Preparatory study for implementing measures of the Ecodesign Directive 2009/125/EC

DG ENTR Lot 9 - Enterprise servers and data equipment

Task 2: Markets

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Glossary

ASP	Average selling price
B2B	Business to business
BGP	Border Gateway Protocol
CAGR	Compound Annual Growth Rate
CAS	Content-addressed storage
CPU	Central processing unit
DAS	Direct Attached Storage
EBGP	External Border Gateway Protocol
ECB	External Controller-Based (SAN & DAS)
ELE	Extreme low energy
EMEA	Europe, Middle East and Africa
EOL	End of life
EU	European Union
FBI	Fabric-based infrastructure
FCoE	Fibre channel over Ethernet
GB	Gigabyte
Gbps	Gigabit per second
GDP	Gross domestic product
GPU	Graphic processing unit
HDD	Hard Disk Drive
HVD	Hosted virtual desktop
IGP	Interior Gateway Protocol
IP	Internet Protocol
ISP	Internet service provider
IT	Information technology
JBOD	just a bunch of disks (that are not under the control of RAID technology)
LAN	Local area network
LCC	Life Cycle Cost
Mbps	Megabit per second
NAND	Not And
NAS	Network Attached Storage
OCP	Open compute project
ODM	Original-design manufacturer
PB	Petabytes
PoE	Power over Ethernet
RAID	Redundant array of independent disks
RAS	Resiliency, Availability and Serviceability
RISC	Reduced instruction set computing
SAN	Storage Area Network
SFF	Small form factor
SME	Small and medium enterprises
SOHO	Small office/home office
SSD	Solid State Devices
TB	Terabytes
USD	US dollar
VAT	Value added tax
VDI	Virtual desktop infrastructure
VPLS	Virtual Private LAN Service
VPN	Virtual private network
WAN	Wide area network
WLAN	Wireless local area network

Introduction

This chapter presents the economic and market analysis of the products covered in the scope of ENTR Lot 9 preparatory study on enterprise servers and data equipment. There are four main objectives of this chapter, which include:

- To place the ENTR Lot 9 product groups within the overall context of EU industry and trade.
- To provide market data (sales and installed stock) for the assessment of EU-wide environmental impacts of the ENTR Lot 9 products.
- To provide insights into the latest market trends to indicate the market structures and ongoing trends in product design. This will serve as an input for the subsequent tasks such as improvement potentials.
- To provide the data on consumer prices and rates that will later be used during the study for the purpose of Life Cycle Cost (LCC) calculations.

1. Generic economic data

The PRODCOM[1] statistics (published by EUROSTAT) are the official European Union (EU) source statistics.

PRODCOM data is based on manufactured goods whose definitions are standardised across the EU, therefore guaranteeing consistency and comparability between Member States. Although these statistics are often used and referenced in other EU policy documents when it comes to trade and economic policy, they have their limitations. Many data points are unreported, estimated, or confidential.

PRODCOM classifies enterprise servers and data equipment in the categories NACE 28.12 "Manufacture of loaded electronic boards", NACE 28.20 "Manufacture of computers and peripheral equipment" and NACE 28.30 "Manufacture of communication equipment". The products covered under these categories, and which are relevant for this study, are presented below:

- Servers:
  - **26201400** – Digital data processing machines: presented in the form of systems;
  - **26201500** – Other digital automatic data processing machines whether or not containing in the same housing one or two of the following units: storage units, input/output units;
- Storage equipment:
  - **26202100** – Storage units;
  - **26203000** – Other units of automatic data processing machines (excluding network communications equipment (e.g. hubs, routers, gateways) for Local area network (LAN) and Wide area network (WAN) and sound, video, network and similar cards for automatic data processing machines);
- Server and storage related network equipment:
  - **26302320** – Machines for the reception, conversion and transmission or regeneration of voice, images or other data, including switching and routing apparatus;
  - **26302370** – Other apparatus for the transmission or reception of voice, images or other data, including apparatus for communication in a wired or wireless network (such as a local or wide area network), other than transmission or reception apparatus of HS 84.43, 85.25, 85.27 or 85.28.

These categories include wide ranges of products, and it is not exactly clear which devices each category covers, as the aggregation level of data remains relatively high. Hence, PRODCOM can only serve as a broad overview of the market size. Table 1 below shows the summary of import, export, production and apparent EU consumption for servers and data equipment, derived from the PRODCOM data[2].

[1] The term 'PRODCOM' comes from the French expression 'PRODuction COMmunautaire' (Community Production) for mining, quarrying and manufacturing: sections B and C of the Statistical Classification of Economy Activity in the European Union (NACE 2). Available at: epp.eurostat.ec.europa.eu/portal/page/portal/prodcom/data/database

[2] The detailed data for import, export, production and apparent EU consumption by Member States for each of the PRODCOM NACE Codes is provided in Annex to this report.

Table 1: Market data from PRODCOM for servers and data equipment in 2012[3], in EU-28[4]

PRODCOM NACE code	Quantity in 1000 units				Value in million €			
	Production	Import	Export	Apparent EU consumption[5]	Production	Import	Export	Apparent EU consumption
26201400	3 085	2 638	3 853	1 870	2 530	872	1 093	2 309
26201500	738	4 775	4 682	831	484	3 770	3 718	536
26202100	11 467	139 836	22 627	128 676	4 500	7 565	3 036	9 028
26203000	80 000	12 377	3 023	89 354	546	745	357	934
26302320	38 876	n.a.	n.a.	n.a.	5 402	12 402	6 920	10 885
26302370	6 861	n.a.	n.a.	n.a.	1 056	532	457	1 131
Total	**141 027**	**159 626**	**34 185**	**220 731**	**14 518**	**25 886**	**15 581**	**24 823**

Figure 1 and Figure 2 present the overall EU-28 production, trade, and apparent consumption in 2012 according to the six PRODCOM categories, respectively in terms of units and value.

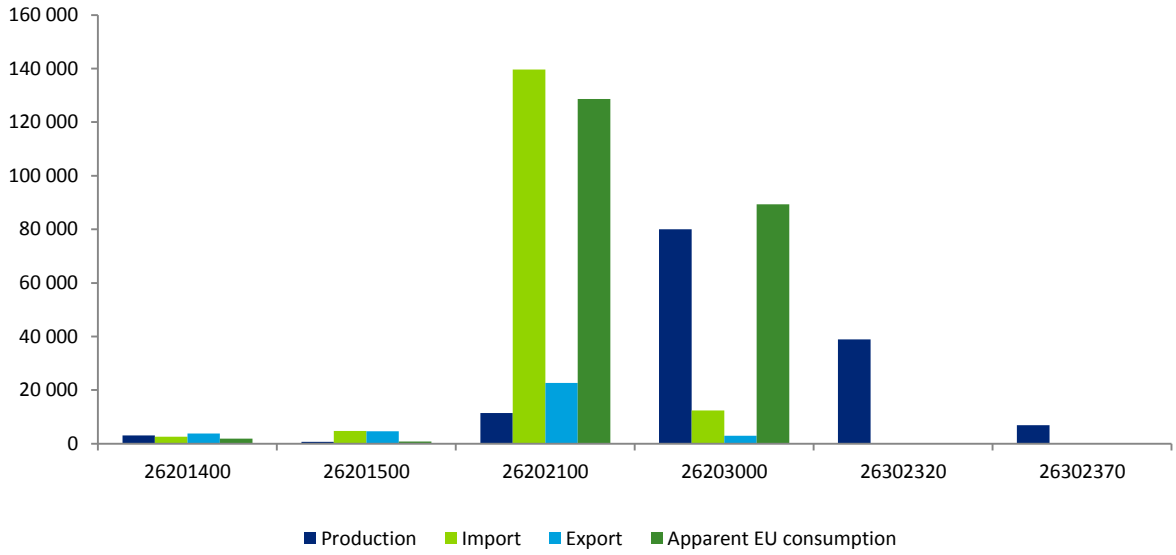


Figure 1: Market size of servers and data equipment in the EU-28 in 2012, PRODCOM (in 1000 units)

Data storage equipment has by far the most unit sales. However, it is not clear what a 'unit' refers to (e.g. storage device or storage product), as the category contains very heterogeneous products. Common practice is to count such products in terms of GB (Gigabyte) of storage, instead of number of devices. Their imports represent the main share of apparent consumption. According to PRODCOM, this is not the case for servers, where exports are slightly higher than imports, which is surprising. Finally, trade information is lacking for server and storage related network equipment.

[3] Latest full year for which at least half of the Member States have reported to Eurostat (last update: 17 June 2014).
[4] Calculated by summing EU-27 and Croatia.
[5] Apparent EU consumption = EU production + EU imports – EU exports

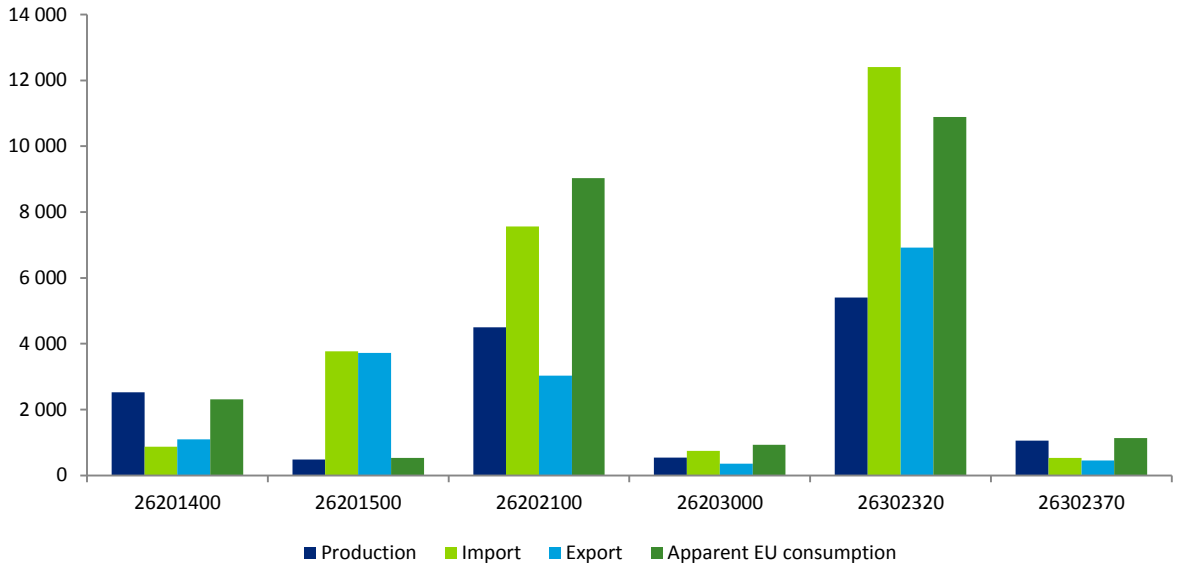


Figure 2: Market value of servers and data equipment in the EU-28 in 2012, PRODCOM (in million €)

In terms of market value, imports of products are much more important than exports for both data storage equipment and server and storage related network equipment, the latter having the highest absolute market value. For servers, the situation is quite similar to the market by units, except that the unit value of production is more important than the one from imports.

Because of the breakdown limitation, the PRODCOM data presented above can only serve for informational purposes and will not be considered in the environmental and life cycle cost analyses during this study.

2. Market and stock data

The aim of this subtask is to go deeper in the market analysis than the PRODCOM data allows to and to provide market and stock data (i.e. number of units sold and installed in the EU-28) for enterprise servers, data and storage equipment covered in ENTR Lot 9 study.

The data presented in this section rely mostly on information provided directly by stakeholders (primarily manufacturers), information technology (IT) market research and advisory firms, as well as literature reviews and available databases.

2.1. Sales data at global and EU level

2.1.1. Enterprise Servers

Table 2 presents market data provided by DIGITALEUROPE through the consultation process. These data are based on a binary form factor parameter (blade, non-blade), as well as on the levels of Resiliency, Availability and Serviceability (RAS), following the ENERGY STAR® product definitions. The data are divided in the following profiles:

- Unmanaged servers (which do not have a service processor or an equivalent);
- Managed servers (that dispose of a service processor and are designed to be configured with redundant power supplies); and
- Resilient servers (which use a specific processor and have distinctive hardware configurations).

Table 2: Sales data for enterprise servers in units in the EU-28[6], figures by DIGITALEUROPE (Contributing companies covering around 77% of the market)

Server categories	2011				2012				Sales change (11/12)
	Blade*	Non-blade*	Annual total	Market share	Blade*	Non-blade*	Annual total	Market share	
Micro servers	1 296	0	1 296	0.04%	8 130	0	8 130	0.25%	527.31%
Managed servers	623 142	2 236 843	2 859 985	81.91%	604 289	2 141 713	2 746 002	83.75%	-3.99%
Unmanaged servers*	0	586 509	586 509	16.80%	0	483 594	483 594	14.75%	-17.55%
Resilient servers*	11 000	33 000	44 000	1.26%	11 000	30 000	41 000	1.25%	-6.82%
Total	**635 438**	**2 856 353**	**3 491 791**	**100%**	**623 419**	**2 655 307**	**3 278 726**	**100%**	**-6.10%**

*According to ENERGY STAR® definitions

As reflected by the sales growth rate between 2011 and 2012, micro-servers are an emerging category even if absolute sales are currently still limited in absolute value. The market share of this server category increased from 0.04% to 0.25% of total sales, and was the only segment growing between 2011 and 2012.

The share of managed servers increased from 81.9% to 83.8% of all sales in the EU-28 between 2011 and 2012, at the expense of unmanaged servers, which now represent less than 15% of the market. Both segments decreased in absolute sales, resulting in an overall sales decrease of 6%. Finally, resilient servers also present limited annual sales and their decrease is in line with the overall market trend. The

[6]Figures were provided for EU-27. However, since the Croatian economy amounts to roughly 0.3% of the EU-28 GDP, the EU-27 figures were taken as a proxy for EU-28 figures.

sharp decline in unmanaged servers is indicative of the reduction in small standalone systems in favour of purchasing services and compute capacity from a more central source. Growth sites are likely to consolidate and centralize data centre activities moving the demand from unmanaged to managed systems.

According to DIGITALEUROPE, the majority of the power use is due to high volume one and two processor socket servers, which are estimated to account for 90% of the worldwide server market. This is confirmed by our estimates shown below (see Table 7), where servers with one or two processor socket(s) represented around 96% of overall sales in 2013. Two processor socket machines have a broad range of power profiles. For example, a machine type of a managed server can have a range of idle power from 78 W to 230 W and of maximum power from 161 W to 556 W with prices differing by tens of thousands of Euros.

Systems with more than four processor sockets represent a very small portion of the market and are designed for highly specialized operations such as intense computations, high performance computing and high reliability, and high utilisation operations.

Table 3 and Table 4 below show worldwide and EMEA[7] estimates by two market research firms, IDC and Gartner.

Table 3: IDC server market estimates worldwide, in EMEA[8] and EU-28

Quarter	Worldwide quarterly shipments (in million units)	Worldwide annual shipments (in million units)	EMEA quarterly shipments (in units)	EMEA annual shipments (in units)	EU-28 annual shipments (in units)[9]
4Q13	2.5	8.7	606 548	2 145 315	1 724 683
3Q13	2.3		535 767		
2Q13	2.0		483 000		
1Q13	1.9		520 000		
4Q12	2.1	8.2	569 000	2 166 889	1 742 027
3Q12	2.1		526 701		
2Q12	2.0		514 311		
1Q12	2.0		556 877		

[7] Europe, Middle East, Africa
[8] Source: Table compiled from IDC quarterly public press releases.
[9] Estimated, based on GDP of countries in the IDC EMEA and EU-28 areas. GDP data was taken from the World Bank.

Table 4: Gartner vendor shipment estimates worldwide and in EMEA[10]

Quarter	Worldwide quarterly shipments	Worldwide annual shipments (in million units)	EMEA quarterly shipments (in units)	EMEA annual shipments (in million units)
4Q13	2 581 723	9 877 066	613 274	2 294 881
3Q13	2 506 223		547 627	
2Q13	2 460 111		550 537	
1Q13	2 329 009		583 443	
4Q12	2 500 722	9 671 873	629 052	2 430 326
3Q12	2 458 589		589 885	
2Q12	2 366 479		585 304	
1Q12	2 346 083		626 085	

The following table reports server shipment estimates for EU-28 based on the above table.

Table 5: Server shipment units in EU-28 (Calculations performed by Bio by Deloitte[11])

Annual shipments (in units)	2012	2013
EU-28	1 713 320	1 618 207

A significant difference between DIGITALEUROPE sales figures and the figures from the two IT research firms can be observed, the latter being considerably lower (3.3 million units in 2012 in EU-28 vs. around 1.7 million units for both IT research firms). According to a statement by DIGITALEUROPE, the following reasons may partly explain the discrepancies between the market figures:

- Differences in definitions (units sold as opposed to units shipped): in market analysts' reporting, unit shipments are defined as the number of server units sold into distribution or sold directly to end users during a given period of time.
- Differences in server types reported: market analysts only report managed servers, whereas including unmanaged servers would close the gap by 586 000 units.
- Customer specific products may not be captured by market analysts, while they are included in DIGITALEUROPE figures.

All sources, however, indicate that the overall market is flat, and even slightly decreasing since 2011. The decline in sales unit figures is, in a great part, inherent to the virtualisation trend and is expected to continue for some years until it reaches its optimum.

As systems are virtualised and consolidated, it is likely that server or storage products to which workloads are virtualised become more sophisticated, can deliver more workloads per watt of energy consumed and have a more efficient power management profile than the total set of units that are replaced. At the same time, data increases and smart civic infrastructures may drive future installations.

Rack-optimised servers represent the largest share of the overall sales (57% in 2012), with three times the sales of rack-mountable or blade servers. Rack-mountable servers have been decreasing since 2009 while blade servers' sales are relatively constant. The blade market share of 14% in 2013 is in line with DIGITALEUROPE figures of around 18% in 2011 and 2012. The slight decrease since 2011, similar to the one for rack-optimised servers, may be explained by the very fast increase in sales of multi-node servers, taking an increasing market share (6% in 2012).

[10] Sources: Table compiled from Gartner quarterly public press releases, see Table 35 in Annex 2

[11] Source: Data from Gartner quarterly public press releases; see Table 4: Gartner vendor shipment estimates worldwide and in EMEA. EMEA figures were taken as a basis and scaled down to EU-28 level using World Bank GDP data.

Table 6: Server shipment units in EU-28, by form factor (Calculations performed by Bio by Deloitte[12])

Form Factor*	2010	2011	2012	2013	Share of total in 2013
Rack-Blade	280 840	280 871	245 087	228 626	14%
Rack-Mountable	326 643	309 776	269 954	236 784	14%
Rack-Optimised	1 036 251	1 061 048	982 110	924 344	57%
Tower/Stand-alone	127 139	138 345	127 019	118 073	7%
Multi-node	26 124	47 653	112 171	125 400	8%

*Gartner Terminology[13]	
Rack-optimised:	A system that has to be installed in a server cabinet.
Rack-mountable:	A system that can be mounted in a rack or as a stand-alone.
Blade:	A discrete CPU card that slides vertically into a shared chassis. Typically, several blade cards are housed in a cabinet or a stand-alone chassis, which houses a common power supply, cooling element, and network switches and connections.
Tower/stand-alone:	A system optimized for stand-alone installation only.
Multi-node server:	Multi-node servers are modular servers that share infrastructure, such as power and cooling, within a chassis. They are distinguished from blade servers by not having a shared network fabric.

The following figure shows cumulated server shipments by form-type. After an increase of total shipments from 2010 to 2011, a slight downwards-trend can be observed from 2011 on.

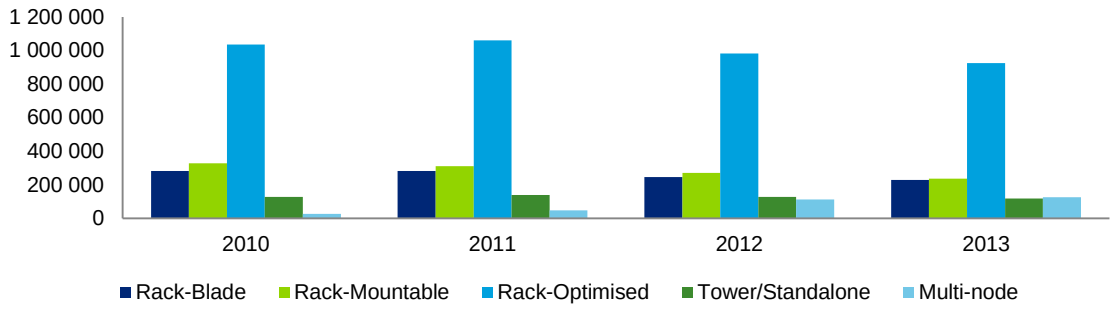


Figure 3: Server shipment units in EU-28, by form factor (calculations performed by Bio by Deloitte[12])

Data is also available based on the number of CPU sockets. As defined by Gartner, this is the maximum number of CPUs available for a server. As an example, from a technical point of view, in a four CPU sockets server (i.e. with a maximum number of four CPUs), not all customers will opt for a maximum configuration (i.e. four CPU sockets populated) for which reason such a server may as well be populated with less CPUs (e.g. one or two).

Table 7 shows that **servers with one and two CPU sockets represent the vast majority of the overall market sales (96.1% in 2013).** Furthermore, the market shares of all other market segments, especially 5-8 socket servers, seem to be decreasing over time. In 2013, servers with more than 4 sockets represented only around 0.3% of overall shipments.

[12] Source: Data from Gartner: Quarterly Statistics: Servers, Worldwide, 1Q14 Update (May 2014), Table 36 in Annex 2. The Western Europe and Eastern Europe figures were taken as a basis and scaled down to EU-28 level, using World Bank GDP data.

[13] Source: Gartner – Market Definitions and Methodology: Servers (May 2012), last reviewed in May 2013.

Table 7: Server shipment units in EU-28, by number of CPU sockets (Calculations performed by Bio by Deloitte[14])

# CPU sockets	2010	2011	2012	2013	Share of total in 2013
1	398 525	426 761	396 788	383 068	23.4%
2	1 319 050	1 329 857	1 269 963	1 186 593	72.7%
3-4	73 206	73 023	64 170	58 493	3.6%
5-8	5 031	6 359	3 712	3 928	0.2%
9+	1 186	1 694	1 708	1 146	0.1%

Table 8: Server shipment units in EU-28, by CPU type (Calculations performed by Bio by Deloitte[14])

CPU*	2010	2011	2012	2013	Share of total in 2013
IA64	7 493	6 445	4 317	2 343	0.14%
RISC	32 743	31 097	22 728	17 972	1,1%
x86	1 756 019	1 799 380	1 708 672	1 612 418	98.73%
Other	743	772	626	495	0,03%
Total	**1 796 998**	**1 837 694**	**1 736 343**	**1 633 228**	**100%**

*Gartner Terminology[15]	
IA64	Intel's family of 64-bit Itanium microprocessors
RISC	Reduced instruction set computer
x86	Intel-compatible processor

Table 8 above shows the dominance of x86 servers (98.7%). When it comes to vender revenues, the following figure shows the decreasing importance of rack-mountable servers and the lion share of rack-optimised servers which accounted for more than 50% of total revenue in 2013. Revenues from Tower / Standalone servers used to make up around 18% of the revenues in 2010 and decreased to roughly 15% in 2013. Both rack-blade servers and multi-node servers gained more importance throughout the last couple of years.

[14] Source: Data from Gartner: Quarterly Statistics: Servers, Worldwide, 1Q14 Update (May 2014), see Table 37 and Table 38 in Annex 2. The Western Europe and Eastern Europe figures were taken as a basis and scaled down to EU-28 level, using World Bank GDP data.

[15] Source: Gartner – Market Definitions and Methodology: Servers (May 2012), last reviewed on 9 May 2013.

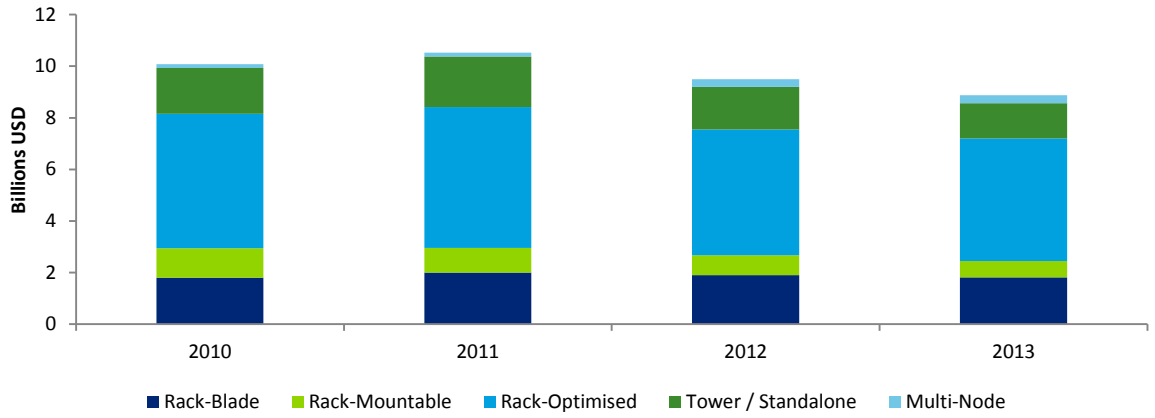


Figure 4: Vendor revenue in EU-28, by form factor (Calculations performed by Bio by Deloitte[16])

2.1.2. Enterprise Storage

When setting up enterprise storage networks, both the storage media and the storage architecture have to be selected. The following subsection presents market data for these two levels.

2.1.2.1. *Storage media*

This subsection presents market data at the device level, for hard disk drives (HDD) as well as for solid-state drives (SSD).

- **Enterprise HDD**

Table 9 below shows that over the period of 2011-2013, the overall number of HDDs shipped worldwide increased from 31 to 35 million for business critical drives, as opposed to the slight decrease in the number of mission-critical drives over the same period. **These drives are used in both servers and storage systems (and not in storage systems only).**

The notion "mission-critical" means that these drives are essential for everyday operations and whose failure or disruption would result in failure of business operations[17]. Here, failure would entail significant losses in production or services. Business-critical drives, on the other hand, concern only one or more of the businesses of the enterprise, but not the enterprise as a whole[18]. Thus, in this case, the consequences of failure would be limited to one area.

As for capacity, total enterprise capacity, for both business- and mission-critical drives, doubled over the same period.

[16] Source: Data from Gartner: Quarterly Statistics: Servers, Worldwide, 1Q14 Update (May 2014), see Table 39 in Annex 2. The Western Europe and Eastern Europe figures were taken as a basis and scaled down to EU-28 level, using World Bank GDP data.
[17] http://www.investopedia.com/terms/m/mission-critical.asp
[18] http://analysing-business.com/business-mission-critical-application

Table 9: Worldwide HDDs and petabytes shipped for use in servers and storage systems[19]

Unit description	2011	2012	2013
2.5-Inch small form factor (SFF) and 3.5-Inch Business-Critical Drives	30 896	30 052	34 913
2.5-Inch SFF and 3.5-Inch Mission-Critical Drives	33 326	33 339	32 468
Total Enterprise HDDs (Thousands units)	**64 222**	**63 391**	**67 381**
Units change (%)		-1.3%	6.3%
2.5-Inch SFF and 3.5-Inch Business-Critical (PB)	40 479	51 515	74 419
2.5-Inch SFF and 3.5-Inch Mission-Critical (PB)	11 915	14 367	16 107
Total Enterprise Capacity (PB)	**52 394**	**65 882**	**90 526**
PB change (%)		25.7%	37.4%

In 2013, around 67 million enterprise HDDs (for storage and server purposes) were shipped, amounting to a total global HDD capacity of 90 526 PB. Concerning the form factor, 2.5-inch drives are used for high performance needs, whereas 3.5-inch drives are rather preferred for the storage of large data volumes.

- **Enterprise SSD**

According to Gartner, around **5.4 million SSD for enterprise servers** and around **1.3 million SSD for enterprise storage** have been shipped in 2013 worldwide.[20] The bulk of the shipment is concentrated in the 256-511 GB and 512-1023 GB segments as can be seen in Figure 5 and Figure 6 below.

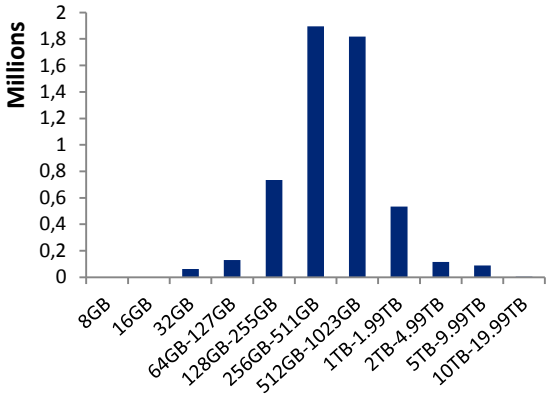


Figure 5: SSD sales for enterprise servers worldwide in 2013[20]

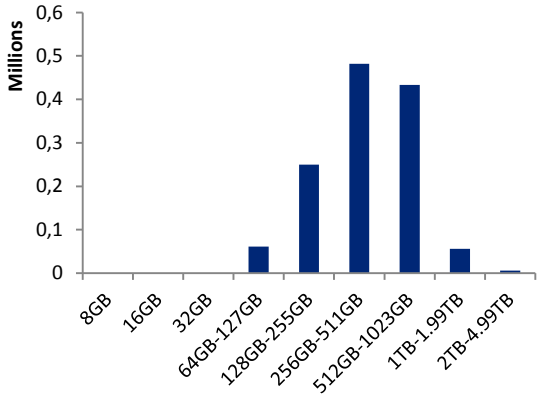


Figure 6: SSD sales for enterprise storage worldwide in 2013[20]

Adjusted to the EU-28 level, SSD components amount to **yearly sales of around 723 000 components for enterprise servers and 174 000 components for enterprise storage in 2013**.
The two figures above show that SSD sales for both servers and storage equipment peak in the categories between 256 and 511 GB in 2013. There is a significant difference between the numbers of HDDs (67.4 million worldwide in 2013) and SSDs shipments (6.7 million worldwide in 2013) for use in enterprise servers and storage systems.

This difference can be mainly explained by the much higher price of SSDs as compared to HDDs. HDDs use magnetism to store data on a rotating platter whereas SSDs have no moving parts and use a NAND-based flash memory. According to the statement of an end-user, this also results in a much lower rate of failure of SSDs. The mean time between failure rate of SSDs is thus of around 2 million hours, vs.1.5 million hours for HDDs.[21]

[19] Source: Gartner - Forecast: Hard-Disk Drives, Worldwide, 2011-2018, 2Q14 Update (June 2014)
[20] Gartner - Market Share Analysis: SSDs and Solid-State Arrays, Worldwide, 2013 (June 2014)
[21] Storage Review: SSD vs HDD. http://www.storagereview.com/ssd_vs_hdd (last accessed: 13/06/2014)

2.1.2.2. *Storage Architecture*

Storage options can either be host based or external controller based as is displayed in the following table:

Table 10: Storage Options

Host Based			External Controller Based (ECB)	
Internal		External	All External	
SATA	SCSI	JBOD Enclosures	iSCSI	Fibre Channel

Servers have their own internal storage resources but data centres typically also work with external storage systems separating the server services and the storage services. For this reason the focus of the storage architecture market analysis will be external controller based storage. External controller based disk storage is a system that has one or more embedded controllers.

The dominant ECB storage units can be divided into four main categories:

- Storage Area Network (SAN): the main advantage of a SAN is the ability to bring together a large amount of computers and systems with centralised storage devices and drives. In the early 2000's, cost for implementing a SAN dropped significantly and both the deployment and management became easier, which resulted in its increased adoption by companies of all sizes.
- Direct Attached Storage (DAS): a DAS is a storage system which is composed of one or more storage devices that are directly connected to one or more servers. The main difference between DAS and the other forms is that there is no network device in between. The number of computers that can be connected is thus limited by the number of ports of the DAS device, which makes the DAS a so-called "island of information"[22], being characterised by the inability to share its information with other servers.
- Network Attached Storage (NAS): As a solution to this limitation of the DAS, the NAS system has been developed, which allows just in the same way as a SAN, to share data between a large number of computers and servers. The difference between the two, however, derives from the fact that in practice, NAS is often used in small business networks, whereas SANs are preferred by large companies. This is due to the fact that adding more storage capacity to a NAS system can only be done by installing additional devices, even though each NAS operates independently. SANs, on the other hand, are deployed to handle very high-speed file transfers or many terabytes of centralised file storage given their high-performance disk arrays.
- Content-Addressed Storage (CAS): CAS is a mechanism employed to store information, which typically assumes the form of fixed content (stored data which is not expected to be updated). In a CAS, an object is stored in such a way that makes it impossible to modify or duplicate it, thus assigning it a permanent place on the disk[23]. CAS makes up the smallest share of the four categories in sales and installed stock.

According to Gartner, **the worldwide installed base of external controller-based (ECB) storage units amounted to around 4 415 677 systems in 2012[24] while the worldwide shipment in 2013 is estimated at 924 654[25].**

The worldwide shipment and revenue shares of the four different categories are shown in the figures below. It can be observed that while NAS represent around two thirds of the overall shipments, they only make up a quarter of the revenues. The reverse is true for SAN, where around 27% of overall shipments make up two thirds of the overall revenue.

This difference can be explained by the maximum amount of storage provided by both types. Indeed, the maximum number of drives and hence capacity, which can be accommodated by a SAN system, is substantially higher than in the case of a NAS (see the figure on the right). Consequently, this also explains

[22] http://www.snia.org/education/storage_networking_primer/san/what_san
[23] http://searchstorage.techtarget.com/definition/content-addressed-storage
[24] Source: Gartner - Forecast: Data Centers, Worldwide, 2010-2017, 2Q13 Update (August 2013)
[25] Source: Gartner - Quarterly Statistics: Disk Array Storage, All Regions, 4Q13 Update (March 2014)

a much higher price for SAN solutions, which can be up to 10 times or more than the one of NAS systems. More than 90% of the overall capacity is provided by SAN and NAS together, as shown in the figure on the right. DAS systems represent only around 7% and CAS only 2% of the capacity share.

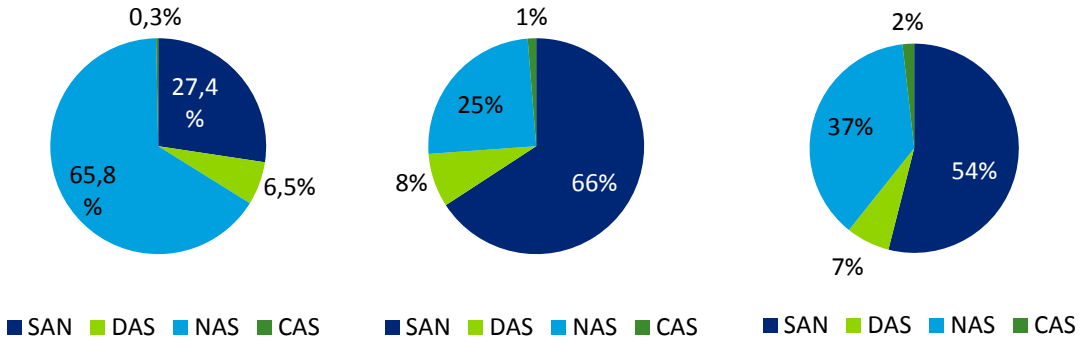


Figure 7: Share of ECB storage shipments (left), revenues (middle), and capacity (right), 2013 worldwide (Calculations performed by Bio by Deloitte[26])

Table 11 below shows worldwide ECB storage revenues, shipments and capacity.

Table 11: External Controller-Based storage revenues, shipments and capacity worldwide (Source: Gartner[27])

	2009	2010	2011	2012	2013
Revenue (million USD)	**16 448**	**19 337**	**21 233**	**22 215**	**22 524**
Revenue year-to-year Change %		18%	10%	5%	1%
Shipments	**805 910**	**1 031 260**	**980 409**	**958 233**	**924 654**
Shipments year-to-year Change %		28%	-5%	-2%	-4%
Capacity (PB)	**7 371**	**11 783**	**15 824**	**18 456**	**23 413**
Capacity year-to-year Change %		60%	34%	17%	27%

While revenues were growing by two-digit numbers in 2010 and 2011, this growth dropped considerably and amounted to only around 1% in 2013. This trend is also reflected in the shipment numbers that have been decreasing from 2010 to 2013. In spite of this decline, capacity continues to grow very quickly (growth rate of 27% in 2013).

According to a TheInfoPro study conducted in 2013, enterprise storage capacity is more than doubling every two years and therefore exceeding the rate of Moore's Law[28]. These findings can be partly confirmed by the above capacity figures: they exceeded the rate of Moore's Law in 2009/2011, but not in the years 2010/2012 (+56%) or 2011/2013 (+48%). The following table shows above figures adapted to the EU-28 level.

[26] Source: Shares were calculated based on data from Gartner - Quarterly Statistics: Disk Array Storage, All Regions, 4Q13 Update (March 2014), see Table 40 in Annex 2.
[27] Gartner - Quarterly Statistics: Disk Array Storage, All Regions, 4Q13 Update (March 2014)
[28] Available at: www.prnewswire.com/news-releases/enterprise-storage-capacity-has-more-than-doubled-over-the-past-two-years-226116661.html

Table 12: External Controller-Based storage revenues, shipments and capacity in the EU-28 (Calculations performed by Bio by Deloitte[29])

	2009	2010	2011	2012	2013
Revenue (million USD)	**3 618**	**4 124**	**4 521**	**4 576**	**4 591**
Revenue year-to-year Change %		14.0%	9.6%	1.2%	0.3%
Shipments	**216 005**	**282 510**	**260 722**	**238 018**	**223 419**
Shipments year-to-year Change %		30.8%	-7.7%	-8.7%	-6.1%
Capacity (PB)	**1 834**	**2 794**	**3 584**	**3 946**	**5 056**
Capacity year-to-year Change %		52.3%	28.3%	10.1%	28.1%

The growth trends, which could be observed at the world level, also hold in the EU-28 region. In terms of revenue, the growth rate was decreasing in the period from 2009 to 2013 with a drastic drop from 10% to 1% in 2012. Moreover, the positive growth which took place in 2013 is negligible and close to zero. This is in line with the number of shipments, which is even suffering from negative growth since 2011. Capacity, on the other hand, has experienced a great increase in the range of 10-52% and has even slightly surpassed growth at the world level in 2013 with 28%.

Table 13: External Storage sales figures for Western Europe, by storage class and price band[30]

	Stoarage Class	Price Band	2009	2010	2011	2012	2013
Units	Entry	$0<5K	37 349	51 255	51 442	31 249	42 325
		$5<10K	38 390	32 449	33 960	39 551	49 371
		$10<15K	31 020	26 503	32 048	24 859	27 461
		$15<25K	20 921	25 453	24 547	29 605	29 123
	Entry Total		**127 680**	**135 660**	**141 997**	**125 264**	**148 280**
	Midrange	$25<50K	27 637	24 492	23 438	26 095	23 805
		$50<100K	11 087	12 726	14 462	12 741	12 797
		$100<150K	3 242	3 051	2 670	1 957	3 637
		$150<250K	1 882	2 761	2 659	3 047	3 252
	Midrange Total		**43 848**	**43 030**	**43 229**	**43 840**	**43 491**
	High-End	$250<500K	2 103	2 454	1 701	1 623	1 974
		$500K+	474	697	1 247	1 193	853
	High-End Total		**2 577**	**3 151**	**2 948**	**2 816**	**2 827**

The figures on external storage sales provided by DIGITALEUROPE are based on IDC data and in line with Table 12. They give more detailed insights about the distribution of the equipment sold. While midrange and high-end unit sales remained relatively stable in the last couple of years, entry level equipment sales increased since 2009 with a temporary break-in in 2012.It is noteworthy that in 2013, 76% of the units sold were entry level, roughly corresponding to the Online 1&2 class according to the SNIA taxonomy. Products situated in the price range between $25<100K (corresponding to Online 3) make up for 19% and midrange products in the $100<250K (corresponding to Online 4 products) around 3% of sales. High-end products represent only 2% of total unit sales. The following figure shows the sales development since 2001.

[29] Source: Data from Gartner - Quarterly Statistics: Disk Array Storage, All Regions, 4Q13 Update (March 2014), see Table 46 in Annex 2. It has been scaled down to EU-28 level, using World Bank GDP data.
[30] Source: IDC Worldwide Quarterly Disk Storage Systems Tracker, 2014 Q3, December 2014

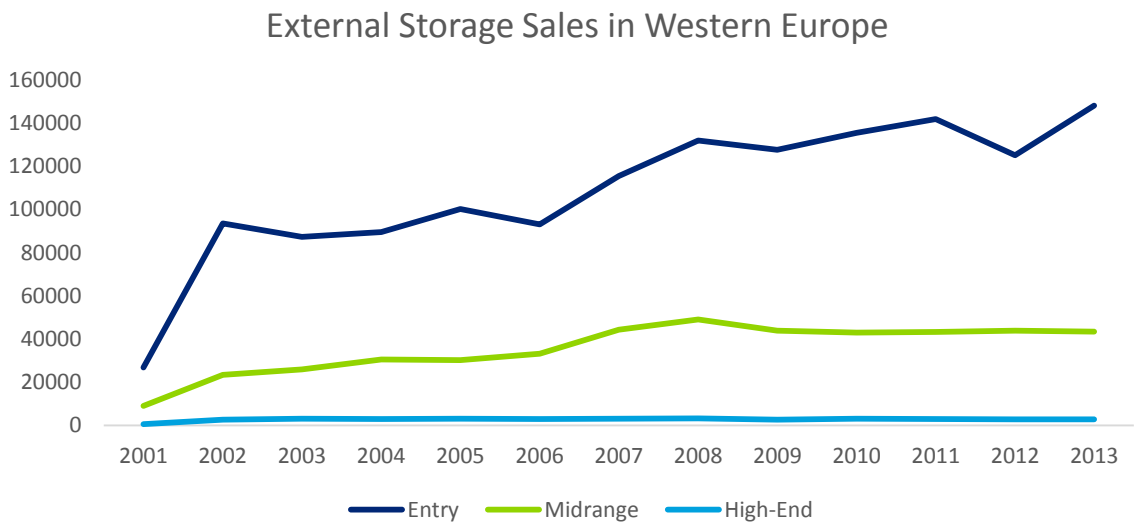


Figure 8: External storage sales development in Western Europe[30]

2.1.3. Enterprise (server and storage related) Network Equipment

Roughly speaking, server and storage related network equipment can be divided into LAN and WAN equipment. The LAN equipment segment consists of Ethernet switches as well as wireless LAN (WLAN). Enterprise WAN equipment includes routers, virtual private networks (VPN)/Firewalls, IPS and application acceleration equipment. Enterprise network firewalls are central products of WAN equipment in that their purpose consists in securing enterprise networks.

2.1.3.1. *Enterprise Ethernet Switches*

Ethernet switches can be segmented according to their bandwidth: 100 Mbps, 1 Gbps, 10 Gbps and 40 Gbps.

Figure 9 shows the global yearly shipments of Ethernet switches by bandwidth. For switches, it is common practice to refer to the number of ports shipped as opposed to the number of switches. In general, the number of ports per switch can range from 2 for small office/home office (SOHO) switches to more than 2000 ports for the high-end range. While globally port shipments rose slightly between 2011 and 2013, the share of 1 Gbps switches increased significantly from 49% in 2011 to 59% in 2013. On the other hand, the importance of smaller bandwidths decreases: the share of 100 Mbps switches declined from 49% in 2011 to 35% in 2013.

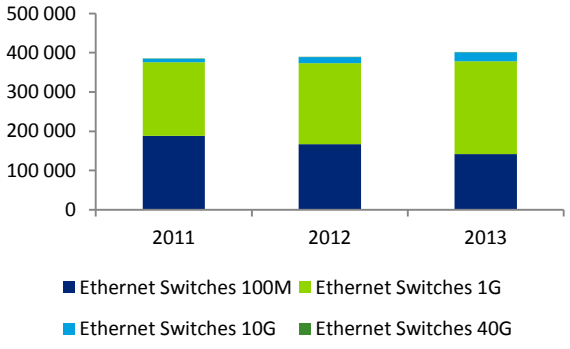


Figure 9: Global port shipments Ethernet switches (in thousands ports) (Source: Gartner[31])

Scaling these figures to the EU-28 level gives rise to the following estimations:

[31] Source: Figure based on data from Gartner – Forecast: Enterprise Network Equipment by Market Segment, Worldwide, 2011-2018, Update 2Q14 (June 2014), see Table 42 in Annex 2.

Table 14: Ethernet switches port shipments in the EU-28 (Calculations performed by Bio by Deloitte[32])

	2011	2012	2013
Ethernet switches port shipment EU-28 (in thousands ports)	77 270	75 907	76 664
Units change (%)		-2%	1%

Table 14 shows that the growth rate of the ports shipped during the period of 2011 to 2013 decreased slightly in the order of 2% before recovering in 2013.

These estimated sales numbers are relatively in line with figures received from stakeholders and which are presented in Table 15. Like for servers, figures from stakeholders give higher estimates than the IT market analysts. Since the data obtained directly from stakeholders provide a more detailed breakdown of products, they will be retained for the subsequent analysis. In 2013, fixed managed Ethernet switches made up 58% of the overall port shipments, followed by fixed unmanaged servers (37%). Modular managed servers play a less important role in the sales figures and represent only a fraction of around 5%. Within each market segment, 1 Gbps port shipments accounted for the majority of sales (>50%).

In terms of functionality, managed switches provide all the features of unmanaged switches, allowing the devices to communicate with each other, but in addition give the possibility to configure, manage and monitor the LAN. This results in increased user control over the access of data and how it travels over the network.[33] Furthermore, there exist modular and fixed configurations of managed switches.

Table 15: Ethernet switches port shipments in EU-28 (number of ports sold, Source: stakeholders)

Switch type	Bandwidth	2013	Market share of product type (in %)	
Modular managed	100M	94 000	2.2%	
	1G	3 550 000	82.2%	
	10G	630 000	14.7%	**5%**
	40G	16 000	0.4%	
	Total	**4 290 000**	**100%**	
Fixed managed	100M	16 506 000	31.3%	
	1G	33 054 000	62.7%	
	10G	3 116 000	5.9%	**58%**
	40G	70 000	0.1%	
	Total	**52 746 000**	**100%**	
Fixed unmanaged	100M	16 282 000	47.8%	
	1G	17 750 000	52.2%	
	10G	0	0%	**37%**
	40G	0	0%	
	Total	**34 032 000**	**100%**	
Total		**91 068 000**		**100%**

[32] Source: Data from Gartner – Forecast: Enterprise Network Equipment by Market Segment, Worldwide, 2011-2018, 2Q14 (June 2014), see Table 43 in Annex 2. The Western Europe and Eastern Europe figures were taken as a basis and scaled down to EU-28 level, using World Bank GDP data.

[33] http://www.cisco.com/c/dam/en/us/products/switches/networking_solutions_products_genericcontent0900aecd806c7afe.pdf

2.1.3.2. *Enterprise Routers*

The following table shows the estimated vendor revenue for traditional enterprise routers from 2010 to 2013 in the EU-28.

Table 16: Routers vendor revenue in the EU-28 (Calculations performed by Bio by Deloitte[34])

	2011	2012	2013
Enterprise Routers Vendors Revenue (M USD)	580	514	539
Revenue change (%)	-	-11%	5%

Routers can come in a variety of product classes such as high end, midrange, low end, SOHO. They differ in their deployment and their connectivity (core, edge).

Access Routers (including SOHO (small office/home office) routers) are usually located directly at their site of deployment, such as branch offices, where no hierarchical routing is needed. They include small office models and are available at low cost.
Edge Routers can be divided into two major categories, namely Provider Edge Routers and Subscriber Edge Routers: a Provider Edge Router is placed at the edge of an Internet Service Provider (ISP) network. Subscriber Edge Routers - also called Customer Edge Routers - are located at the edge of the subscriber's network. They are typically used in enterprises.

Core Routers function as so-called collapsed backbones in order to interconnect the traffic between edge routers from different buildings of a campus or large enterprise locations. They usually are optimized for high bandwidth rates, but lack some of the technical specifications of edge routers.[35]

The following table shows unit shipments for the four categories of routers in EU-28, together with their market share in 2013, according to stakeholder data.

Table 17: Routers unit shipments in EU-28 (Source: stakeholders)

Router type	2013	Market share (in %)
High-end	34 000	4.4%
Mid-range	23 000	3.0%
Low-end	140 000	18.2%
SOHO	574 000	74.4%
Total	**771 000**	**100%**

SOHO routers account for the largest amount of routers sold on the European market with nearly 75% of the market share. However, they are considered mostly as Class B equipment, according to stakeholders' feedback, and will therefore not be considered in the next tasks of the study (see Task 1). Low-end routers make up the second biggest group in terms of units sold. High-end and mid-range routers, on the other hand, both accounted for less than 5% of the market with unit shipments in the range of 20 000 – 35 000 routers per year.

2.2. Sales growth rate

Table 18 below displays the current and forecasted annual growth rates for x86 servers in the EU-28 by form factor. From this table it appears that multi-node servers have been increasingly sold over the past years, partly at the expense of blade servers, which even experienced a negative growth rate in 2012 and

[34] Source: Data from Gartner – Forecast: Enterprise Network Equipment by Market Segment, Worldwide, 2011-2018, 2Q14 (June 2014), see Table 44 in Annex 2. The Western Europe and Eastern Europe figures were taken as a basis and scaled down to EU-28 level, using World Bank GDP data.

[35] http://technet.microsoft.com/en-us/library/dd894458%28WS.10%29.aspx; http://www.juniper.net/techpubs/qrc/m160-qrc.pdf

2013. Blade server sales are, however, expected to regain momentum from 2014. The number of rack-mountable servers was already declining over the past years and, according to the presented forecasts, it will continue this downwards trend in the near future. Rack-optimised servers, however, experienced negative growth until 2013, but now are expected to increase slowly. Finally, tower servers show a similar evolution as blade servers in that they experienced negative growth over the last two years but are also expecting positive growth rates up to 2017 before demand will drop again.

Table 18: Server Unit Growth Rates for x86 servers in EU-28 (Calculations performed by Bio by Deloitte[36])

Form Factor	2012	2013	2014	2015	2016	2017	2018
Rack-Blade	-14.7%	-5.3%	0.6%	2.9%	4.0%	2.8%	3.2%
Rack-Mountable	-14.3%	-10.7%	-19.4%	-14.4%	-9.9%	-8.8%	1.7%
Tower/Standalone	-8.5%	-6.7%	12.5%	13.7%	3.5%	-5.8%	-2.7%
Rack-Optimised	-7.9%	-5.1%	-0.9%	0.4%	1.0%	1.8%	1.8%
Multi-node	140.7%	10.5%	15.0%	9.6%	8.2%	10.7%	2.1%
Total units	**-6.1%**	**-5.0%**	**-1.1%**	**1.0%**	**1.3%**	**1.3%**	**1.6%**

As the following two tables show, storage sales have been declining in the last few years but are expected to recover growth by 2017.

Table 19: Storage Unit Growth Rates in EU-28 (Calculations performed by Bio by Deloitte[37])

Segment	2010	2011	2012	2013
CAS	-2%	14%	27%	18%
DAS	21%	-10%	-21%	-5%
SAN	13%	6%	-4%	2%
NAS	37%	-11%	-9%	-9%
Total	31%	-8%	-9%	-6%

Table 20: Storage Unit Growth Rate forecasts in EU-28 (Calculations performed by Bio by Deloitte[38])

Segment	2014	2015	2016	2017	2018
NAS	3%	-3%	-1%	1%	1%
DAS & SAN	-6%	0%	-1%	2%	2%
Total units	0%	-2%	-1%	1%	1%

Ethernet switches as well as enterprise routers have experienced a negative growth rate in the last couple of years and are expected to pursue this trend in the coming years, as shown in Table 21.

Table 20: Network equipment related growth rates in Western and Eastern Europe (Calculations performed by Bio by Deloitte[39])

Segment	2012	2013	2014	2015	2016	2017
Ethernet switches (unit change)	1%	-1%	-1%	-3%	-4%	-3%
Enterprise traditional routers (revenue change)	-11%	5%	-4%	-3%	-5%	-6%

[36] Source: Data from Gartner: Forecast: Servers, All Countries, 2011-2018, 2Q14 Update (June 2014), see Table 45 in Annex 2. The Western Europe and Eastern Europe figures were taken as a basis and scaled down to EU-28 level, using World Bank GDP data.
[37] Source: Data from Gartner: Quarterly Statistics: Disk Array Storage, All Regions, 4Q13 (March 2014), see Table 46 in Annex 2. The EMEA figures were taken as a basis and scaled down to EU-28 level, using World Bank GDP data.
[38] Source: Data from Gartner: Forecast: External Controller-Based Disk Storage, Worldwide, All Countries, 2014-2018, 2Q14 Update (June 2014), see Table 47: ECB storage unit shipments forecast in EMEA, 2013-2018 (Source: Gartner) in Annex 2. The EMEA figures were taken as a basis and scaled down to EU-28 level, using World Bank GDP data.
[39] Source: Calculation of unit growth rates based on data from Gartner: Forecast: Enterprise Network Equipment by Market Segment, Worldwide, 2011-2018, 2Q14 (June 2014), see Table 48 and Table 49 in Annex 2. The Western Europe and Eastern Europe figures were taken as a basis and scaled down to EU-28 level, using World Bank GDP data.

2.3. Product lifetimes

There are several different definitions for the word “lifetime” and it is important to make clear to which type of lifetime the reference is made. In particular, one can distinguish:

- The economic lifetime, which refers to the time after which equipment is renewed by the owner/operator for economic and business reasons (even if it is still functional); and
- The technical lifetime, that refers to the time after which the product does not function anymore and cannot be repaired. The technical lifetime is usually longer than the economic lifetime.

The technical lifetime of enterprise servers and data equipment may be above 10 years for certain equipment. One issue is that the modularity of equipment makes it difficult to determine the lifetime for an entire product, as failing components (memory, hard drive, etc.) can be replaced progressively, so that after several years, a product could be composed of completely different components while still being the same product. Environmental conditions (temperature, humidity) and their variations have an influence on the failure rates of products and components.

Based on the stakeholder consultation, the economic lifetime of servers is estimated between **3 and 5 years**. This estimate is also in accordance with a recent survey by Intel Czech Tradings, which found that 51% of the responding companies deployed servers older than 4 years. 20% administered their data on servers which are older than 5 years.[40] Fault tolerant servers/mainframes are estimated to have a longer economic lifetime, typically **7-10 years**. The economic lifetime is therefore quite variable, and depends upon the operator, the applications, as well as the economic context.

According to DIGITALEUROPE, there are examples in the industry as well as inside manufacturers, where accelerated conversion of servers allowed cost avoidance due to the capability to defer expansion or build-out of data centre space. The OPerating EXpense (OPEX) can also be decreased where data centre operators take advantage of newer technology that increase the number of images or applications supported on a single server or storage product through virtualization and enables the reduction of data centre energy consumption through the implementation of power proportional computing capabilities (power management modes). As OPEX increases or compute demand increases, some level of early system retirement is expected to save on OPEX and/or avoid building another data centre. Retirement is expected to be less sensitive to long-term hardware reliability as opposed to OPEX efficiency. The limiting factor is either to replace servers or build a new facility.

Reasons for early replacement include energy efficiency improvement in latest products, operating system conversions, new (compute) capacity or capability, and service contracts. For example, technologies such as virtualisation and those arising from software defined hardware structures (e.g. Software Defined Data Centres, Software Defined Infrastructure, Software Defined Networking, etc.) will reconfigure or accelerate retirement of older systems. The same is true for enterprise storage and server- and storage- related network equipment. A survey among IT experts[41] revealed that one virtualised server can replace 15 five-year old normal ones saving the company millions of dollars of ownership cost. At the same time operating costs can be drastically reduced, while substantially increasing performance at the same time. The Gigant Group, for instance, could reduce operating costs by 76% while improving computing performance by 40%.

Table 21 gives an overview over estimated lifetimes and shows that there is a significant gap between the technical and economic lifetime of the different products, as estimated by DIGITALEUROPE.

[40] CIA – Daily News: Intel: 50% of companies have servers older than 4 years (16 June 2014)
[41] CIA – Daily News: Intel: One virtualised server can replace 15 normal ones (16 June 2014)

Table 21: Average lifetime, by type of equipment, according to DIGITALEUROPE

Equipment type	Average economic lifetime (in years)	Average technical lifetime (in years)
Tower, rack, multi-node or blade servers	3 for lease 3 to 5 for primary users up 5 to 7 for secondary user	7 - 10
Mainframe servers	7 - 15	20
Data storage devices (hard disk drives, solid-state drives, hybrid drives) and systems	5 - 7	7 - 10
Server and storage related network equipment (switches and routers)	5 - 7	15 - 20

This is in line with IDC estimates, according to which, pre-recessionary server life cycles for volume and midrange servers were consistently around three to five years in length[42]. IDC also estimates that a significant decline in the availability and reliability of most x86 servers is observed once they have been in operation for about three to 3.5 years[43]: extending server replacement from three years to five years increases the failure rate by 85% and hardware that is five years old has 21% more downtime than equipment that is three years old. IDC recommends 4-year server refresh cycle to business managers[44] for the three following benefits: increased processing power/performance, increased reliability, and reduced costs. However, many companies are pushing their servers to five or more years, especially because of the economic context: due to constrained IT budgets, replacement of these servers has been pushed out throughout 2009 and into 2010, so that some devices reached five- to six-year life cycles. This usage behaviour was confirmed in an interview with an end-user, who stated that they would replace their servers every 5 years preventatively, since after this period the rate of failure would increase. According to this IT expert, the main determinant of the renewal decision would be the trade-off between risk of failure, on one hand and the product costs on the other hand.

The design lifecycle for enterprise servers and data equipment is longer than general consumer equipment, and the service lifecycle of the equipment can go up to 20 years. Customers expect to be able to maintain and upgrade their equipment for a long period of time. In some situations, manufacturers no longer produce the service parts for these products for purchase, but draw on stocked equipment for service of older machines.

Regarding data storage systems and devices, including hard disk drives (HDD), as well as solid-state drives (SSD) and hybrid drives, DIGITALEUROPE finds an average economic lifetime of 5-7 years, whereas the technical life expectancy is estimated to be between 7 and 10 years. The former estimates have been confirmed in a study by Carnegie Mellon University in 2007, during which the researchers analysed a sample of 100 000 drives from a number of large-scale production systems. They found that the failure rate[45] increased substantially after an operating time of 5-7 years towards the end of the lifecycle.[46] Storage products are designed in a modular way, to change storage devices (drives) that fail. Thus, it can be considered that the lifetime of the controller is the limiting factor of the product lifetime.

As for server and storage related network equipment, such as routers and switches, DIGITALEUROPE stated that the economic lifetime would be around 5 years, whereas the technical lifetime would be in the range of 15-20 years. However, replacement should not take place on a regular basis, but should rather depend on the following four factors, which are thus determining the economic lifetime:

- Market innovation: it may in some cases render an already existing product obsolete in that a technology upgrade is required. On the other hand, in the case of an increasingly standardized

[42] http://i.dell.com/sites/content/business/smb/sb360/en/Documents/idc-server-trends-whitepaper.pdf
[43] IDC (2012) Server Refresh Cycles: The Costs of Extending Life Cycles
[44] http://i.dell.com/sites/doccontent/business/smb/sb360/en/Documents/wp-cost-of-server-refresh-delay.pdf
[45] Here disk failure is defined as a situation leading to the replacement of the drive.
[46] http://www.pdl.cmu.edu/ftp/Failure/failure-fast07.pdf

market or when facing a product with a small number of software features, we are more likely to observe extended product lives.

- Vendors' end-of-life (EOL) policies: the end of the support for hard- and software of the network equipment constitutes an issue for the operator, but it does not necessarily imply the replacement of equipment given that the operator can turn to third parties for support.
- Operating costs, through which firms take the direct financial aspect into account: the introduction of more energy-efficient products, as well as of new lifetime warranties, among others, provides companies with a strong incentive to purchase new equipment; consequently decreasing economic lifetime.
- Level of risk

2.4. Replacement sales and new sales

When it comes to sales figures, a distinction between replacement and new (non-replacement) sales can be made. The overall sales of products are the combination of:

- New sales, which result from new service needs: the proliferation of applications may drive increasing new sales. According to IDC[47], on average, the demand for data within a company is growing at about 35% to 40% per year. This rate may even reach 60% for small businesses[48].
- Replacement sales, which are replacing products that reach their economic lifetime: according to DIGITALEUROPE, the current replacement rate is between 1 new for 5 to 10 old server units, partly because of the consolidation and virtualisation trends. It should be noted that storage systems can also be consolidated as new generation products are rolled out.

It seems that due to increasing utilisation rates through virtualisation the installed stock is able to absorb the increasing workloads to a certain extent. However, new sales might again become important, once this transition period is over. The process is analysed more thoroughly in the next section.

2.5. Stock models

The objective of this section is to present forecasts of the installed stock development of the different products in scope of ENTR Lot 9. The forecasted stocks are geographically limited to EU-28 and projected until 2030. **At this point it has to be noted that the equipment under consideration is undergoing very fast technological changes, for which reason these long term estimations, required by the MEErP, have to be considered with caution**. In particular, these estimations are based on the current knowledge and perspectives of the market and new calculations based on updated data may result in variations of the outcomes. The EC will therefore be provided with the stock model tool developed, in order to be able to proceed with updates after the completion of DG ENTR Lot 9.

For the server equipment, a double approach with two different models has been retained:

- **Model A** is based on forecasts using yearly sales figures, expected demand growth and life-time assumptions. Information from DIGITALEUROPE and IT research firms have been taken into consideration in separate estimations in order to check for consistency.
- **Model B** is based on inferences made from IP traffic and workload projections provided by the Cisco publication "Cisco Global Cloud Index: Forecast and Methodology, 2012-2017 (2013)" and is used as an alternative approach to check consistency with Model A results.

For storage and network equipment only Model A has been retained, using input data from either research firms or stakeholders, presented in the previous sections.

The models do not consider the business applications of the products, more information on this aspect can be found in Task 3.

[47] IDC (2012). Server Refresh Cycles: The Costs of Extending Life Cycles.
[48] http://i.dell.com/sites/doccontent/business/smb/sb360/en/Documents/wp-cost-of-server-refresh-delay.pdf

2.5.1. Background information on the different models

2.5.1.1. *Model A*

Model A takes as an input current and forecasted annual sales and estimated life-times of the different equipment. It has to be again reminded that that the market for servers, storage and server- and storage-related network equipment is very dynamic and subject to important technological changes. For this reason, even though it is possible to get an overview over the current market situation, it is difficult to anticipate the development over the next 10-15 years. While the underlying forecasting model is very simplified, it gives an idea of how the stock might develop. In case the market situation changes, the model can be adapted accordingly in the future thanks to the corresponding Microsoft Excel tool which will be provided to the Commission with the final report.

In order to “build” a stock, several important assumptions with respect to different variables have been made and will be clarified in the following subsections.

*2.5.1.1.1. **Lifetime***

When it comes to the estimation and simulation of failure rates, reliability and lifetimes, the Weibull distribution is one most employed probability distribution because of its versatility and relative simplicity. It can be adapted accordingly by means of the shape parameter *k* and the scale parameter *λ*.

$$f(x;\lambda,k) = \begin{cases} \frac{k}{\lambda}\left(\frac{x}{\lambda}\right)^{k-1} e^{-(x/\lambda)^k} & x \geq 0, \\ 0 & x < 0, \end{cases}$$

The shape parameter of the Weibull distribution has an important impact on the final interpretation of the process. More precisely, if *X* stands for a "time-to-failure", the Weibull distribution represents a distribution for which the failure rate is proportional to a power of time. The shape parameter, *k*, is that power plus one. It can be interpreted in the following way:

- A value of $k < 1$ indicates that the failure rate decreases over time.
- A value of $k = 1$ indicates that the failure rate is constant over time.
- A value of $k > 1$ indicates that the failure rate increases with time.

As far as electronic equipment is concerned, a shape parameter of $k > 1$ will be retained, since failure is expected to increase with time. In general, this happens when there is an "ageing" process, and when parts are more likely to fail as time passes by.

Different values for *k* like *k=1* (exponential function), *k=2* (Rayleigh function) and *k=3.6* (Gaussian/normal distribution) have been considered. However, since the resulting outputs did not show significant differences, the normal distribution has been retained for all projections.

The value of the scale parameter *λ* determines the statistical dispersion of the probability distribution. A change in the scale parameter, *λ*, has the same effect on the distribution as a change of the horizontal scale. Increasing *λ* while holding *k* constant stretches the probability density function (pdf). Since the area under a pdf curve is a constant value of one, the "peak" of the pdf curve will decrease with the increase of *λ*.

If *λ* is increased, while *k* is kept constant, the distribution is being stretched out to the right and its height decreases, while maintaining its shape and location. If *λ* is decreased, while *k* is kept constant, the distribution gets pushed in towards the left, and its height increases.

λ is the time at which 63.2% are expected to fail. This is true for all Weibull distributions regardless of the shape parameter.

2.5.1.1.2. Sales growth rate

The assumptions on the demand growth rate can be summarised in the following formula:

$$g_t = \sqrt[t]{(1 + r_1) * (1 + r_2)^{t-1}} - 1$$

This expression models a smooth transition from growth rate parameter r_1 to parameter r_2.

- If $r_1 < r_2$ demand growth is increasing in time from $\boldsymbol{r_1}$ to $\boldsymbol{r_2}$
- If $r_1 = r_2$ demand growth is constant in time
- If $r_1 > r_2$ demand growth is decreasing in time from $\boldsymbol{r_1}$ to $\boldsymbol{r_2}$

Even if future growth rates are difficult to anticipate, this approach has been chosen in order to allow giving a growth tendency for each product.

2.5.1.2. *Model B*

According to Cisco Global Cloud Index (2013)[49], a forecast including trends associated with data centre virtualisation and cloud computing, annual global data centre IP traffic will reach 7.7 zettabytes by the end of 2017, growing with a Compound Annual Growth Rate (CAGR) of 25% from 2012-2017. Total data centre workloads[50] are forecasted to reach 188.2 million, as compared to 83.4 million in 2012. This development is depicted in the following figures:

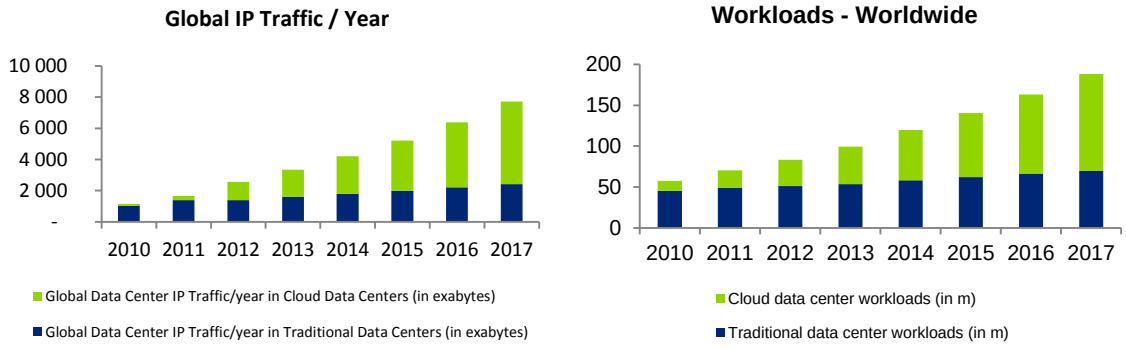


Figure 10: Forecasts for Global IP Traffic / Year and Worldwide Workloads[49]

By 2017, almost two-thirds of all workloads will be processed in the cloud, as compared to around 39% in 2012 and this trend can be expected to continue. Extending these forecasts until 2030 by keeping the above growth assumptions (CAGR) constant leads to the following traffic and workload projections.

[49] Cisco Global Cloud Index: Forecast and Methodology, 2012-2017 (2013) ; figures for 2010 and 2011 were taken from the previous publication: Cisco Global Cloud Index: Forecast and Methodology, 2010-2015

[50] A workload can be defined as the amount of processing a server undertakes to run an application and support a number of users interacting with the application. (Source: Cisco)

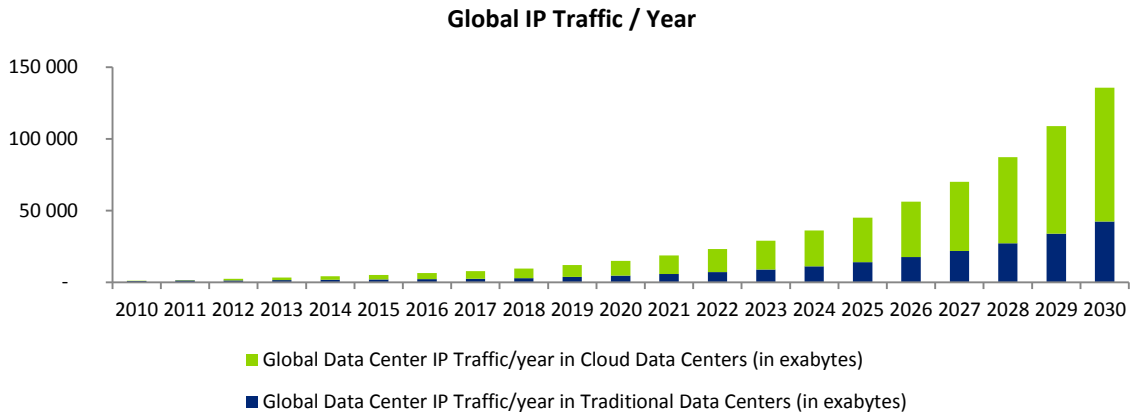


Figure 11: Forecasts for Global IP Traffic / Year until 2030

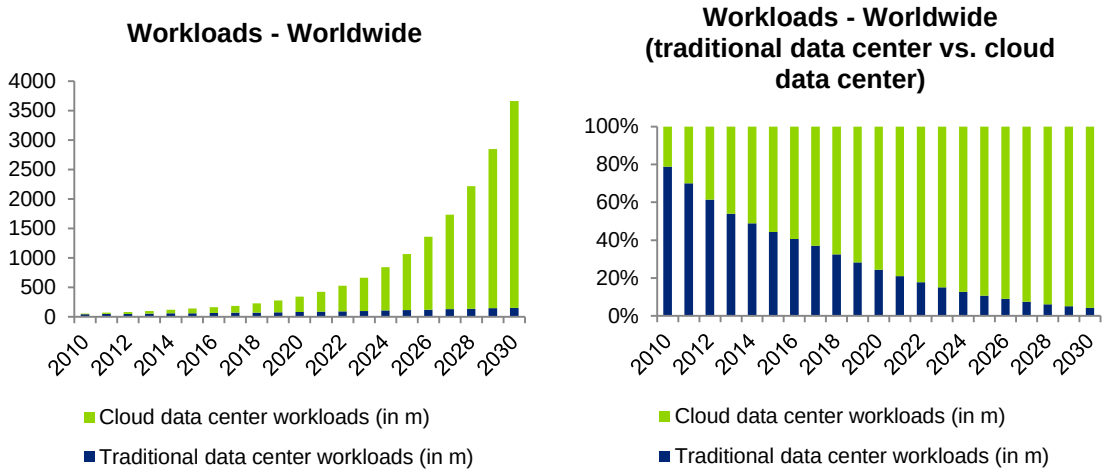


Figure 12: Forecast of worldwide workloads until 2030

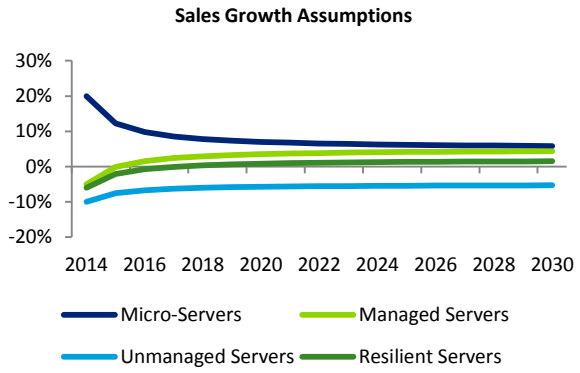
The above figures make clear that a radical change might happen in the next years if the current trend is maintained. Cloud workloads become more and more important and traditional data centre workloads could make up only a minor share in 2030. Global IP traffic is projected to surpass the 100 zettabyte level, while workloads could rise up to 3.5 billion by 2030.

2.5.2. Enterprise Server stocks

2.5.2.1. *Model A with inputs from DIGITALEUROPE (A1)*

2.5.2.1.1. Assumptions for Model A1

Based on inputs received from DIGITALEUROPE the following assumptions for the current breakdown of the installed stock, the lifetimes, and the expected demand growth were retained for different server categories:



Form Factor	Share of installed stock in 2012 (%)	λ
Micro Servers	0,25%	5
Managed Servers	83,75%	
Unmanaged Servers	14,75%	
Resilient Servers	1,25%	

2.5.2.1.2. Output of Model A1

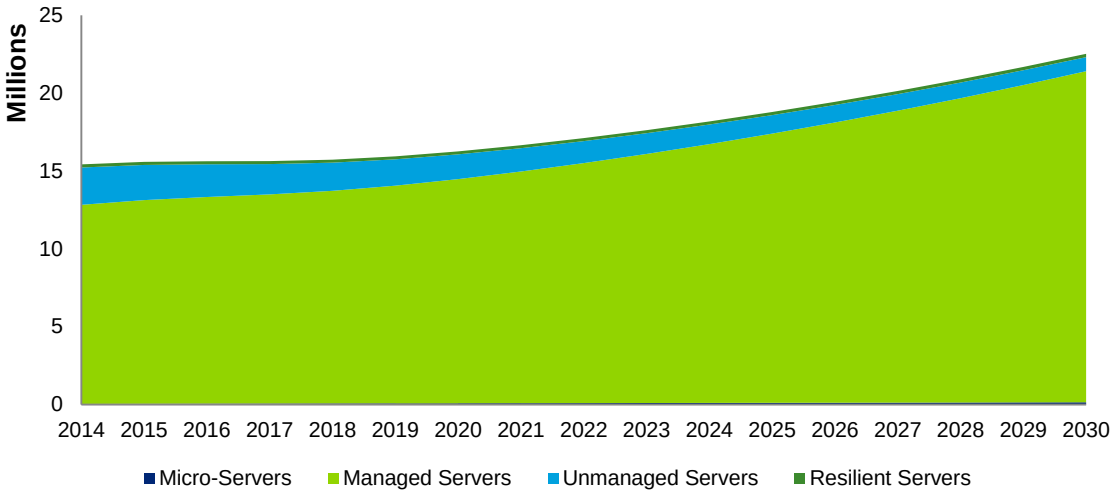


Figure 13: Projected server stock in EU-28 according to stock model A1

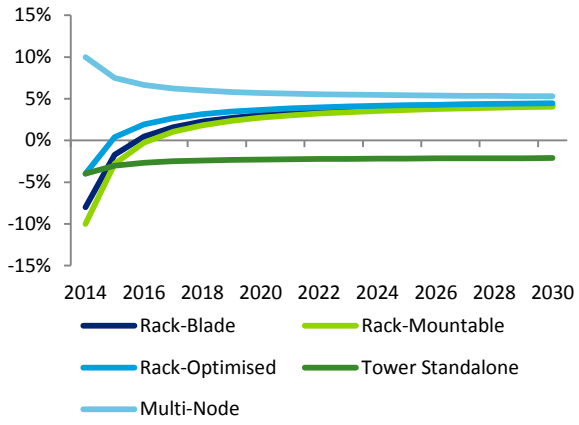
The first output of Model A, using sales figures provided by DIGITALEUROPE, shows an overall installed server stock of around 15 million servers in 2014. The stock is forecasted to remain relatively flat until 2020 and increase afterwards. Managed servers keep on dominating the overall shares.

Since the underlying sales figures are higher than those obtained during the literature review and the consultation of IT research companies, the estimated stock is larger than calculated in the next estimation.

2.5.2.2. ***Model A with alternative inputs (A2)***

2.5.2.2.1. Assumptions for Model A2[51]

Based on literature review and the consultation of stakeholders and end-users, the following assumptions for the current breakdown of the installed stock, the lifetimes, and the expected demand growth were retained for enterprise servers by form factor:



Form Factor	Share of installed stock in 2013 (%)	λ
Rack-Blade	14%	5
Rack-Mountable	17%	
Rack-Optimised	57%	
Tower/ Standalone	8%	
Multi-node	4%	

As far as enterprise servers are concerned, it is assumed that overall sales follow a negative growth trend in the next couple of years during the process of virtualisation and consolidation and should pick up afterwards. Multi-node servers make up the lowest share in the stock but are supposed to have the highest growth rate as compared to the other form factors.

2.5.2.2.2. Outputs of Model A2

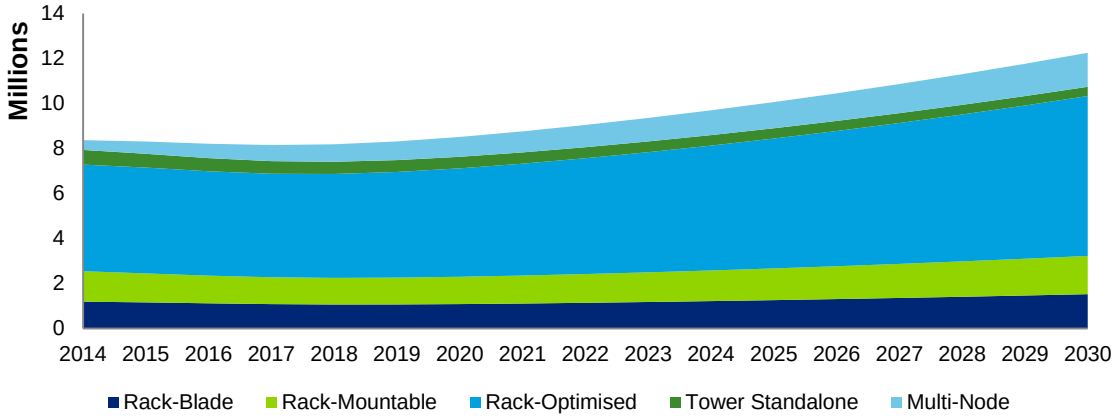


Figure 14: Projected server stock in EU-28 according to stock model A2

It can be observed that with the retained calibration, the calculated stock is smaller than in the previous projection and amounts to around 8.3 million enterprise servers in EU-28. As before, it is projected to remain relatively constant in the next couple of years and only pick up after 2020. This is particularly driven by the effect of increased chip performance and the virtualisation process as discussed earlier. Rack-optimised servers constitute the bulk of the stock (>50%), followed by rack-mountable, rack-blade and tower standalone servers. Multi-node servers constitute a minor share for the time being but are projected to increase their market share significantly.

[51] Assumptions on the currently installed stock are based on historic sales figures and the life-time parameters of the Weibull-Distribution. Assumptions with respect to growth rates by form factor are Bio by Deloitte estimates reflecting current market trends and the consolidation process. The value of λ=5 has been retained for the scale parameter, meaning that 63.2% of the equipment is replaced after 5 years.

2.5.2.3. *Model B with Cisco inputs*

The tremendous workload projections based on the Cisco publication presented beforehand do not necessarily imply that the server stock needs to follow similar dynamics, since servers are able to handle more and more workloads due to increased chip performance (Moore's law) and utilisation rates through virtualisation.

The installed server stock estimation presented in Figure 15 below is based on the Cisco forecasts shown earlier and a forecast of workloads that servers will be able to manage in the future. This number is expected to increase significantly with the increasing role of virtualisation and improved chip performance. According to Gartner[52], 41.3 million servers were installed in data centres in 2010 worldwide. Cisco estimated total data centre workloads at around 57.5 million in 2010. While this number jumped to 83.4 million (+45%) in 2012, the overall installed server stock in data centres remained flat with a slight decrease to 41.2 million (-0.2%) in the same year. **This means that while a server could handle around 1.39 workloads on average in 2010, the performance increased to 2.02 in 2012.** This trend shows that the currently installed stock is able to handle the rapidly rising workloads. Under the assumption that the ability of a server to absorb these rapidly increasing workloads keeps on growing as could be observed between 2010 and 2012, the server stock scaled to the European level[53] can be projected in the following way:

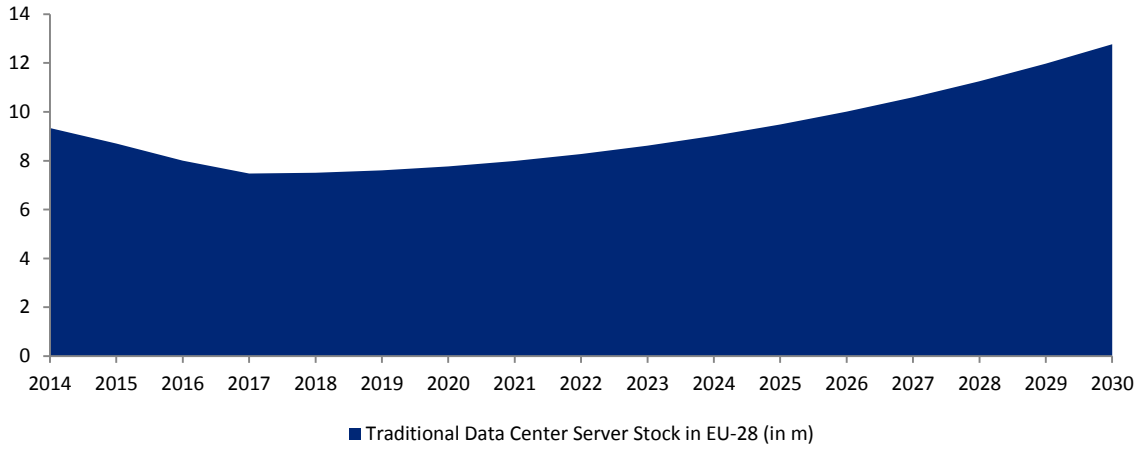


Figure 15: Projected server stock in EU-28 according to stock model B (in millions)

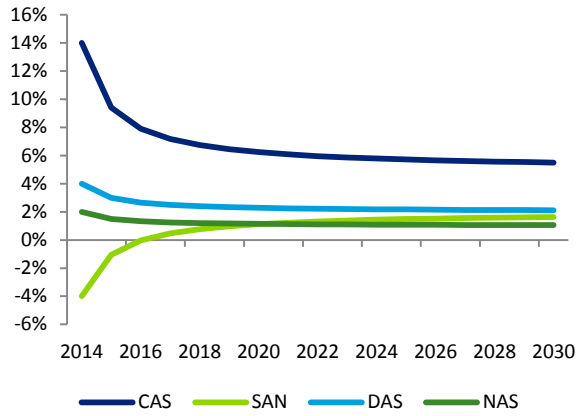
In 2014, the installed server stock is estimated at around 9.3 million units, which is relatively close to results obtained through model A2 (8.3 million). The total server stock is projected to decrease in the next couple of years and to remain relatively flat in the next 10 years. The main reason for this development is again the important potential for virtualisation and consolidation on the market that should be saturated around 2020. Sales might regain momentum when this potential is exhausted and IP traffic and workloads continue to increase. By 2030 the installed stock could reach 12.8 million units, in line with projections of model A2. But, as explained above, a server unit in 2030 will not be equivalent to a unit in 2013, in terms of functionality.

[52] See Table 50: Sales and Installed Base of Servers and Storage in Data Centres worldwide (Source: Gartner) in the Annex 2.

[53] According to Cisco, around 25% of the workload was related to Europe (Western & Central/Eastern Europe) in 2012. Since in particular Asia is forecasted to increase its traffic, this share is projected to decrease to around 21% in 2017. For the projection until 2030 it is assumed that the European share remains at 21%

2.5.3. Enterprise Storage stock (Gartner data)

2.5.3.1. *Assumptions for the enterprise storage stock by storage architecture*[54]



Storage Architecture	Share of installed stock in 2013 (%)	λ
SAN	22.8%	7
DAS	6%	
NAS	71%	
CAS	0.2%	

Apart from SAN systems, storage systems are forecasted to follow a positive growth trend on a global scale. SAN are projected to recover growth around 2017.

2.5.3.2. *Output of model A for storage equipment by storage architecture*

Applying equivalently above assumptions for sales, lifetime and demand growth to model A gives the following results for the storage stock model:

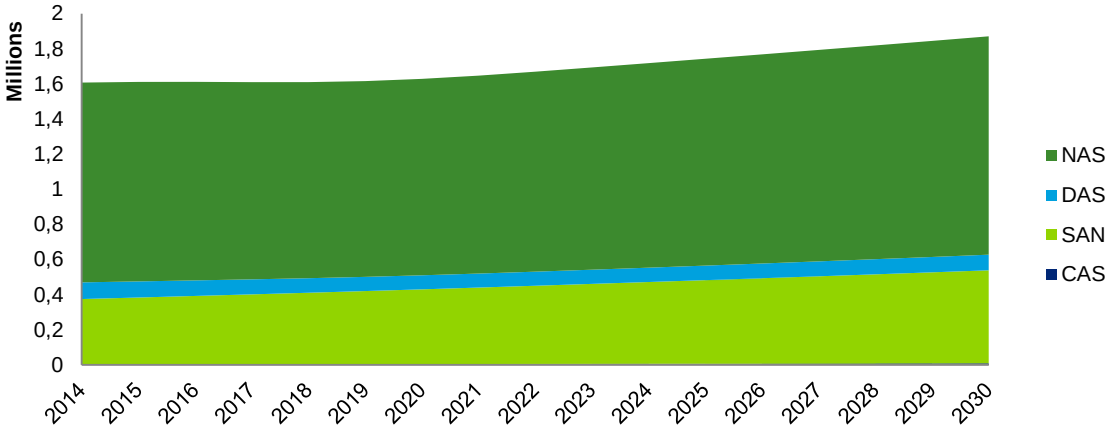


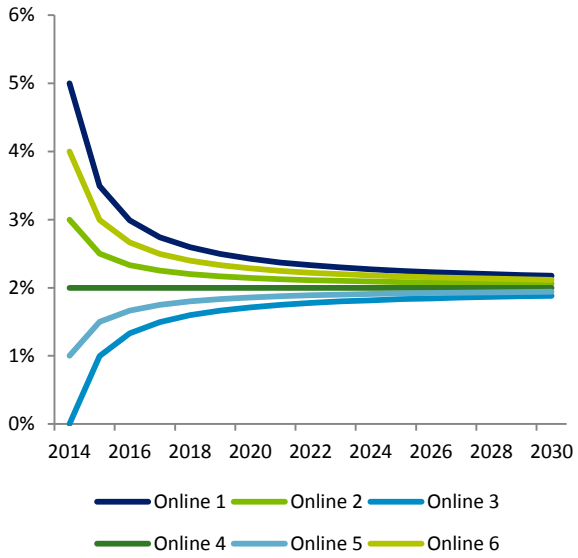
Figure 16: Projection of the installed ECB storage stock in EU-28 according to stock model A

Above figure shows that that the stock of ECB storage systems is estimated at around 1.6 million units and is projected to remain relatively flat. NAS systems constitute the largest share, followed by SAN. The overall stock is projected to reach around 1.9 million units in 2030.

[54] Assumptions on the currently installed stock are based on historic sales figures and the life-time parameters of the Weibull-Distribution. Assumptions with respect to growth rates by form factor are Bio by Deloitte estimates reflecting current market trends. The value of λ=7 has been retained for the scale parameter, meaning that 63.2% of the equipment is replaced after 7 years.

2.5.3.3. *Assumptions for the enterprise storage stock by SNIA taxonomy*

The stock projections of storage according to the SNIA taxonomy were estimated by using historical IDC data of storage classes and price band price ranges. It should therefore be considered as an approximation.



Storage Architecture	Share of installed stock in 2013 (%)	λ
Online 1	44.4%	7
Online 2	30.4%	
Online 3	21.5%	
Online 4	3%	
Online 5	0.3%	
Online 6	0.4%	

2.5.3.4. *Output of model A for storage equipment by SNIA taxonomy*

No projections are available according to the SNIA taxonomy and it is assumed that growth rates converge to 2%. The estimated stock projection takes the following picture:

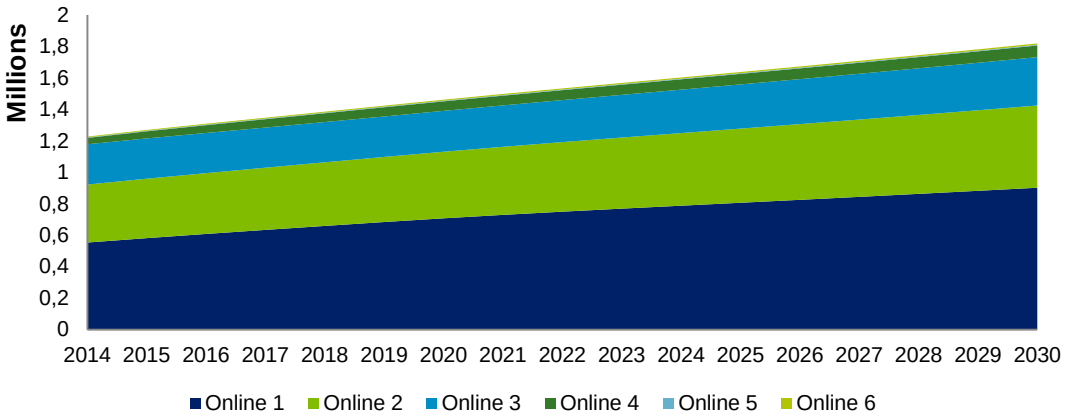
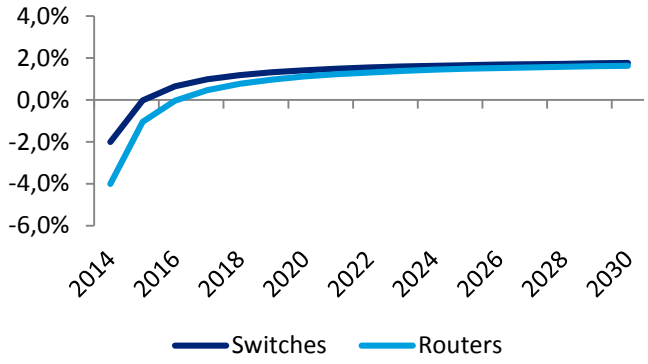


Figure 17: Projection of the installed external storage stock in EU-28 according to stock model A

Figure 17 shows that Online 1 and Online 2 products constitute the lion share of the installed stock. The EU-28 total stock is estimated at around 1.2 million products (around 25% less than with the previous estimation, using another dataset). Based on above mentioned assumptions the stock is projected to increase to around 1.8 million units in 2030.

2.5.4. Enterprise (server and storage related) network equipment

2.5.4.1. *Assumptions for enterprise (server and storage related) network equipment stock*[55]



Network Products	λ
Ethernet Switches	7
High-end, Mid-range & Low-end Routers	

Both switches and routers are projected to recover from negative sales growth rates around 2016 and continue a positive trend afterwards.

2.5.4.2. *Outputs of Model A for switches and routers*

- **Enterprise Ethernet Switches (and installed ports)**

The following figure shows the forecasted stock development of installed ethernet switches ports from 2014 till 2030.

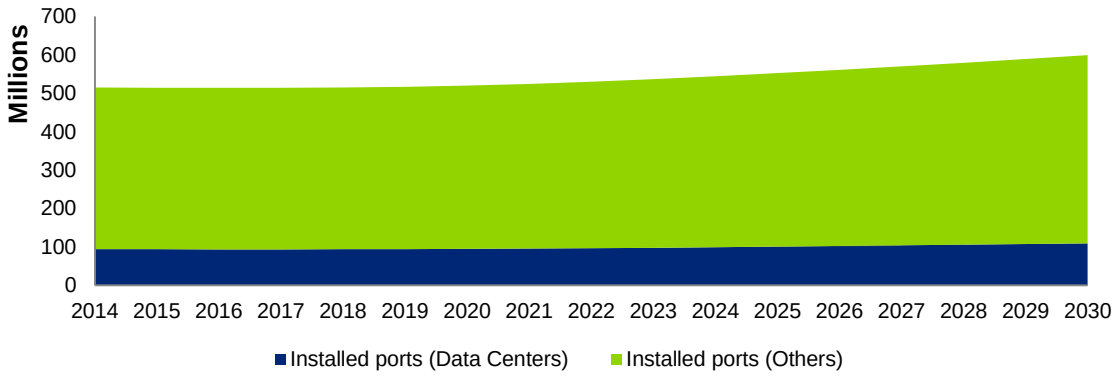


Figure 18: Projections of the installed ports (Ethernet switches) in EU-28 according to the stock model

The above Figure shows that the installed ports are expected to slightly increase from around 500 million ports in 2014 to around 600 million in 2030. These ports are, however, not only related to data centres but also used elsewhere like e.g. in the telecommunication sector. An analysis performed by Bio by Deloitte resulted in the estimation that only around 18% of the shipped ports find their destination in data centres (see above Figure). Standard switches used in data centres are usually equipped with either 24 or 48 ports, which means that installed switches in the EU should be in the range of around 2 – 4 million installed units as can be seen in below graph:

[55] Assumptions on the currently installed stock are based on historic sales figures and the life-time parameters of the Weibull-Distribution. Assumptions with respect to growth rates by form factor are Bio by Deloitte estimates reflecting current market trends. The value of λ=7 has been retained for the scale parameter, meaning that 63.2% of the equipment is replaced after 7 years.

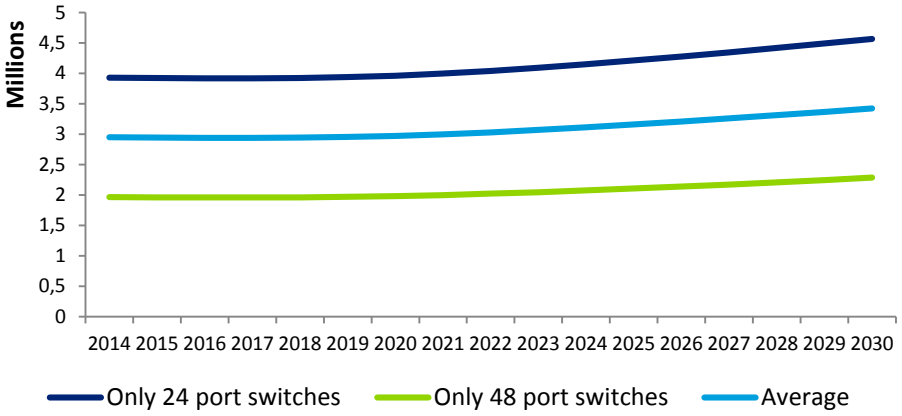


Figure 19: Installed enterprise switches in EU-28 according to the stock model

- **Enterprise Routers**

As far as routers are concerned, only high-end, mid-range and low-end routers have been taken into account, since SOHO routers are considered to be predominantly classified as Class B products. The following figure shows the enterprise routers stock projections for low-end, mid-range and high-end products.

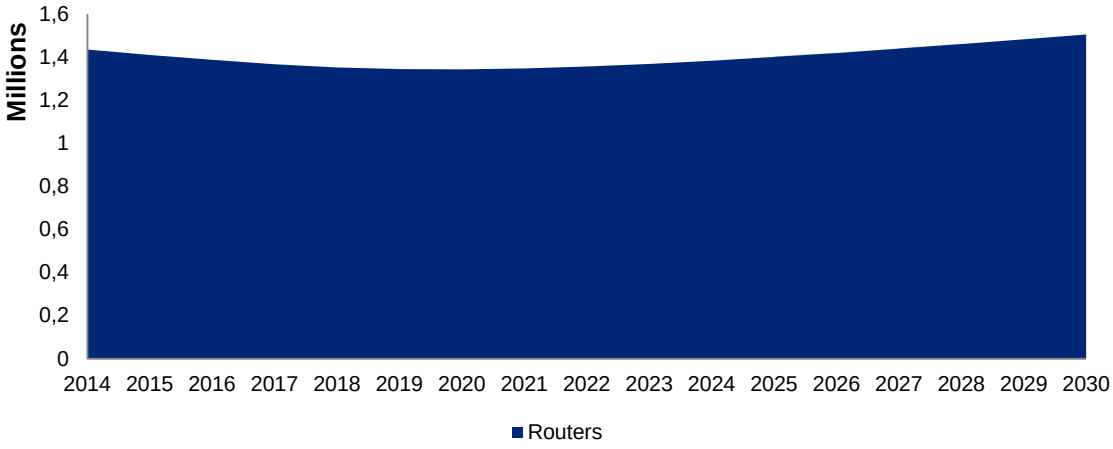


Figure 20: Projections of the installed routers in EU-28 according to the stock model

According to the model outputs, routers are forecasted to experience a relatively flat stock amounting to around 1.4 million units.

3. Market trends

3.1. General market trends

The following market trends, influencing the sales and stock of IT equipment, can be observed:

- **Cloud services:** A main market driver in the next few years is cloud-computing services including software-as-a-service such as for productivity software. Cloud services are also related to media and data storage, video streaming and customised media services, as well as gaming and platforms. Cloud services are expected to demand high volumes of data storage capacity. Data transfer volumes are expected to increase at a steady rate of 25 % CGAR according to the current Cisco Virtual Network Index. This trend translates into a continued growth in shipments of blade servers and emerging categories such as micro-servers for lower compute intensive workloads (although increasing capabilities are anticipated in the future), which are associated with reduced power consumption and cost of ownership and considered as the building blocks for clouds. Low compute intensive workloads include, for instance, cold storage, which is referring to the storage of data which is seldom accessed.[56]
- **Big data:** Big data infrastructure includes ubiquitous and automatic sensor data acquisition (e.g. from industry applications), automatic filing and analysis, software-defined IT resource utilisation and increased data security provisioning (monitoring systems). There is an increasing collection of sensor data from various sources in all fields of application including from industry (e.g. remote condition monitoring, ambient data for robots), transportation (e.g. RFID, GPS, traffic control), energy grid (e.g. decentralized energy production form renewable resources), environmental applications (e.g. water, air soil properties), customer relationship (e.g. shopping behaviour) and other end-user data (e.g. smart meters). It is expected that the server, storage and related network equipment market will continue to evolve around these changing applications and workloads.
- **Fixed-mobile conversion:** Mobile computing and communication is a third and important market driver. Ubiquitous access to information (e.g. email, internet) and social networks (e.g. Facebook, Twitter), localisation services (e.g. GPS, Navi), mobile shopping and payment (e.g. micro payment), video on demand and video communication are all services that require increased IT equipment and data centre resources. Through mobile applications (mobile availability of online services and social networks) will the number of downloaded and uploaded data grow continuously. This trend is illustrated by Facebook's disaggregated data centre proposal to the Open Compute Project (OCP), which enables separation of compute, storage, and network resources in hyperscale data centres. According to Facebook's former vice president of hardware design and supply chain optimisation, off-the-shelf servers are in general not economical, since they include features that most organisations do not need, leading to increased costs and wasted electricity.[57]
- **Security and encryption**: Driven not only by recent events, secure communication and data handling will continuously change design and architectures of products and network systems. Encryption technology is a growing trend leading to both – software-based and hardware-based solutions. It must be expected that the security overhead in terms of computing and network demand will increase. The new SPEC SERT test standard is reflecting the growing demand in encryption technology by testing a specific encryption workload (worklet).
- **Real time computing:** The demand for very fast computing and immediate communication (latency and bandwidth) is a continuous demand particularly in the banking sector. The number of servers utilised and the workload created in the finance and banking sector is considerable with about 25 % market share (see Task 3 report). Real time computing demands new computing architectures for parallel computing, computing in memory (immediate access), and high volume / bandwidth I/O. New semiconductor technologies for processors and memory as well as photonic

[56] http://www.dailyfinance.com/2014/05/13/will-the-growing-popularity-of-microservers-disrup/

[57] ServerWatch: New Trends in the World of Servers and Virtualization. (12 May 2014) http://www.serverwatch.com/server-trends/servers-and-virtualization.html

technologies for light-speed data transport within and between computing devices is an important driver for the technical development.

It should be noted, that technology advancements, the expansion of the Internet of Things (IoT) representing the increasing proliferation of sensors and collection and analysis of their data, data privacy requirements, and other developments in IT system capabilities and management policies, may also change market demand.

3.2. Market channels and production structure

The servers, storage and server- and storage-related network equipment market in the EU is mainly comprised of a few large manufacturers, which are global players and mostly producing outside of the EU-28. They develop key technologies, which are however installed in very wide range of different configuration. Small and Medium Enterprises (SMEs) have a very low share of the market. According to Gartner data for 1Q13 in EMEA[58], the five top international vendors accounted for 78% of the shipments.

These manufacturers are well represented by industry associations at the Member State and EU level, mainly through DIGITALEUROPE[59]. DIGITALEUROPE represents the European digital technology industry, which includes large and small companies in the Information and Communications Technology and Consumer Electronics Industry sectors, and regroups more than 10,000 companies all over Europe. Some of the main equipment manufacturers are listed by alphabetical order in the Table 22 below (non-exhaustive lists).

Table 22 : Main manufacturers of servers, storage and server- and storage-related network equipment

Servers	Storage equipment	Server- and storage-related network equipment
• Cisco • Dell • Fujitsu • Hitachi • HP • IBM • Lenovo • NEC • Oracle • Quanta • Supermicro	• Dell • EMC • Fujitsu • HGST • Hitachi • HP • IBM • NEC • Netapp • Oracle • Seagate • Western Digital	• Brocade • Cisco • Extreme Networks • Dell • HP • Huawei • Lenovo • Oracle • Supermicro

The European Data Centre Association (EUDCA) is a growing organisation membership from 17 countries addressing specific issues relating to the data centre industry at a European level. EUDCA created multiple working groups that will deal with policy and regulation, standardisation, data protection and energy policy. The objective of EUDCA is to facilitate proper understanding and good practice with respect to standards and regulations.[60]

The product distribution channels of ENTR Lot 9 products are mostly business-to-business, as these products usually require experience and engineering knowledge for proper installation and configuration.

3.3. Trends in product design and features

With respect to product features, key drivers are expandability, reliability, energy efficiency and cost as opposed to just traditional compute performance. According to industry stakeholders, there are a number of other product features and technologies under development, which are confidential. There is however,

[58] http://www.gartner.com/newsroom/id/2497015

[59] More information at: http://www.digitaleurope.org/

[60] http://www.datacentres.com/news/european-data-centre-association-announce-launch-4-new-working-groups

recognition of resource limitations in the data centre, so most market segments will be striving to maximize useful output for those limited resources to meet the growing demand in the various segments. The energy density will increase and advanced integrated cooling technologies will enter the market. First products with liquid or hybrid cooling technologies are available or already implemented in the field (mainly in HPC data centres).

The overall market composition can also be expected to change as a result of the increasingly important position, which original-design manufacturers (ODMs) take in the areas of enterprise servers, storage and server- and storage-related network equipment. ODMs accounted for 13.4% of the most common type of servers sold worldwide in 2013, which is equivalent to an increase of 347% over the last 5 years. The combined share of the traditional manufacturers HP and Dell fell from 60% to 52% in 2013.[61]

Products of ODMs are characterised by lower prices and by the fact that they allow for user-customisation. One end-user found that the plastic logos which are placed on most servers proved to be an obstacle for air flow and consequently increased cooling costs. The manufacturer then stripped off its logos saving the end-user about 25 Watts of electricity per server.[61]

Other trends include:

- Continuous growth of virtualisation is leading to dematerialisation and lower demand in physical servers. The trend in virtualisation is not only observed for servers themselves, but also for storage products like SANs. Thus, the availability of effective and low-cost virtual SAN technology can be expected to exert a big effect on many organisations.[57]
- Increasing modularity of server designs, driven by changing server workloads and costs of ownership.
- Purpose built systems: Server manufacturers are offering purpose built systems, which provide an optimal hardware structure through integrated network, storage, and server products, and workload specific software. These systems are designed to maximize the workload delivered per each unit of energy consumed, the benefits of which are driven by the overall optimization of the combined hardware and software systems.
- The introduction of low power ARM processors to the server market, also driven by costs of ownership: AMD has announced the planned introduction of ARM server processors in 2014.
- The increasing use of graphics processing units (GPUs) as compute engines in servers, driven by increased performance (gigaflops) per Watt.

Product diversity: As a general trend the product diversity of the market will increase. This development is driven by new specialized applications such as big data, fixed-mobile conversion, encryption and secure communication and naturally by cost considerations including both CAPEX and OPEX. According to stakeholders there are no dominating new product trends although system-on-chip micro-server architectures utilising different processors (e.g. ARM) as well as storage-heavy server products (in memory computing) are expected to get considerable market shares in a short period of time. Vendors introduce new products approximately every 18 to 24 months that are much more powerful than the previous generation and at roughly the same price because of added features or at a lower price. Higher physical density (space saving), shared infrastructure, and flexible modular design (enabling higher utilisation) are other drivers of this trend of micro-servers. In practice, micro-servers can thus be deployed to handle lightweight tasks, which subsequently allows for the freeing up of larger servers to run the compute intensive tasks. Consequently, micro-servers are not likely to become as popular as traditional servers, making it a niche market. Tech Pro Research found that one of the biggest drawbacks of micro-servers at the current state seems to be their input/output limitations, which was given as a reason by a large part of the 47% of companies not evaluating their deployment.[62] Any shift to a new architecture would also entail the adaptation of companies' software stacks in order to render them compatible, consequently slowing down the adoption of micro-server chips. Thus, it is estimated that the market for micro-server chips will grow to 5% of worldwide server ship revenue by 2017.[63]

[61] The Wall Street Journal Online: Web Weapon: No-Frills Servers; Companies Like Quanta Computer Make Inroads Against IBM, Dell, Cisco. (9 June 2014) http://online.wsj.com/articles/web-weapon-no-frills-servers-1402358378
[62] http://www.dailyfinance.com/2014/05/13/will-the-growing-popularity-of-microservers-disrup/
[63] http://www.fool.com/investing/general/2014/06/09/amd-vs-intel-will-arm-server-chips-tip-the-balance.aspx

New technologies: On a technical level, performance is related to three basic elements – parallel processing capacity, highest memory capacity with latency, and respective input/output bandwidth. These required properties are only possible by continuous investments into research and development particularly in the field of nanostructure semiconductor technologies and photonic technologies. The trend of shrinking the form factor will continue (miniaturisation paradigm according to Moore's Law). With each new semiconductor technology generation the thermal and electromagnetic challenges are increasing. One of the most recent introductions of a purpose built system is "The Machine" by HP, which, according to its manufacturer, would encompass a server, PC, workstation, device and phone. The resulting system could be six times more powerful than currently existing servers with a computing capacity of 640 TBs of data in one nanosecond, while on the other hand, requiring 80 times less energy.[64] HP's new product uses clusters of special-purpose cores in line with the actual workload instead of a small number of general purpose processors, linking them to universal memory through photonics, optical transistors out of silicon, rather than with slow and energy-consuming copper wires. Finally, HP is also developing so-called memristors (memory resistors) as the universal memory store, which should at the same time perform data processing, as well as storage tasks. As a consequence this should allow the handling of massive data sets not only taking them, but also ingesting, storing and manipulating them.[65] HP is not expecting to provide samples until 2015 and the first devices equipped with The Machine are scheduled for 2018.

[64] IFLScience : New Type Of Computer Capable Of Calculating 640TBs Of Data In One Billionth Of A Second, Could Revolutionize Computing (16 June 2014) http://www.iflscience.com/technology/new-type-computer-capable-calculating-640tbs-data-one-billionth-second-could

[65] Jon Fingas: HP's Machine technology rethinks the basics of computing. (12 June 2014) Available at: http://www.engadget.com/2014/06/11/hp-the-machine/

4. Consumer expenditure data

Average EU consumer prices, as well as applicable rates for running costs (e.g. electricity, water) and other financial parameters (e.g. taxes, rates of interest, inflation rates) are presented in this section. These data represent important inputs for Task 5, where both LCC for new products and annual cost are calculated.

4.1. Average EU consumer prices

This section reports the range of purchase prices together with a typical purchase price for enterprise servers, storage and server- and storage- related network equipment. Data were collected through research on the manufacturers' websites and in the cases for which no official prices could be found, trusted online stores were referred to.

4.1.1. Enterprise Servers

With regard to servers, price ranges are indicated for six typical products. Data were collected for 51 different server models from the five biggest manufacturers (by market share measured in terms of unit shipments), namely HP, Dell, IBM, Fujitsu and Cisco. The research was further narrowed down to x86 servers with 1 to 4 CPUs. This sample is assumed to be representative, since previous sections have already identified x86 servers (98.4% of the market share) and 1-4 CPUs servers as prevalent (99.7% of the market share).

As far as obtained prices are concerned, some of the data were treated as follows in order to render it comparable. All prices given in US dollars (USD) were converted using the annual average exchange rate 2013 of USD 1.3281.[66] All prices were provided exclusive VAT with the exception of PC Pro. Here, a VAT of 21.5%, which is the average standard rate for the EU-28, was deducted.[67] Subsequently, all results were rounded to the nearest 50 unit; down for the low-end and up for the high-end of the price range.

Table 23: Purchase prices (excluding VAT) of some typical server products in Euros/unit

Product type		Range of purchase price (€/unit)	Source[68]
Servers	**# Sockets**		
Rack managed	1	700 – 1 300	2, 5, 6
Rack managed	2	1 300 – 76 100	2, 4, 5, 6, 7
Tower managed	2	750 – 4 600	2, 3, 5
Blade managed	4	3 500 – 11 800	1, 3, 5, 6
Rack resilient*	2	4 950 – 6 750	1
Rack resilient*	4	3 400 – 72 050	2, 4

* Data is scarce for these product types with respectively 2 and 6 models only

Table 23 shows that there are very wide price variations within the presented categories. This is due to the fact that servers are highly customisable products, which can be configured in great detail according to

[66] Deutsche Bundesbank : Exchange rate statistics as of June 5, 2014

[67] Calculated from a report by the EC "VAT Rates Applied in the Member States of the European Union – Situation at 13th January 2014" (2014). Available at: http://ec.europa.eu/taxation_customs/resources/documents/taxation/vat/how_vat_works/rates/vat_rates_en.pdf

[68] The numbers indicated refer to the following sources respectively: 1. HP Product Catalogue Russia (2013) 2. HP official website (U.S.) http://www.hp.com/ (last accessed: 25/04/2014) 3. Dell official website (U.S.) http://www.dell.com/ (last accessed: 24/04/2014) 4. IBM Price List as of 21 April 2014 as published by Kernel Software Inc. http://www.kernelsoftware.com/products/catalog/ibm.html (last accessed: 24/04/2014) 5. Business Systems international (BSi) http://www.e-business.com/ (last accessed: 24/04/2014) 6.Insight (U.S.) https://www.insight.com/ (last accessed: 24/04/2014) 7. PC PRO http://www.pcpro.co.uk/ (last accessed: 24/04/2014) 8. EMC online store https://store.emc.com/ 9. SearchStorage: http://searchstorage.techtarget.com/news/1147208/EMC-Centera-channel-charges-ahead / http://searchstorage.techtarget.com/tip/EMC-introduces-Centera-to-the-fixed-content-market

customers' needs. Therefore, the consumer purchase prices which are reported in the above table are highly variable and can only be seen as indicative for the range of possible prices. In most of the cases, they are presented with starting prices for the most basic configuration so that the high-end prices concern highly specialised products. During the research process, the following factors could be identified as having an important influence on server prices:

- Number and speed of CPUs;
- Type, speed and capacity of the memory;
- Type, number and size of disk drives;
- Operating system;
- Years of warranty included.

4.1.2. Storage systems

Price ranges for storage systems are given for the four different types, namely CAS, DAS, NAS and SAN.

Table 24: Purchase prices (excluding VAT) of some typical storage systems in Euros/unit

Type of storage system	Range of purchase price (€/unit)	Source[68]
CAS	100 000 – 205 000	9
DAS	3 950 – 63 550	3
NAS	2 800 – 50 950	3, 8
SAN	4 850 – 36 150	3

Once more, the difference between the price ranges for the different storage systems is very large and depends on the respective features, which were already outlined in the chapter on Storage Architecture.

As for the variation of price within one of the four classes, the most important factor influencing price is the number of drives, which are characterized by their type (HDDs or SSDs), as well as their capacity. Additional important drive features are speed and read-/write intensity. This gets also reflected in the purchase price of the storage system given that a write-intensive drive, with exactly the same speed and size, costs nearly twice as much when compared to a drive not possessing this attribute.[69] This is due to the fact that write-intensive drives are more adequate for transfers of large amount of data to the drive. Taking, for instance, Dell's PowerVault MD3260, a DAS system, the price amounts to USD 2 248.68 for a 200 GB SSD[70], whereas it is of USD 4 198.24 for an otherwise identical drive, but with the additional feature of being write-intensive.[68]

There exists also a large price difference because of the following two technical specifications: high performance tiering, which increases the array of input-output performance; and SSD cache, which accelerates application performance by utilising SSDs as extended controller read cache.

[69] Dell official website (U.S.) http://www.dell.com/ (last accessed: 13/06/2014)
[70] SAS Value SLC 6Gbps 2.5in Hot-plug Drive

4.1.3. Enterprise (server and storage related) Network Equipment

The following two tables report data on switches and routers, which were obtained directly from the industry.

Table 25: Purchase prices (excluding VAT) of switches (Source: stakeholders)

Product class	Number/ bandwidth of downlink ports	Uplink count and type	Range of purchase price (€/unit)
Access	12+ / 1Gbps	2-8 / 1Gbps	750 – 18 800
High Speed Access	12+ / 1Gbps	2-8 / 10Gbps	3 000 – 33 100
Distribution and/or Aggregation	8+ / 1Gbps	2+ / 10Gbps	5 250 – 45 200
Core	8+ / 10Gbps	4-16 / 10Gbps	33 900 – 60 250
Data Centre	12 – 48 / 1Gbps	2 / 10Gbps	75 300

Table 25 shows that the main criterion influencing the average purchase price is the type of the switch, even though price ranges can be overlapping. Also, not surprisingly, the purchase price tends to increase with the number of ports.

Table 26: Purchase prices (excluding VAT) of routers (Source: stakeholders)

Product class	Range of purchase price (€/unit)
Access	450 – 75 300
Edge	45 200 – 150 600
Core	75 300 – 1 129 450

The huge range of purchase prices can be explained by the fact that each product class of routers can be once more divided into three sub-classes, depending on their characteristics and features:

- Route Scale: Users can connect to other internet protocol (IP) addresses within and outside the LANs/WANs. Thus, the most important characteristics here are the border gateway protocol (BGP) and the interior gateway protocol (IGP). The BGP is the routing protocol of the internet, which is used to route traffic across the internet. The IGP, on the other hand, is used for the information exchange between routers within an autonomous system, such as a system of LANs. Price is then increasing in connection speed and in the number of multicast routes.
- Service Scale: Features are centred on the LAN, which can then be extended. Using, for instance, Virtual Private LAN Services (VPLS), this allows for the LAN to be extended to the edge of the provider network. Since VLANS are functionally equivalent to multiple separate switches, a router is needed to route traffic between them. Important factors are the number of people who can connect to the router, the IP range and at what speed.
- Logical Interface Scale: This is the configuration of one or multiple units including all protocol information, addressing and other logical interface properties in order to enable the router to function.[71] Once again, the faster and the more connections exist, the higher the selling price.

Regarding port configuration, the underlying logic is the same as for switches, since a greater number of ports and increased speed result in higher prices.

[71]http://www.juniper.net/techpubs/en_US/junos13.3/topics/concept/interfaces-logical-interfaces-configuration-properties-overview.html

4.2. Repair, maintenance and installation costs

Enterprise servers and data equipment are not only expensive to buy, but also to operate and maintain. Therefore, the total cost of ownership is close to the top criteria of customer purchasing decisions. Most manufacturers include a three year repair warranty in their purchase prices for servers, even though it can sometimes be only a one year warranty, in particular for low-end models. In some cases, a three year warranty can be extended to up to seven years for an extra charge and depending on the product. This was confirmed by an interviewed end-user.

Dell[72], for instance, offers one to seven year maintenance contracts including one or two events per year for its servers. Here, the costs range from one year of maintenance with one event for 150 € to 1 725 € for seven years of maintenance including two yearly interventions. Regarding storage systems, on-site installation costs are slightly lower amounting to 132 €, while maintenance during one year with one intervention costs around 210 € and the highest level of maintenance available is of five years including two events for 1 700 €. However, these contracts are not always purchased, since many large organisations have their own IT experts that take care of the maintenance. For this reason, it is not straightforward to estimate the average maintenance costs for the equipment under consideration.

For switches, Cisco - for example - provides three different hardware warranties:

- the Cisco 90-Day Limited Hardware Warranty, which among others is applicable to blade switches;
- the Cisco One-Year Limited Hardware Warranty for data centre switches;
- a five year warranty starting from end of sale of the product for Small Business products.

These warranties are included in the purchase price of the products, with the 90-Day Limited Hardware Warranty being the minimum applied to all Cisco hardware and software products.

As far as installation costs for servers and storage are concerned, they are usually subject to an additional fee[73], and onsite installations of switches might be declined. For example, Dell[72] charges around 340 € for an onsite installation of a blade server, whereas this service is not offered for rack and tower servers. As for storage systems, the remote onsite hardware installation with remote configuration assistance costs the customer 425 €. Dell does not offer any onsite installations of switches, but only a remote implementation including phone support assistance. The costs depend on the type of switch and ranges from 237 € for an Ethernet switch to 850 € for a layer 3 Ethernet switch.

4.3. Energy and water costs

Electricity and water prices as listed in the new MEErP methodology[74] are presented in this subsection. Table 27 shows the generic electricity and water prices, the energy escalation rate and VAT values in the EU-28. These values require adaptation to the year considered in the assessment in Tasks 5, 6 and 7, as they refer to the year 2013.

[72] Dell official website (U.S.) http://www.dell.com/ (last accessed: 12/06/2014)

[73] See for instance: Dell official website (U.S.) http://www.dell.com/ (last accessed: 12/06/2014), HP official website (U.S.) http://www.hp.com/ (last accessed: 12/06/2014)

[74] VHU, MEErP 2011 Methodolody Part 1. Available at:
http://www.meerp.eu/downloads/MEErP%20Methodology%20Part%201%20Final.pdf

Table 27: Generic electricity and water prices in the EU-28, 2013 (source: MEErP)

	Unit	Domestic incl. VAT	Long term growth per year	Non-domestic excl. VAT
Electricity	€/ kWh	0.18	5%	0.12
Water	€/m3	3.70	2.5%	
Energy escalation rate	%	4%		
VAT	%	20%		

4.4.Interest and inflation rates

A default value of 4% is suggested as the EU average discount rate in the new MEErP methodology. Table 28 presents the generic interest, inflation and discount rates in the EU-28.

Table 28: Generic interest and inflation rates in the EU-28, 01.01.2011 (Source: MEErP)

	Unit	Domestic incl. VAT	Long term growth per year	Non-domestic excl. VAT
Interest	%	7.7%		6.5%
Inflation rate	%	2.1%		
Discount rate (EU default)	%	4%		

5. Recommendations

5.1. Refined product scope from an economic and commercial perspective

Given the market figures presented in this chapter, no specific form factor can be excluded categorically from the server scope, as they all have annual sales shares above 5% (>100,000 units). As far as server categories are concerned, micro-servers - even if still having very low sales shares to date (0.325%) and being considered as a niche market - are a fast growing segment and represent one of the future trends that should be taken into account in the next chapters to the best extent possible. Regarding the number of CPU sockets, servers with more than 4 CPUs will be excluded from the analysis in the next chapters, since they only represent 0.3% of sales being used for very specific applications (High Performance Computing, etc.).

Concerning storage products, CAS will be excluded from the next chapters of the study, given its minor share in shipments, revenues and capacity, amongst other storage solutions (DAS, NAS, SAN). Furthermore, Online 1 storage products are not studied in detail, since they refer to consumer components as well as Online 5 and 6 products, since they belong to high-end or mainframe categories and represent together only 3% of the market.

5.2. Barriers and opportunities for Ecodesign from the economical/commercial perspective

One of the most important barriers to Ecodesign measures for servers, storage and server- and storage-related network equipment can be seen in the very fast technology development of the industry, and hence short redesign cycles. The business-as-usual product evolution (including energy efficiency improvements) that has been ongoing over the past decades has been amongst others driven by Moore's law. Furthermore, new technologies are regularly entering the market such that it is extremely difficult to predict what potential improvement of the products could arise in the mid- and long-term. The IT industry is known to be one of the most innovative industries, because the market itself requires constant improvement and adaptation of the goods and services provided. The way IT systems are currently designed and managed in data centres may even undergo drastic changes in the future, depending on forthcoming technology developments, e.g. switching from the currently modular organisation of a data centre (specific functionalities of servers, storage and network equipment) to integrated systems.

Given this fast and continuous evolution, relevant and well balanced Ecodesign measures may be very difficult to define. In particular, the time required for going through the Ecodesign legislative process may result in outdated measures, if the process is not fast enough or does not allow regular adjustments. Furthermore, once implemented, regular updates should be ensured every 2-3 years, given the short design cycles. This may result in heavier administrative burden than for other product groups, both for the EC and manufacturers.

On the other hand, given the concentrated structure of the market with a few global players, the implementation of appropriate Ecodesign measures is likely to have an impact beyond the EU-28 market, in terms of environmental performance improvement.

Annexes

Annex 1.Detailed PRODCOM data

The tables (Table 29 to Table 34) below present the detailed import, export, production and EU apparent consumption by Member State (both by number of units and by value in million Euros) in 2012 for the NACE Codes concerning products covered in ENTR lot 9 study as reported by PRODCOM. Negative apparent consumption figures appear which reveal inconsistencies in the data, as negative apparent consumption is theoretically not possible.

Table 29: PRODCOM data on production, import and export volumes for 26201400 - Digital data processing machines: presented in the form of systems, in 2012

Member State	Quantity in 1000 units				Value in million €			
	Production	Imports	Exports	Apparent EU consumption	Production	Imports	Exports	Apparent EU consumption
Austria	32 550	344 153	118 775	257 928	24 421 600	143 718 920	81 225 530	86 914 990
Belgium	n.a.	626 027	258 930	n.a.	n.a.	218 501 710	107 750 710	n.a.
Bulgaria	1 147	32 007	9 962	23 192	398 302	8 786 470	16 494 390	-7 309 618
Croatia	953	0	0	953	5 778 374	0	0	5 778 374
Cyprus	0	1 352	126	1 226	0	1 096 260	934 410	161 850
Cz. Republic	n.a.	284 121	1 263 496	n.a.	n.a.	105 180 710	431 423 820	n.a.
Denmark	7 412	144 838	28 043	124 207	11 049 881	66 312 550	27 289 350	50 073 081
Estonia	0	2 248	116	2 132	0	1 789 560	309 460	1 480 100
Finland	0	126 181	6 672	119 509	0	70 835 950	41 420 600	29 415 350
France	n.a.	1 465 708	1 581 828	n.a.	n.a.	626 110 720	143 513 900	n.a.
Germany	2 111 352	1 298 463	678 262	2 731 553	1 207 590 945	831 517 540	443 471 850	1 595 636 635
Greece	n.a.	105 105	3 933	n.a.	n.a.	14 779 510	667 500	n.a.
Hungary	127 338	81 564	65 849	143 053	194 355 364	72 739 870	52 448 840	214 646 394
Iceland	0	n.a.	n.a.	n.a.	0	n.a.	n.a.	n.a.
Ireland	n.a.	96 610	43 278	n.a.	n.a.	60 718 190	23 241 070	n.a.
Italy	27 188	613 898	64 393	576 693	14 800 000	194 488 990	35 945 720	173 343 270
Latvia	n.a.	8 453	2 239	n.a.	n.a.	7 390 300	2 415 030	n.a.
Lituania	82	20 439	2 936	17 585	575 475	9 767 940	4 367 950	5 975 465
Luxemburg	0	22 368	2 922	19 446	0	18 187 610	1 631 130	16 556 480
Malta	0	3 659	12	3 647	0	1 754 320	87 150	1 667 170
Netherlands	n.a.	2 008 025	1 958 968	n.a.	n.a.	846 944 050	753 961 210	n.a.
Norway	0	n.a.	n.a.	n.a.	0	n.a.	n.a.	n.a.
Poland	4 490	102 802	3 480 303	-3 373 011	17 467 011	41 975 160	1 817 594 730	-1 758 152 559
Portugal	0	93 641	6 745	86 896	0	45 551 330	6 306 800	39 244 530
Romania	0	41 249	2 732	38 517	0	18 383 560	2 155 400	16 228 160
Slovakia	n.a.	177 207	10 457	n.a.	n.a.	12 890 520	2 465 910	n.a.
Slovenia	n.a.	9 417	6 669	n.a.	n.a.	12 833 570	4 652 510	n.a.
Spain	11 316	459 681	405 657	65 340	14 432 896	120 599 910	22 665 030	112 367 776
Sweden	16 655	258 016	125 920	148 751	30 854 770	138 915 330	117 934 170	51 835 930
UK	n.a.	3 523 750	659 871	n.a.	n.a.	749 038 480	163 438 670	n.a.

Table 30: PRODCOM data on production, import and export volumes for 26201500 - Other digital automatic data processing machines [...], in 2012

Member State	Quantity in 1000 units				Value in million €			
	Production	Imports	Exports	Apparent EU consumption	Production	Imports	Exports	Apparent EU consumption
Austria	8 277	507 838	108 370	407 745	14 506 900	202 634 640	115 112 170	102 029 370
Belgium	n.a.	371 305	120 505	n.a.	n.a.	331 894 080	108 746 680	n.a.
Bulgaria	1 241	84 283	18 315	67 209	n.a.	21 524 920	3 488 330	n.a.
Croatia	313	0	0	313	105 356	0	0	105 356
Cyprus	0	15 737	109	15 628	0	8 209 390	219 970	7 989 420
Cz. Republic	n.a.	529 209	5 440 346	n.a.	1 267 247	236 327 580	2 801 279 990	-2 563 685 163
Denmark	12	323 861	95 274	228 599	28 346	219 089 280	75 189 290	143 928 336
Estonia	2 482	15 380	736	17 126	2 563 829	7 828 430	1 260 790	9 131 469
Finland	n.a.	201 102	54 734	n.a.	12 877 371	164 559 720	49 195 170	128 241 921
France	n.a.	2 170 681	422 865	n.a.	n.a.	1 196 083 460	484 218 900	n.a.
Germany	107 100	2 333 737	2 168 049	272 788	181 373 670	1 552 914 930	1 457 506 080	276 782 520
Greece	0	59 845	1 962	57 883	0	15 984 990	783 210	15 201 780
Hungary	321 587	152 468	1 367 722	-893 667	81 381 162	79 846 290	568 350 260	-407 122 808
Iceland	0	n.a.	n.a.	n.a.	0	n.a.	n.a.	n.a.
Ireland	0	182 949	151 794	31 155	0	165 695 170	380 639 510	-214 944 340
Italy	50 667	1 758 250	241 684	1 567 233	27 501 000	634 710 410	175 565 290	486 646 120
Latvia	0	9 107	4 648	4 459	0	6 164 850	1 406 770	4 758 080
Lituania	1 270	104 984	27 080	79 174	653 672	18 847 900	11 683 320	7 818 252
Luxemburg	0	37 016	56 487	-19 471	0	78 358 400	95 828 450	-17 470 050
Malta	0	6 471	54	6 417	0	6 169 080	47 500	6 121 580
Netherlands	n.a.	2 793 104	3 573 896	n.a.	n.a.	1 909 456 970	2 825 993 350	n.a.
Norway	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Poland	n.a.	716 960	272 457	n.a.	7 691 089	174 361 320	57 037 170	125 015 239
Portugal	n.a.	123 355	119 881	n.a.	n.a.	43 064 910	9 106 780	n.a.
Romania	0	118 916	53 260	65 656	0	49 731 790	4 628 790	45 103 000
Slovakia	n.a.	66 909	16 605	n.a.	n.a.	27 361 120	2 110 390	n.a.
Slovenia	n.a.	25 530	1 505	n.a.	n.a.	14 538 950	1 393 260	n.a.
Spain	2 973	936 580	205 074	734 479	6 431 939	319 464 540	18 490 610	307 405 869
Sweden	n.a.	611 589	159 902	n.a.	n.a.	375 535 110	64 091 670	n.a.
UK	91 740	2 990 074	1 217 079	1 864 735	99 133 030	1 748 163 120	315 302 190	1 531 993 960

Table 31: PRODCOM data on production, import and export volumes for 26202100 - Storage units, in 2012

Member State	Quantity in 1000 units				Value in million €			
	Production	Imports	Exports	Apparent EU consumption	Production	Imports	Exports	Apparent EU consumption
Austria	n.a.	3 033 026	1 288 649	n.a.	n.a.	259 233 240	109 081 180	n.a.
Belgium	0	10 944 365	6 165 423	4 778 942	0	773 887 350	544 283 660	229 603 690
Bulgaria	0	389 705	60 340	329 365	0	19 238 810	2 237 220	17 001 590
Croatia	0	0	0	0	0	0	0	0
Cyprus	0	57 960	3 022	54 938	0	5 745 240	224 690	5 520 550
Cz. Republic	n.a.	28 804 805	15 071 559	n.a.	n.a.	1 569 127 780	1 417 639 030	n.a.
Denmark	661	2 354 490	887 039	1 468 112	50 513	250 282 260	104 644 670	145 688 103
Estonia	0	127 481	7 839	119 642	0	10 386 870	569 000	9 817 870
Finland	0	1 092 096	195 050	897 046	0	105 820 840	45 871 750	59 949 090
France	616 261	15 456 570	3 836 699	12 236 132	n.a.	1 146 473 380	337 866 350	n.a.
Germany	539 827	59 425 742	34 059 160	25 906 409	28 598 715	3 529 518 500	1 743 768 910	1 814 348 305
Greece	0	2 555 621	46 983	2 508 638	0	36 189 940	3 515 060	32 674 880
Hungary	3 215 426	6 042 428	2 720 649	6 537 205	98 170 524	439 231 660	655 714 190	-118 312 006
Iceland	0	n.a.	n.a.	n.a.	0	n.a.	n.a.	n.a.
Ireland	n.a.	6 155 976	2 328 996	n.a.	n.a.	1 000 860 270	1 380 745 540	n.a.
Italy	8 835	5 842 271	719 897	5 131 209	1 334 000	358 774 650	75 808 040	284 300 610
Latvia	0	402 593	194 913	207 680	0	18 067 160	9 415 140	8 652 020
Lituania	0	390 151	382 810	7 341	0	16 742 430	8 094 140	8 648 290
Luxemburg	0	224 952	38 304	186 648	0	102 760 470	149 378 190	-46 617 720
Malta	0	39 847	631	39 216	0	3 299 260	88 270	3 210 990
Netherlands	n.a.	47 883 283	35 239 653	n.a.	n.a.	3 219 388 260	3 520 621 810	n.a.
Norway	0	n.a.	n.a.	n.a.	0	n.a.	n.a.	n.a.
Poland	n.a.	18 055 465	2 829 133	n.a.	n.a.	917 204 500	173 361 680	n.a.
Portugal	0	1 584 924	280 532	1 304 392	0	88 310 320	17 936 010	70 374 310
Romania	0	1 388 696	140 104	1 248 592	0	65 694 380	12 334 310	53 360 070
Slovakia	n.a.	1 230 565	800 964	n.a.	n.a.	77 867 820	50 193 430	n.a.
Slovenia	0	405 958	30 836	375 122	0	16 414 270	1 992 330	14 421 940
Spain	n.a.	5 727 643	824 956	n.a.	n.a.	362 726 890	90 634 030	n.a.
Sweden	n.a.	3 944 330	1 237 886	n.a.	n.a.	292 154 610	96 860 100	n.a.
UK	n.a.	24 105 165	8 885 322	n.a.	n.a.	1 585 443 840	680 109 080	n.a.

Table 32: PRODCOM data on production, import and export volumes for 26203000 - Other units of automatic data processing machines [...], in 2012

Member State	Quantity in 1000 units				Value in million €			
	Production	Imports	Exports	Apparent EU consumption	Production	Imports	Exports	Apparent EU consumption
Austria	57 123	n.a.	n.a.	n.a.	6 545 900	n.a.	n.a.	n.a.
Belgium	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Bulgaria	n.a.	n.a.	n.a.	n.a.	1 713 877	n.a.	n.a.	n.a.
Croatia	0	0	0	0	0	0	0	0
Cyprus	0	n.a.	n.a.	n.a.	0	n.a.	n.a.	n.a.
Cz. Republic	12 188	n.a.	n.a.	n.a.	5 033 560	n.a.	n.a.	n.a.
Denmark	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Estonia	31	n.a.	n.a.	n.a.	12 038	n.a.	n.a.	n.a.
Finland	2 394	n.a.	n.a.	n.a.	1 473 969	n.a.	n.a.	n.a.
France	n.a.	4 488 480	4 660 147	n.a.	n.a.	181 133 650	191 463 530	n.a.
Germany	124 056	n.a.	n.a.	n.a.	56 998 571	n.a.	n.a.	n.a.
Greece	0	n.a.	n.a.	n.a.	0	n.a.	n.a.	n.a.
Hungary	258 662	n.a.	n.a.	n.a.	7 241 570	n.a.	n.a.	n.a.
Iceland	0	n.a.	n.a.	n.a.	0	n.a.	n.a.	n.a.
Ireland	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Italy	253 814	n.a.	n.a.	n.a.	132 991 000	n.a.	n.a.	n.a.
Latvia	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Lituania	50	n.a.	n.a.	n.a.	3 620	n.a.	n.a.	n.a.
Luxemburg	0	n.a.	n.a.	n.a.	0	n.a.	n.a.	n.a.
Malta	0	n.a.	n.a.	n.a.	0	n.a.	n.a.	n.a.
Netherlands	n.a.	13 438 374	10 852 955	n.a.	n.a.	965 282 370	1 398 002 560	n.a.
Norway	0	n.a.	n.a.	n.a.	0	n.a.	n.a.	n.a.
Poland	8 873	n.a.	n.a.	n.a.	4 420 986	n.a.	n.a.	n.a.
Portugal	365	n.a.	n.a.	n.a.	429 855	n.a.	n.a.	n.a.
Romania	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Slovakia	0	n.a.	n.a.	n.a.	0	n.a.	n.a.	n.a.
Slovenia	0	n.a.	n.a.	n.a.	0	n.a.	n.a.	n.a.
Spain	24 054	n.a.	n.a.	n.a.	3 121 378	n.a.	n.a.	n.a.
Sweden	102 048	n.a.	n.a.	n.a.	17 464 528	n.a.	n.a.	n.a.
UK	n.a.	n.a.	n.a.	n.a.	124 836 287	n.a.	n.a.	n.a.

Table 33: PRODCOM data on production, import and export volumes for 26302320, in 2012

Member State	Quantity in 1000 units				Value in million €			
	Production	Imports	Exports	Apparent EU consumption	Production	Imports	Exports	Apparent EU consumption
Austria	3 039 665	n.a.	n.a.	n.a.	45 666 800	349 141 830	288 897 940	n.a.
Belgium	2 059 777	n.a.	n.a.	n.a.	25 768 533	601 012 140	268 097 600	358 683 073
Bulgaria	41 479	n.a.	n.a.	n.a.	9 973 412	74 446 700	3 642 370	80 777 742
Croatia	2 255	0	0	2 255	138 932 787	0	0	138 932 787
Cyprus	0	n.a.	n.a.	n.a.	0	15 482 550	869 660	14 612 890
Cz. Republic	50 445	n.a.	n.a.	n.a.	37 952 921	602 961 720	857 217 640	-216 302 999
Denmark	120 806	n.a.	n.a.	n.a.	89 111 866	302 003 680	235 159 960	155 955 586
Estonia	516 000	n.a.	n.a.	n.a.	6 021 862	80 586 330	534 286 640	-447 678 448
Finland	n.a.	n.a.	n.a.	n.a.	n.a.	290 514 380	225 137 600	n.a.
France	942 538	n.a.	n.a.	n.a.	224 454 186	1 985 068 380	1 218 263 720	991 258 846
Germany	7 450 405	n.a.	n.a.	n.a.	1 321 343 808	4 176 640 050	3 200 579 490	2 297 404 368
Greece	4 795	n.a.	n.a.	n.a.	9 838 820	84 987 090	7 237 170	n.a.
Hungary	637 031	n.a.	n.a.	n.a.	16 627 578	187 288 050	721 971 110	-518 055 482
Iceland	0	n.a.	n.a.	n.a.	0	n.a.	n.a.	n.a.
Ireland	0	n.a.	n.a.	n.a.	0	283 186 890	267 785 210	n.a.
Italy	7 629 995	n.a.	n.a.	n.a.	760 092 000	1 105 886 740	251 529 880	1 614 448 860
Latvia	n.a.	n.a.	n.a.	n.a.	n.a.	45 331 030	45 552 420	n.a.
Lituania	17 551	n.a.	n.a.	n.a.	920 702	52 911 730	22 903 780	30 928 652
Luxemburg	0	n.a.	n.a.	n.a.	0	140 528 810	218 865 320	-78 336 510
Malta	0	n.a.	n.a.	n.a.	0	3 559 730	86 320	n.a.
Netherlands	n.a.	n.a.	n.a.	n.a.	n.a.	8 083 016 170	7 333 022 800	n.a.
Norway	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Poland	37 697	n.a.	n.a.	n.a.	n.a.	512 896 590	238 138 990	n.a.
Portugal	67 825	n.a.	n.a.	n.a.	13 417 802	149 695 870	26 890 790	136 222 882
Romania	186 584	n.a.	n.a.	n.a.	79 490 678	266 671 060	179 513 980	n.a.
Slovakia	75 538	n.a.	n.a.	n.a.	47 963 607	52 190 290	38 304 000	n.a.
Slovenia	n.a.	n.a.	n.a.	n.a.	n.a.	38 129 820	55 908 940	n.a.
Spain	429 527	n.a.	n.a.	n.a.	40 061 364	626 271 130	67 175 250	599 157 244
Sweden	n.a.	n.a.	n.a.	n.a.	n.a.	1 354 589 050	2 007 089 590	n.a.
UK	639 452	n.a.	n.a.	n.a.	291 786 600	3 027 935 920	1 588 167 770	1 731 554 750

Table 34: PRODCOM data on production, import and export volumes for 26302370, in 2012

Member State	Quantity in 1000 units				Value in million €			
	Production	Imports	Exports	Apparent EU consumption	Production	Imports	Exports	Apparent EU consumption
Austria	n.a.	n.a.	n.a.	n.a.	n.a.	34 625 670	21 089 750	n.a.
Belgium	300 986	n.a.	n.a.	n.a.	14 514 648	33 055 020	32 975 100	14 594 568
Bulgaria	n.a.	n.a.	n.a.	n.a.	133 961	5 308 870	3 149 870	2 292 961
Croatia	5 931	0	0	5 931	317 666	0	0	317 666
Cyprus	0	n.a.	n.a.	n.a.	0	1 185 430	5 201 670	-4 016 240
Cz. Republic	83 857	n.a.	n.a.	n.a.	32 408 128	19 598 740	23 268 060	28 738 808
Denmark	23 960	n.a.	n.a.	n.a.	24 900 654	14 100 360	25 652 900	13 348 114
Estonia	1 100	n.a.	n.a.	n.a.	160 549	5 281 510	6 212 700	-770 641
Finland	n.a.	n.a.	n.a.	n.a.	n.a.	26 028 060	5 982 420	n.a.
France	n.a.	n.a.	n.a.	n.a.	111 479 836	104 583 500	74 201 000	141 862 336
Germany	1 188 056	n.a.	n.a.	n.a.	167 537 984	200 513 660	250 426 390	117 625 254
Greece	n.a.	n.a.	n.a.	n.a.	n.a.	18 327 400	16 480 720	n.a.
Hungary	82 137	n.a.	n.a.	n.a.	1 326 787	8 887 260	3 890 030	6 324 017
Iceland	0	n.a.	n.a.	n.a.	0	n.a.	n.a.	n.a.
Ireland	n.a.	n.a.	n.a.	n.a.	n.a.	7 816 350	9 369 060	n.a.
Italy	1 053 705	n.a.	n.a.	n.a.	543 536 000	68 177 160	87 512 640	524 200 520
Latvia	n.a.	n.a.	n.a.	n.a.	n.a.	916 590	588 950	n.a.
Lituania	192 449	n.a.	n.a.	n.a.	7 130 010	2 857 860	5 844 740	4 143 130
Luxemburg	0	n.a.	n.a.	n.a.	0	7 118 140	547 350	6 570 790
Malta	0	n.a.	n.a.	n.a.	0	278 800	n.a.	n.a.
Netherlands	n.a.	n.a.	n.a.	n.a.	n.a.	114 140 120	133 151 710	n.a.
Norway	774 145	n.a.	n.a.	n.a.	37 150 540	n.a.	n.a.	n.a.
Poland	562 229	n.a.	n.a.	n.a.	12 469 209	88 891 010	23 517 250	77 842 969
Portugal	443 767	n.a.	n.a.	n.a.	2 189 240	19 250 390	9 768 730	11 670 900
Romania	n.a.	n.a.	n.a.	n.a.	n.a.	35 048 630	13 314 230	n.a.
Slovakia	n.a.	n.a.	n.a.	n.a.	n.a.	11 607 570	2 117 040	n.a.
Slovenia	n.a.	n.a.	n.a.	n.a.	n.a.	2 569 810	575 970	n.a.
Spain	1 217 354	n.a.	n.a.	n.a.	32 933 308	81 157 150	16 526 510	97 563 948
Sweden	3 287	n.a.	n.a.	n.a.	8 300 916	48 066 380	35 058 480	21 308 816
UK	649 851	n.a.	n.a.	n.a.	41 841 479	162 178 890	138 683 760	65 336 609

Annex 2. Detailed market data

Table 35: Gartner server market data worldwide and in EMEA

	Gartner Quarterly Server Vendor Shipment Estimates	
Q1	2013	http://www.gartner.com/newsroom/id/2497015
Q2	2013	http://www.gartner.com/newsroom/id/2580515
Q3	2013	http://www.gartner.com/newsroom/id/2632515
Q4	2013	http://www.gartner.com/newsroom/id/2671315

Table 36: Server shipment units in Western and Eastern Europe, by form factor (Source: Gartner[75])

Form Factor	2010	2011	2012	2013
Rack-Blade	345 730	345 769	301 716	281 452
Rack-Mountable	402 116	381 352	332 329	291 495
Rack-Optimised	1 275 684	1 306 210	1 209 033	1 137 920
Tower / Standalone	156 515	170 311	156 368	145 355
Multi-Node	32 160	58 663	138 089	154 375

Table 37: Server shipment units in Western and Eastern Europe, by number of CPU sockets (Source: Gartner[75])

Number of CPU sockets	2010	2011	2012	2013
1	490 607	525 367	488 469	471 578
2	1 623 826	1 637 130	1 563 397	1 460 764
3-4	90 121	89 896	78 997	72 008
5-8	6 193	7 828	4 570	4 835
9+	1 460	2 085	2 103	1 411

Table 38: Server shipment units in Western and Eastern Europe, by CPU type (Source: Gartner[75])

CPU family	2010	2011	2012	2013
IA64	9 224	7 934	5 314	2 884
RISC	40 308	38 282	27 979	22 125
x86	2 161 760	2 215 139	2 103 473	1 984 978
other	914	950	770	609

[75] Quarterly Statistics: Servers, Worldwide, 1Q14 Update (May 2014), Western and Eastern Europe data.

Table 39: Vendor revenue in Western and Eastern Europe, by form factor (Source: Gartner[75])

Form Factor	2010	2011	2012	2013
Rack-Blade	2 254 081 719	2 501 921 371	2 376 522 604	2 269 248 655
Rack-Mountable	1 425 839 747	1 191 368 396	955 417 502	784 931 369
Rack-Optimised	6 518 427 511	6 822 852 690	6 100 737 973	5 943 323 597
Tower/ Standalone	2 207 129 164	2 459 983 683	2 071 617 843	1 714 805 395
Multi-Node	186 404 262	174 746 091	360 051 695	376 813 920

Table 40: ECB storage revenues, shipments and capacity worldwide in 2013 (Source: Gartner[76])

2013	NAS	CAS	SAN	DAS
Total sum of revenue	5 602 852 051	285 768 699	14 819 919 357	1 815 374 661
Total sum of shipments	608 642	2 920	253 227	59 865
Total sum of capacity	8 776 773	420 417	12 634 064	1 582 140

Table 41: Unit shipments of SSDs by segment and capacity, worldwide, 2013 (Thousands of units) (Source: Gartner[77])

Drive size	Enterprise Server	Enterprise Storage
32GB-63GB	63	-
64GB-127GB	129	61
128GB-255GB	734	250
256GB-511GB	1 896	482
512GB-1023GB	1 818	433
1TB-1.99TB	533	56
2TB-4.99TB	115	6
5TB-9.99TB	90	-
10TB-19.99TB	5	-

[76] Quarterly Statistics: Quarterly Statistics: Disk Array Storage, All Regions, 4Q13 Update (March 2014)
[77] Market Share Analysis: SSDs and Solid-State Arrays, Worldwide, 2013 (June 2014), worldwide data.

Table 42: Enterprise Ethernet switch market worldwide, port shipments (in thousands ports) (Source: Gartner[78])

Segment	2011	2012	2013
Enterprise Ethernet switches 100M	188 571	166 676	142 084
Enterprise Ethernet switches 1G	187 166	206 517	236 153
Enterprise Ethernet switches 10G	9 177	16 141	22 815
Enterprise Ethernet switches 40G	16	109	414
Total port shipments	384 930	389 443	401 466

Table 43: Enterprise Ethernet switch market by region, port shipments (in thousands ports) (Source: Gartner[78])

Region	2011	2012	2013
Eastern Europe	16 160	15 920	16 709
Western Europe	78 964	77 526	77 669

Table 44: Enterprise routers, Western and Eastern Europe, vendor revenues (in M USD) (Source: Gartner[78])

Region	2011	2012	2013
Eastern Europe	120	119	128
Western Europe	595	514	536

Table 45: Server form factor unit shipment forecast, Eastern and Western Europe, 2011-2018 (in thousands units) (Source: Gartner[79])

Form Factor	2011	2012	2013	2014	2015	2016	2017	2018
Rack-Blade	315	269	255	256	264	274	282	291
Rack-Mountable	337	289	258	208	178	160	146	149
Rack-Optimised	1 187	1093	1 037	1 028	1 032	1 042	1 061	1 080
Tower/ Standalone	160	146	136	153	174	180	170	165
Multi-Node	55	132	146	168	184	199	220	225

[78] Forecast: Enterprise Network Equipment by Market Segment, Worldwide, 2011-2018, 2Q14 (June 2014), Western and Eastern Europe data.
[79] Forecast: Servers, All Countries, 2011-2018, 2Q14 Update (June 2014), Western and Eastern Europe data.

Table 46: ECB storage unit shipments in EMEA, 2009-2013 (Source: Gartner[80])

		2009	2010	2011	2012	2013
Sum of shipments	CAS	456	449	514	653	770
	DAS	21 022	25 346	22 865	17 962	17 134
	SAN	68 850	77 851	82 461	79 010	80 223
	NAS	216 063	297 078	263 979	239 990	218 780
	Total	306 390	400 724	369 819	337 614	316 907
Sum of revenue	CAS	47 333 333	35 336 367	37 267 167	35 427 898	108 188 898
	DAS	442 542 772	540 676 039	539 283 339	496 359 840	437 799 714
	SAN	3 714 950 821	4 095 661 166	4 430 937 237	4 413 684 688	4 300 008 775
	NAS	927 543 503	1 178 243 330	1 405 067 670	1 545 500 004	1 666 461 382
	Total	4 157 493 593	4 636 337 205	4 970 220 576	4 910 044 528	4 737 808 489
Sum of capacity	CAS	18 073	17 984	23 601	25 973	195 178
	DAS	177 211	287 234	345 880	400 162	413 393
	SAN	1 330 158	1 987 626	2 729 889	3 266 530	3 788 093
	NAS	1 076 095	1 669 688	1 983 933	1 904 371	2 774 764
	Total	1 507 369	2 274 860	3 075 768	3 666 692	4 201 486

[80] Quarterly Statistics: Disk Array Storage, All Regions, 4Q13 (March 2014), EMEA data.

Table 47: ECB storage unit shipments forecast in EMEA, 2013-2018 (Source: Gartner[81])

		2013	2014	2015	2016	2017	2018
Sum of shipments	NAS	218 780	225 095	219 437	218 186	219 883	221 580
	Block ECB (DAS & SAN)	97 357	91 656	91 307	90 761	92 428	94 094
	Total	316 136	316 751	310 744	308 947	312 310	315 673
Sum of Vendor Revenue (in US $)	NAS	1 666 461 382	1 681 328 860	1 737 752 432	1 804 799 482	1 877 926 572	1 951 053 662
	Block ECB (DAS & SAN)	4 737 808 489	4 786 065 751	4 936 471 462	5 087 095 232	5 252 075 489	5 417 055 747
	Total	6 404 269 871	6 467 394 610	6 674 223 894	6 891 894 714	7 130 002 062	7 368 109 409
Sum of Terabytes	NAS	2 774 764	3 501 442	4 550 461	5 938 160	7 335 397	8 732 633
	Block ECB (DAS & SAN)	4 201 486	5 359 218	6 903 905	8 886 821	10 628 545	12 370 270
	Total	6 976 250	8 860 660	11 454 366	14 824 981	17 963 942	21 102 903
Sum of End User Spending (in US $)	NAS	2 187 920 148	2 207 439 864	2 281 519 151	2 369 546 149	2 465 555 714	2 561 565 280
	Block ECB (DAS & SAN)	6 204 870 887	6 268 071 010	6 465 049 850	6 662 314 269	6 878 380 664	7 094 447 059
	Total	8 392 791 035	8 475 510 874	8 746 569 000	9 031 860 418	9 343 936 378	9 656 012 338

Table 48: Enterprise Ethernet switch market by region, port shipments (in thousands ports) (Source: Gartner[82])

Region	2011	2012	2013	2014	2015	2016	2017	2018
Eastern Europe	16 160	15 920	16 709	17 262	17 649	17 664	17 434	17 005
Western Europe	78 964	77 526	77 669	76 468	74 727	72 138	68 893	66 638

Table 49: Enterprise Traditional Routers vendor revenue ($m) by region (Source: Gartner[82])

Region	2011	2012	2013	2014	2015	2016	2017	2018
Eastern Europe	120	119	128	129	127	124	118	111
Western Europe	595	514	536	511	493	463	435	403
Total	715	633	664	640	620	587	553	514
Growth		-11%	5%	-4%	-3%	-5%	-6%	-7%

[81] Forecast: External Controller-Based Disk Storage, Worldwide, All Countries, 2014-2018, 2Q14 Update (June 2014), EMEA data.
[82] Forecast: Enterprise Network Equipment by Market Segment, Worldwide, 2011-2018, 2Q14 (June 2014), Western and Eastern Europe data.

Table 50: Sales and Installed Base of Servers and Storage in Data Centres worldwide (Source: Gartner[83])

	2010	2011	2012	2013
Installed Base of x86 Servers	39 022 636	39 513 118	39 597 663	41 247 950
Installed Base of non-x86 Servers	2 276 282	1 945 882	1 599 853	1 281 740

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[83] Forecast: Data Centers, Worldwide, 2010-2017, 2Q13 Update (August 2013)