

<sup>67</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 48.

- (122) Fourth, the merged entity will also face competitive pressure from new and emerging memory technologies such as storage class memory<sup>68</sup> solutions, including 3D Xpoint<sup>69</sup> and NVDIMM.<sup>70</sup>
- (123) Fifth, similarly to the overall enterprise SSDs and enterprise solid state storage markets, their respective SAS segments are also bidding markets, where a relatively low number of large and powerful buyers such as EMC, HP, IBM, Oracle and Dell exercise considerable countervailing buyer power.
- (124) In addition, the Notifying Party submits that, due to the lack of material barriers to entry, the merged entity will be constrained post-transaction by the threat of entry of new competitors or expansion of existing competitors. An example in this regard is the recent entry of Samsung, as well as the expected expansion of Seagate and Micron into SAS enterprise SSDs as a result of their strategic alliance in SAS enterprise SSDs announced in February 2015. The Notifying Party also considers that Intel, currently not active on the merchant market for SAS enterprise SSDs would be able to enter this market easily [...] <sup>71</sup> [...].
- (125) Finally, the Notifying Party claims that the vertical integration brought by the Transaction, i.e. the access for the merged entity to in-house NAND flash would allow the merged entity to lower prices and step up innovation.

#### 4.1.2.2. Competitive landscape and Commission's assessment

- (126) Table 2 below illustrates the market shares of the Parties and their competitors on the possible markets for SAS enterprise solid state storage and SAS enterprise SSDs.

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<sup>68</sup> Storage class memory (“SCM”) is a collective term for a number of emerging memory technologies that blur the current distinction between memory (e.g., DRAM) and storage (e.g., HDDs and SSDs). SCM describes a form of memory that has similar capacity and economics to that of non-volatile flash (NVDIMM – see footnote 70 below – provides similar read/write performance to DRAM (which is higher than current SSD performance, particularly in relation to write operations), while being non-volatile (i.e., retaining stored data after the power is cycled, similar to an SSD).) but with performance that is similar to volatile memory (RAM). SCM is expected to initially have a cost premium over NAND flash and a cost advantage over DRAM.

<sup>69</sup> 3D Xpoint, in joint development by Intel and Micron, is a type of non-volatile memory that aims at combining the performance and cost advantages of available memory technologies with speed and endurance greater than that of current NAND; see [http://newsroom.intel.com/community/intel\\_newsroom/blog/2015/07/28/intel-and-micron-producebreakthrough-memory-technology](http://newsroom.intel.com/community/intel_newsroom/blog/2015/07/28/intel-and-micron-producebreakthrough-memory-technology); and <http://www.micron.com/about/innovations/3d-xpoint-technology>.

<sup>70</sup> Non-volatile DIMM (“NVDIMM”) is an emerging technology that could reduce the need for high-performance NAND-based enterprise SSDs in servers in certain applications. NVDIMM provides similar read/write performance to DRAM (which is higher than current SSD performance, particularly in relation to write operations), while being non-volatile.

<sup>71</sup> Intel has a Joint Development Agreement and Sales Agreement with Western Digital for SAS enterprise SSDs. Under these agreements Intel [...]. In turn, Western Digital [...].



**Table 2: Market shares on the markets for SAS enterprise solid state storage and SAS enterprise SSDs.**

		2014		Q1-Q3 2015	
		Revenue %	Volume % <sup>72</sup>	Revenue %	Volume %
<b>SAS Enterprise solid state storage (including own-use sales and NAND based AFAs)</b>	Western Digital	[30-40]%	[30-40]%	[30-40]%	[30-40]%
	SanDisk	[20-30]%	[10-20]%	[10-20]%	[10-20]%
	<b>Combined</b>	<b>[50-60]%</b>	<b>[50-60]%</b>	<b>[40-50]%</b>	<b>[40-50]%</b>
	<i>Intel</i>	<i>not active</i>	<i>not active</i>	<i>not active</i>	<i>not active</i>
	<i>Samsung</i>	[5-10]%	[10-20]%	[10-20]%	[10-20]%
	<i>Micron</i>	[0-5]%	[0-5]%	[0-5]%	[0-5]%
	<i>Toshiba</i>	[5-10]%	[10-20]%	[10-20]%	[10-20]%
	<i>LSI/Seagate</i>	[0-5]%	[0-5]%	[0-5]%	[0-5]%
<b>SAS Enterprise SSDs</b>	Western Digital	[40-50]%	[40-50]%	[50-60]%	[50-60]%
	SanDisk	[30-40]%	[20-30]%	[10-20]%	[10-20]%
	<b>Combined</b>	<b>[70-80]%</b>	<b>[60-70]%</b>	<b>[60-70]%</b>	<b>[60-70]%</b>
	<i>Intel</i>	<i>not active</i>	<i>not active</i>	<i>not active</i>	<i>not active</i>
	<i>Samsung</i>	[10-20]%	[10-20]%	[10-20]%	[10-20]%
	<i>Micron</i>	[0-5]%	[0-5]%	[0-5]%	[0-5]%
	<i>Toshiba</i>	[10-20]%	[10-20]%	[10-20]%	[10-20]%
	<i>LSI/Seagate</i>	[0-5]%	[0-5]%	[0-5]%	[0-5]%

- (127) As regards the possible market for SAS enterprise solid state storage, the Parties' combined market shares in 2014 are high, amounting to [50-60]% in terms of revenues and [50-60]% in terms of volume. However, the shares of the Parties have been steadily decreasing both by revenue and by volume: from [50-60]% by revenue in 2013 to [50-60]% in 2014 and [40-50]% in the period Q1-Q3 2015, and from [70-80]% by volume in 2013 to [50-60]% in 2014 and [40-50]% in Q1-Q3 2015. The largest competitor in that market is Samsung, with a revenue based market share of [5-10]% by revenue and [10-20]% by volume in 2014 and [10-20]% and [10-20]% respectively in the period Q1-Q3 2015. Other competitors include Toshiba ([5-10]% / [10-20]% in 2014 and [10-20]% / [10-20]% in the period Q1-Q3 2015), LSI/Seagate ([0-5]% / [0-5]% in 2014 and [0-5]% / [0-5]% in the period Q1-Q3 2015) and Micron ([0-5]% / [0-5]% in 2014 and approximately [0-5]% / [0-5]% in the period Q1-Q3 2015).
- (128) The Parties' combined market shares on the possible market for SAS enterprise SSDs are even higher, amounting to [70-80]% in terms of revenues in 2014 and [60-70]% in terms of revenues for the first three quarters of 2015. Similarly to the trend observed for SAS enterprise solid state storage, the combined market shares of the Parties in the SAS enterprise SSDs segment also seems to be decreasing.
- (129) Also in this possible market, Samsung is the largest competitor, with a revenue based market share of [10-20]% in 2014 and [10-20]% in the first three quarters of 2015. Other competitors include Toshiba ([10-20]% / [10-20]%), LSI/Seagate ([0-5]% / [0-5]%) and Micron ([0-5]% / [0-5]%).
- (130) Since its entry in the production of SSDs in 2012, Samsung's market share in both SAS enterprise SSDs and SAS enterprise solid state storage has grown considerably, increasing its market presence from [0-5]% to [10-20]% by revenue in the period 2013 to Q1-Q3 2015 for SAS enterprise solid state storage and from

<sup>72</sup> The market shares by volume for SAS Enterprise Solid State Storage market include own-use sales but exclude NAND-based AFAs.

[0-5]% to [10-20]% over the same period for SAS enterprise SSDs. This is partly due to the fact that Samsung is vertically integrated into the production of NAND flash memory but also to the fact that, at present, it is significantly ahead of its competitors in launching SAS-based solid state storage solutions that rely on next-generation NAND flash memory, including 3D NAND flash memory.

- (131) Toshiba, an established SAS enterprise solid state player with a wide range of enterprise SSDs covering high, mid and low endurance as well as read-intensive solutions, has also recently significantly grown its market presence: from [0-5]% in 2013 to [10-20]% in Q1-Q3 2015 by revenue and from [0-5]% in 2013 to [10-20]% in Q1-Q3 2015 by volume. Toshiba is vertically integrated in the production of NAND flash memory which puts it in a strong position to continue competing in the SAS segment of both enterprise solid state storage and enterprise SSDs markets.
- (132) Other competitors include Micron and Seagate. Micron, with a modest but stable position with a market share by revenue of around [0-5]% to [0-5]% in 2013 and 2014, has recently entered into a strategic partnership with Seagate for development of enterprise solid state solutions with the SAS interface (see paragraph (103) above). Micron also produces in-house the NAND flash memory it uses for its SSDs.
- (133) Seagate, which is a fairly recent entrant on the SAS enterprise SSDs space (Seagate introduced its first SAS enterprise SSD solutions in mid-2014) has managed within this short period of time to gain a market share of [0-5]% by revenue and [0-5]% by volume for 2014. Seagate sources NAND flash memory from Micron under their strategic alliance.
- (134) Intel, which is an important competitor on the other enterprise SSDs and solid state storage markets, is currently not active on the segments for SAS based solid state storage solutions as it entered into a collaboration and [...] agreement with Western Digital. Under this agreement, Intel [...].
- (135) As already explained in more detail in paragraph (110) the Parties' customers of SAS enterprise SSDs overlap only to a limited extent as there are [...] customers accounting for a considerable share of each of the Parties' revenues in the first half of 2015: [...]. The market investigation did not provide any further indications as to the closeness of competition between the Parties.<sup>73</sup>
- (136) In light of the above, and in particular in light of the fact that each of the Parties serves different business units for these customers (see paragraph (110)) the Commission considers that the Parties are not close competitors.
- (137) Notwithstanding the high market shares of the merged entity and its strong position in the SAS enterprise SSDs space, a majority of respondents to the market investigation consider that there will be a sufficient number of viable alternative suppliers offering SAS enterprise SSDs post-transaction. A customer states that: *"there are many established alternates for these particular products. More than*

*enough to maintain a competitive environment.*"<sup>74</sup> The Commission notes that also those particular customers that currently source SAS enterprise SSDs from both SanDisk and Western Digital (that is to say [...]) consider that post-transaction a sufficient number of competitors will remain active in the SAS enterprise SSD space.<sup>75</sup>

- (138) The qualification of suppliers and procurement process already described in paragraphs (113), (114) and (115) above are fully applicable for the provision of SAS enterprise SSDs and solid state storage solutions. The same combination of different criteria including price, performance, products roadmap and product quality characteristics such as reliability and endurance are important for customers of SAS enterprise storage solutions.<sup>76</sup>
- (139) As regards the question whether customers have separate qualification processes according to the interface of the enterprise SSDs concerned, the results of the market investigation did not yield a clear picture as certain customers confirm having different qualification processes per interface while other customers state that they do not segregate their respective qualification processes according to interface.<sup>77</sup>
- (140) As already established for the provision of enterprise SSDs having several suppliers is very important for customers in order to guarantee that the multi-sourcing strategy is effective. In this relation the majority of the customers consider that their existing level of bargaining power is sufficient to ensure a balanced relationship between customers and suppliers of SAS enterprise SSDs.<sup>78</sup> The large majority of customers also consider that the Transaction will have no impact on their current bargaining position vis-à-vis their respective SAS enterprise SSD suppliers.<sup>79</sup>
- (141) Moreover almost all respondents in the market investigation share the view that the Transaction overall will have a neutral impact in relation to SAS enterprise SSDs. A couple of customers foresee a positive impact as the Transaction might allow the merged entity to enhance the performance of its product line in addition to improving its ability to source raw NAND flash.<sup>80</sup>
- (142) Finally, regarding potential entry the Commission notes that, as already mentioned in paragraph (134) above, although it is not currently active on the merchant market, Intel [...]. Intel sources most of the NAND flash memory for its enterprise

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<sup>74</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 51 and Replies to the Commission questionnaire to competitors Q2 of 4 January 2016, question 47.

<sup>75</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 51.

<sup>76</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 35 and Replies to the Commission questionnaire to competitors Q2 of 4 January 2016, question 34.

<sup>77</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 35.6 and Replies to the Commission questionnaire to competitors Q2 of 4 January 2016, question 34.4.

<sup>78</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 47.

<sup>79</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 48.

<sup>80</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 52 and Replies to the Commission questionnaire to competitors Q2 of 4 January 2016, question 57.

SSD solutions primarily from its joint venture with Micron. The threat of Intel's entry into SAS enterprise SSDs would constitute a competitive constraint on the merged entity.

- (143) With respect to the joint development and sales agreement between Intel and Western Digital the Commission also notes that [...].

#### 4.1.2.3. Conclusion on SAS enterprise solid state storage and SAS enterprise SSDs

- (144) Despite the high market shares, in light of the above and in particular of the indications provided by the results of the market investigation that markets for SAS enterprise SSDs and solid state storage solutions will remain competitive post-transaction and a sufficient number of alternative suppliers will remain active the Commission considers that the Transaction does not give rise to serious doubts as to its compatibility with the internal market with respect to the possible markets for SAS enterprise SSDs and enterprise solid state storage.

#### 4.1.3. *PCIe enterprise SSDs*

##### 4.1.3.1. The Notifying Party's view

- (145) The Notifying Party submits that the Transaction would not give rise to any competition concerns on the possible market for PCIe enterprise SSDs as the combined market share of the Parties, which is below 30% both by volume and by revenue for the period Q1-Q3 2015, is modest.
- (146) Second, the Notifying Party claims that the possible PCIe enterprise SSD market, where a relatively high number of competitors of varying size are active, is highly fragmented and intensely dynamic and competitive. The launch of the non-proprietary PCIe NVMe standard in 2011 has facilitated the entry of more players in the PCIe space and especially of competitors with an already established position in the enterprise solid state storage market such as Intel, Samsung, Micron and Toshiba.
- (147) Third, certain enterprise SSD customers have the ability to produce PCIe SSDs for their own use and do so. Google, NetApp and Huawei are the most telling examples of such customers.
- (148) Fourth, the Parties are not close competitors as SanDisk currently offers only PCIe solutions based on its proprietary protocol, while Western Digital's PCIe SSDs use the standard NVMe protocol. In addition, the Notifying Party notes that due to the pressure of the NVMe solutions, the market position of proprietary PCIe SSDs is steadily declining.
- (149) Fifth, the merged entity will be constrained by competitors that develop new or emerging technologies such as 3D Xpoint and NVDIMM.
- (150) Sixth, similarly to the SAS segments of the possible markets for enterprise SSDs and enterprise solid state storage, the PCIe segment of the possible enterprise SSD markets has the same characteristics of a bidding market where sophisticated and powerful customers have significant countervailing buyer power.
- (151) In addition, the Notifying Party claims that the merged entity will be constraint by the threat of entry or expansion as the NVMe protocol has allowed the entry of new

players and has made it possible for SATA and SAS enterprise SSD suppliers to expand to the PCIe space.

- (152) Finally, the Notifying Party submits that the vertical integration brought by the Transaction will allow the merged entity to lower prices and step up innovation, especially in view of the fact that [...].

#### 4.1.3.2. Competitive landscape and Commission's assessment

- (153) Table 3 below illustrates the market shares of the Parties and their competitors on the possible market for PCIe enterprise SSDs.

**Table 3: Market shares on the markets for PCIe enterprise SSDs.**

		2014		Q1-Q3 2015		
		Revenue %	Volume %	Revenue %	Volume %	
<b>PCIe SSDs</b>	<b>Enterprise</b>	Western Digital	[0-5]%	[0-5]%	[5-10]%	[0-5]%
		SanDisk	[30-40]%	[20-30]%	[20-30]%	[10-20]%
		<b>Combined</b>	<b>[40-50]%</b>	<b>[20-30]%</b>	<b>[20-30]%</b>	<b>[10-20]%</b>
		<i>Intel</i>	[5-10]%	[5-10]%	[20-30]%	[40-50]%
		<i>Samsung</i>	[0-5]%	[5-10]%	[0-5]%	[0-5]%
		<i>Micron</i>	[0-5]%	[0-5]%	<i>n/a</i>	<i>n/a</i>
		<i>Toshiba</i>	[0-5]%	[0-5]%	<i>n/a</i>	<i>n/a</i>
		<i>LSI/Seagate</i>	[20-30]%	[30-40]%	[10-20]%	[10-20]%
		<i>NetApp</i>	[10-20]%	[5-10]%	[5-10]%	[0-5]%
		<i>Others</i>	[10-20]%	[10-20]%	[10-20]%	[10-20]%

- (154) The Parties' combined market share on the possible market for PCIe enterprise SSDs is [40-50]% by revenue in 2014 and to [20-30]% in the period Q1-Q3 2015 with a relatively low increment of [0-5]% brought by the Transaction. The largest competitor in that market in 2014 was LSI/Seagate ([20-30]% by revenue and [30-40]% by volume) while in the first three quarters of 2015 it has had a share of [10-20]% by revenue and [10-20]% by volume leaving Intel, with a revenue based market share of [20-30]% the market leader for that period. Other competitors include NetApp ([10-20]% in 2014 and [5-10]% in Q1-Q3 2015 by revenue) and Samsung ([0-5]% and [0-5]% respectively). Enterprise solid state storage providers Toshiba and Micron are also active in the PCIe segment of enterprise SSDs.
- (155) As a forerunner in the development of the standard PCI protocol called NVMe<sup>81</sup>, Intel has been a significant player in the supply of PCIe enterprise SSDs and solid state storage solutions for several years. Intel's market share has grown considerably from [5-10]% in terms of revenue and [5-10]% in terms of volume in 2014 to [20-30]% and [40-50]% respectively in the period Q1-Q3 2015.
- (156) Seagate has only very recently entered the PCIe market through the acquisition of LSI, which was the second largest participant in the PCIe space at that time. LSI/Seagate's solid position has been to some extent undermined with the advancement of the standard NVMe protocol.

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<sup>81</sup> Non-Volatile Memory Express ("NVMe") is a standardized PCIe protocol that was developed by an industry consortium and released in 2011. Originally, the specifications for the protocol used to manage memory devices using the PCIe interface were proprietary to a small number of companies such as Fusion-io, which was acquired by SanDisk in 2014 and LSI has been bought by Seagate also in 2014.

- (157) Toshiba and Samsung are another example of recent entrants in the PCIe space: Toshiba in 2014 via the acquisition of OCZ offering NVMe type PCIe enterprise SSD solutions and Samsung in late 2013 also releasing NVMe SSDs. Both Toshiba and Samsung are vertically integrated in the production of NAND flash.
- (158) Other, smaller PCIe manufacturers include Micron, present on the market since 2011 but who has not yet released a NVMe PCIe solution as well as companies such as SK Hynix and Lite-On.
- (159) As illustrated in graph 1 below, the share of PCIe based enterprise SSD units is expected to grow in importance in the coming years along with SAS SSDs to the detriment of the SATA interface, both for server and storage applications.

[Graph provided by the Notifying Party illustrating expected evolution of Enterprise SSD shipments by interface.]

- (160) The results of the market investigation was inconclusive as regards the closeness of competition between Western Digital and SanDisk as respondents who replied to the relevant question seem to position SanDisk, Intel, Samsung and Seagate as similar/comparable suppliers of PCIe enterprise SSDs.<sup>82</sup>
- (161) Based on the information provided by the Parties and in particular in light of the fact that the PCIe-based SSDs of Western Digital use the standard NVMe PCIe protocol whereas SanDisk's enterprise SSDs are based on a proprietary PCIe protocol, the Commission considers that the Parties are not likely to be close competitors.
- (162) Similarly to SAS enterprise SSDs, the qualification of suppliers and procurement process for enterprise SSDs is equally valid also for the provision of PCIe enterprise SSDs and solid state storage solutions. Customers take into account a number of factors such as price, product performance and technical characteristics as well as time to market.<sup>83</sup>
- (163) The majority of the customers consider that they have sufficient bargaining power vis-à-vis the respective PCIe enterprise SSD suppliers to ensure a balanced commercial relationship and negotiate terms that are acceptable for both sides.<sup>84</sup> The large majority of customers share the view that the Transaction will not impact their current bargaining position with respect to PCIe enterprise SSDs.<sup>85</sup>

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<sup>82</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 46 and Replies to the Commission questionnaire to competitors Q2 of 4 January 2016, question 45.

<sup>83</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 35 and Replies to the Commission questionnaire to competitors Q2 of 4 January 2016, question 34.

<sup>84</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 47.

<sup>85</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 48.

- (164) The majority of market players also believe that a sufficient number of alternative suppliers of PCIe enterprise SSDs remain post-transaction, including Samsung, Micron and Toshiba.<sup>86</sup>
- (165) In addition, the majority of the respondents in the market investigation share the view that the Transaction overall will have a neutral impact in relation to PCIe enterprise SSDs, while a few customers consider that the Transaction can have a positive impact on the merged entity's ability to compete.<sup>87</sup>

#### 4.1.3.3. Conclusion on PCIe enterprise SSDs

- (166) In light of the above and in particular in view of the very low increment brought about the Transaction as well as the important number of competitors of varying size that will remain active post-merger and the dynamic character of the PCIe market segment the Commission considers that the Transaction does not give rise to serious doubts as to its compatibility with the internal market with respect to the possible markets for PCIe enterprise SSDs and enterprise solid state storage.

#### 4.1.4. Client storage

- (167) Table 4 below illustrates the market shares of the Parties and their competitors on the possible market for Client storage (client SSDs and client HDDs).

**Table 4: Market shares on the possible market for client storage**

		2014	
		Revenue %	Volume %
<b>client storage</b>	Western Digital	[30-40]%	[30-40]%
	SanDisk	[0-5]%	[0-5]%
	<b>Combined</b>	<b>[30-40]%</b>	<b>[40-50]%</b>
	<i>Intel</i>	<i>[0-5]%</i>	<i>[0-5]%</i>
	<i>Samsung</i>	<i>[10-20]%</i>	<i>[0-5]%</i>
	<i>Micron</i>	<i>[0-5]%</i>	<i>[0-5]%</i>
	<i>Toshiba</i>	<i>[10-20]%</i>	<i>[10-20]%</i>
	<i>LSI/Seagate</i>	<i>[30-40]%</i>	<i>[30-40]%</i>
	<i>Others</i>	<i>[0-5]%</i>	<i>[0-5]%</i>

- (168) On the possible market for client storage the Parties' combined market shares in 2014 are at [30-40]% by revenue and [40-50]% by volume with a very low increment of [0-5]% and [0-5]% respectively brought by the Transaction. The largest competitor by far in this market is LSI/Seagate with a revenue based market share of [30-40]% and a volume based market share of [30-40]% 2014. Other strong and important competitors include Toshiba ([10-20]% / [10-20]%), and Samsung ([10-20]% / [0-5]%).
- (169) The merged entity's behaviour on this possible market will be constrained by the presence of an important number of strong and well-resourced competitors: LSI/Seagate, Toshiba, Intel and Samsung, who produce a range of client storage solutions, either client HDDs, client SSDs or both.

<sup>86</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 51 and Replies to the Commission questionnaire to competitors Q2 of 4 January 2016, question 47.

<sup>87</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 52 and Replies to the Commission questionnaire to competitors Q2 of 4 January 2016, question 57.

- (170) The Parties also do not appear to be close competitors due to the very limited overlap in the Parties' product offerings: SanDisk does not produce any client HDDs while Western Digital is not active in the production of client SSDs.
- (171) Moreover, no customers or competitors raised any issue regarding the impact of the Transaction on the possible client storage market; as regards SSDs in particular, the majority of respondents to the market investigation consider that the Transaction will have a neutral impact.<sup>88</sup>
- (172) The Commission therefore concludes that in light of the small increment brought by the transaction and the fact that a sufficient number of credible competitors will remain in the client storage market, the Transaction does not give rise to serious doubts as to its compatibility with the internal market.

#### **4.2. Vertical relationship between NAND flash memory and SSDs**

- (173) There is a vertical link between SanDisk's activities on the upstream market for the production of NAND flash memory<sup>89</sup> through a joint venture with Toshiba (the "Flash Ventures")<sup>90</sup> and the possible downstream markets for SSDs for which NAND flash memory constitutes an essential input.
- (174) According to the Guidelines on the assessment of non-horizontal mergers<sup>91</sup>, non-coordinated effects may significantly impede effective competition as a result of a non-horizontal merger if such merger gives rise to foreclosure. Foreclosure occurs where actual or potential rivals' access to supplies or markets is hampered or eliminated as a result of the merger, thereby reducing these companies' ability and/or incentive to compete.<sup>92</sup> Such foreclosure may discourage entry or expansion of rivals or encourage their exit.<sup>93</sup>
- (175) The non-horizontal Guidelines distinguish between two forms of foreclosure: input foreclosure occurs where the merger is likely to raise the costs of downstream rivals by restricting their access to an important input and customer foreclosure

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<sup>88</sup> Replies to the Commission questionnaire to customers Q1 of 4 January 2016, question 52 and Replies to the Commission questionnaire to competitors Q2 of 4 January 2016, question 57.

<sup>89</sup> As regards 3D NAND flash memory the Commission notes that at present Samsung is the only 3D NAND flash memory manufacturer enjoying a 100% share. The assessment of the vertical link resulting from the Transaction in this section therefore applies equally for the plausible narrower market for production of 2D NAND flash memory.

<sup>90</sup> SanDisk has together with Toshiba established three jointly controlled NAND flash memory manufacturing joint ventures. Each of the Flash Ventures is situated in Toshiba's semiconductor manufacturing facilities in Yokkaichi, Japan. Through the Flash Ventures, SanDisk and Toshiba collaborate in the development and manufacture of NAND. SanDisk and Toshiba also collaborate on joint R&D activities. SanDisk owns 49.9% and Toshiba owns 50.1% of each of the Flash Ventures. Toshiba manufactures NAND using the semiconductor manufacturing equipment owned or leased by the Flash Ventures. [...].

<sup>91</sup> Guidelines on the assessment of non-horizontal mergers under the Council Regulation on the control of concentrations between undertakings, OJ C 265, 18.10.2008, p. 6.

<sup>92</sup> Non-horizontal guidelines, paragraph 18.

<sup>93</sup> Non-horizontal guidelines, paragraph 29.



occurs where the merger is likely to foreclose upstream rivals by restricting their access to a sufficient customer base.<sup>94</sup>

- (176) The Commission considers that the Transaction is unlikely to lead to any foreclosure effects resulting from the vertical link mentioned in paragraph (173) for the reasons stated below.
- (177) SanDisk currently uses the vast majority<sup>95</sup> of its share of the NAND flash memory produced by the Flash Ventures captively for its own downstream operations. Western Digital currently sources [...] its NAND flash memory from [...]. Even in the event that, post-transaction, the merged entity were to decide to satisfy most of its demand for NAND flash memory in-house, neither customer foreclosure nor input foreclosure is likely to occur.
- (178) As regards possible input foreclosure, the combined market share of the Parties on the upstream NAND flash memory market is negligible: the combined market share for 2014 amounts to approximately [0-5]% in terms of revenues and volume when considering only the merchant market. It is also limited, amounting to [10-20]% in terms of revenues and [10-20]% in terms of volume, when including captive sales.
- (179) In addition, a number of other suppliers of NAND flash memory with considerably higher market shares, including Samsung ([20-30]% by revenue and [20-30]% by volume on the merchant market for 2014), SK Hynix ([10-20]% by revenue and by volume for the same period) and Micron ([10-20]%) will remain available to suppliers of solid state storage solutions.<sup>96</sup> Importantly, Toshiba (with a [30-40]% market share by revenue and [30-40]% by volume on the merchant market for 2014) will remain able to continue selling its share of NAND flash memory produced by the Flash Ventures.
- (180) Furthermore, the majority of the merged entity's largest competitors on the downstream enterprise SSD markets are in fact already vertically integrated in the production of NAND flash memory: Intel, Samsung, Toshiba and Micron.
- (181) Finally, none of the competitors and customers who replied to the market investigation raised concerns about possible input foreclosure by the merged entity post-transaction.
- (182) In light of the above, it is unlikely that the merged entity will have the ability or the incentive to engage in any input foreclosure strategy.
- (183) As regards possible customer foreclosure, the quantities of NAND flash memory purchased by the Parties account for less than [0-5]% of total sales in terms of volume (measured in petabytes) in the merchant market for NAND flash memory (Western Digital: [0-5]% and SanDisk: [0-5]%). The Parties are thus unlikely to represent an important customer that would be lost for upstream NAND flash

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<sup>94</sup> Non-horizontal guidelines, paragraph 30.

<sup>95</sup> [...] % in terms of volume and [...] % in terms of revenue.

<sup>96</sup> Those players are themselves vertically integrated and satisfy parts of their demand for NAND flash memory in-house.

memory suppliers. A number of alternative customers sourcing NAND flash memory on the open market will remain post-transaction. Those include, notably, those SSD suppliers that are not vertically integrated into NAND flash memory production such as Seagate, Kingston, PNY, Lite-On and Transcend.<sup>97</sup>

- (184) Given also that Western Digital accounts for less than [0-5]% of the overall market for the sale of NAND flash memory (non-captive and captive sales), the Transaction results in no material change from the current situation.
- (185) Thus, even if Western Digital were to shift all of its demand to the Flash Ventures, NAND flash memory suppliers would continue to have sufficient alternatives to sell their output and the Transaction is unlikely to give rise to any customer foreclosure in relation to the provision of NAND flash.
- (186) The Commission therefore concludes that the Transaction does not give rise to serious doubts as to its compatibility with the internal market as regards the vertical relationship between the market for NAND flash memory and the downstream markets for SSDs.

### **4.3. Conglomerate relationship between different storage solutions**

- (187) As explained in paragraph (82) above, the different markets for enterprise solid state storage are closely related markets. Also, the markets for HDDs, client SSDs and embedded flash storage on the one hand and the markets for enterprise solid state storage on the other hand are closely related markets.
- (188) According to paragraph 92 of the non-horizontal Guidelines, “*conglomerate mergers in the majority of circumstances will not lead to any competition problems*”. According to paragraph 93 of the non-horizontal Guidelines, “*the main concern in the context of conglomerate mergers is foreclosure. The combination of products in related markets may confer on the merged entity the ability and incentive to leverage a strong market position from one market to another by means of tying or bundling or other exclusionary practices.*”
- (189) The Commission has therefore assessed whether, as a result of the Transaction, the merged entity would have the ability and incentive (i) to start offering storage solutions in bundles at a price that would be lower than the sum of the stand-alone prices of each solution (enterprise SSDs with client SSDs for example or SSDs only in combination with HDDs) to such an extent that competitors would be foreclosed; and/or (ii) to refuse to sell certain solutions, such as enterprise SSDs, on a standalone basis.
- (190) For the reasons already discussed in detail in sections 4.1.1, 4.1.2 and 4.1.3, and in particular in light of the presence of a sufficient number of credible competitors post-transaction, the merged entity will not have a sufficient degree of market power to engage in a foreclosure strategy on any of the respective enterprise storage markets (where the merged entity's share accounts for around [40-50]%) including on the SAS enterprise SSD and SAS enterprise solid state storage markets where the combined market share of the Parties is higher.

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<sup>97</sup> In any event, according to the Notifying Party enterprise SSDs account for only approximately [...] % of NAND use.

- (191) Western Digital has been already active pre-transaction across a broad range of storage solutions, including enterprise SSDs, without engaging in any bundling or tying strategy.<sup>98</sup>
- (192) More importantly, there will be a number of competitors that will be able to offer tied or bundled storage solutions similar to those that merged entity could commercialise post-transaction: Seagate and Toshiba are in the position to offer bundles combining HDDs and SSDs whereas each of Intel, Micron, Toshiba and SK Hynix could provide combinations of enterprise SSDs and client SSDs. As regards bundling SAS enterprise SSDs with enterprise SSDs based on any of the other two interfaces, Micron, Toshiba and Samsung on the one hand could provide combinations of SATA and SAS enterprise SSDs while Micron, Toshiba, Seagate and Samsung on the other hand are capable of replicating bundles of SAS and PCIe based enterprise SSDs. The ability of other competitors to counteract by offering similar bundles could therefore make the possible bundling strategy of the merged entity ineffective. For the same reasons a tying strategy would be equally ineffective.
- (193) The Commission therefore considers that the Transaction is unlikely to significantly increase the already existing ability of the Notifying Party to engage in any tying and/or bundling of storage solutions.
- (194) The Transaction does not raise serious doubts with regard to its compatibility with the internal market for what concerns possible foreclosure effects resulting from conglomerate links.

## **5. CONCLUSION**

- (195) For the above reasons, the European Commission has decided not to oppose the Transaction and to declare it compatible with the internal market and with the EEA Agreement. This decision is adopted in application of Article 6(1)(b) of the Merger Regulation and Article 57 of the EEA Agreement.

*For the Commission*  
*(Signed)*  
*Margrethe VESTAGER*  
*Member of the Commission*

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<sup>98</sup> Form CO, paragraph 7.286 (page 161).