

Market Forecast

Worldwide HPC Market Forecast for Arm-Based HPC Servers

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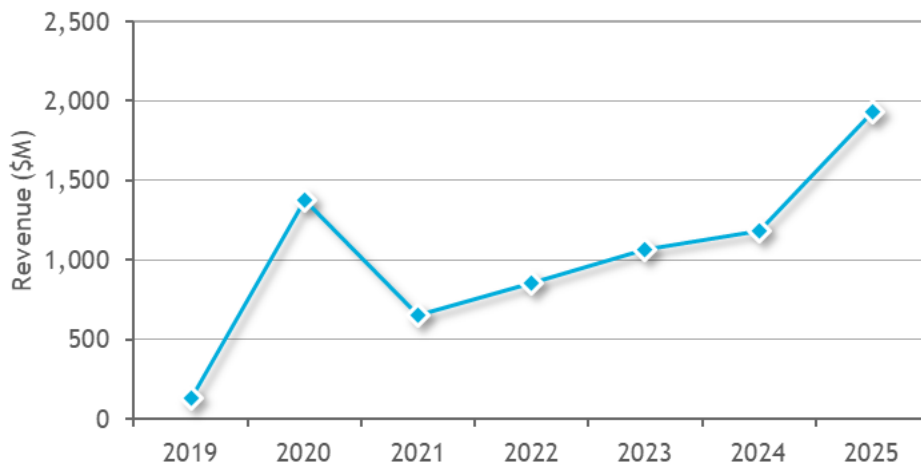
HYPERION RESEARCH OPINION

Hyperion Research has been following the rise of Arm processors in HPC for the past few years, tracking the development of processors as well as the evolution of the HPC software ecosystem to take advantage of Arm. Arm recently came into the spotlight with the acceptance of the Fugaku machine at Riken, which claimed the top spot on the Top500. Based on Fujitsu's Arm-based A64fx processor, Fugaku is a powerful and effective HPC system, rising to the top of many major HPC and AI benchmarks. Hyperion Research believes that the Fugaku machine is part of a wider growth of Arm adoption in HPC.

x86-based servers dominate the HPC market and are expected to continue to represent the majority of systems for the foreseeable future. However, careful tracking from several years of Hyperion Research forecasts has shown a consistent rise in the adoption of Arm-based HPC systems. The latest forecast projects Arm-based HPC server revenues to grow to nearly \$2 billion by 2025, generally outpacing the HPC market writ large. This growth will be supported both by some exceptionally large exascale-class systems and strong growth across all segments of the market.

FIGURE 1

Arm-Based On-Premises HPC Server Forecast



Note: High value for 2020 driven by acceptance of RIKEN Fugaku system

Source: Hyperion Research, 2021

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THE SERVER MARKET FORECAST

Worldwide revenue for the overall HPC technical server market grew less than 1% from 2019 to 2020 due to the worldwide pandemic and global supply chain delays. Hyperion Research predicts the HPC technical server market will grow around 8.0% CAGR over the forecast period (2020-2025) to reach nearly \$20B in 2025.

- The Supercomputer market segment for HPC systems priced at \$500,000 and up is projected to show the highest growth rate (9.0% CAGR), driven by many high-priced exascale systems worldwide.
- The Divisional and Departmental segments will also exhibit strong growth (8.1% and 8.8% five-year CAGRs, respectively).
- Meanwhile, the Workgroup segment is expected to remain relatively flat over the forecast period, following a major decline from 2019 to 2020.

TABLE 1

Worldwide Technical Server Market Forecast by Price Band

(\$M)	2019	2020	2021	2022	2023	2024	2025	CAGR 2020-2025
Supercomputer	\$5,118	\$6,021	\$6,258	\$7,726	\$8,653	\$9,401	\$9,251	9.0%
Divisional	\$3,164	\$2,849	\$3,091	\$3,532	\$3,858	\$4,156	\$4,199	8.1%
Departmental	\$3,193	\$3,324	\$3,726	\$4,234	\$4,625	\$4,968	\$5,078	8.8%
Workgroup	\$1,894	\$1,329	\$1,475	\$1,456	\$1,430	\$1,422	\$1,373	0.7%
Total	\$13,368	\$13,523	\$14,550	\$16,947	\$18,565	\$19,947	\$19,901	8.0%

Source: Hyperion Research, 2021

The Arm HPC Server Market Forecast

Arm-based HPC server revenues, system counts, average selling price, and processor counts are summarized below. Server revenues are expected to show strong growth between 2021 and 2025 (31.3% CAGR), far outpacing the growth rate of the overall HPC server market. 2020 was an anomalously high year for Arm-based HPC server revenues due to the acceptance of the Fugaku system, priced at more than \$1 billion. Beyond the Fugaku machine, Arm-based HPC revenues more than doubled between 2019 and 2020 and are expected to double again in 2021.

Revenue growth is largely due to significant increases in the number of systems sold, highlighted by the 10x difference between systems sold in 2019 and 2023. Arm systems are becoming more mainstream as many HPC users are planning to procure Arm-based systems, at least experimentally. Arm's usefulness for AI and big data workloads is attractive for many HPC sites, while the associated software ecosystem and community are rapidly developing and lowering barriers for adoption.

Processor counts are growing at an even higher rate than revenues and units (35.8% CAGR 2021-2025) due to the anticipated growing size of many Arm-based deployments. However, ASPs of Arm-based HPCs are expected to show minor growth over the forecast period due to the price of Arm-based processors decreasing while deployment sizes are expected to increase (3.6% CAGR 2021-2025).

The updated forecast reflects a slightly slower adoption than previous iterations of the Arm HPC forecast due to data collected in new studies. However, there are a number of large Arm-based HPC systems expected to be accepted during the forecast period, including two European exascale machines slated for 2025. Developments with these large Arm systems may affect the forecast substantially in terms of the timing of these expenditures, but the value of these systems are unlikely to change dramatically.

TABLE 2

Arm-Based On-Premises HPC Server Forecast

	2019	2020	2021	2022	2023	2024	2025	CAGR '20-'25	CAGR '21-'25
System Revenues (\$M)	128	1,375	650	856	1,061	1,186	1,932	7.0%	31.3%
Total HPC Systems	191	508	940	1,556	2,076	2,284	2,421	36.7%	26.7%
ASP (\$K)	672	2,709	692	550	511	519	798	-21.7%	3.6%
Arm Processors	44,455	125,000	118,182	259,394	331,700	394,027	402,055	26.3%	35.8%

Note: December 2021 forecast. Reflects a slight decline in Arm HPC system sales from previous iteration due to slower adoption of Arm in HPC based on assumption that units installed will decline roughly 10% from previous iteration.

Note: Market could shift dramatically due to singular large Arm installments. 2020 was a very strong year with the Fugaku system at over US\$1B. Hyperion Research is anticipating two European exascale machines based on Arm processors in 2025.

Note: There are many more providers of Arm processors than x86 or Power processors, thus some sites will purchase multiple, small Arm-based machines for experimentation. Many systems are expected to have a mix of processors, both Arm and x86, as well as other processor types.

Note: A broad set of novel and established HPC applications are expected to be ported and tested on Arm-based systems over the forecast period.

Source: Hyperion Research, 2021

The following tables show the Arm-based HPC server forecast by verticals in terms of revenues, processor counts, and system units. Revenues for all verticals (except Government Research) are expected to grow at a more than 30% CAGR from 2020 to 2025. It is important to note that while growth rates are expected to be similar between verticals, certain verticals, like CAE, are expected to spend a larger amount on Arm-based HPCs than others. One key factor that could shift the vertical

forecast in favor of one vertical lies on the conversion of major ISV codes to Arm. Some verticals are heavily dependent on ISV support, and if those ISV providers port their code to Arm, it could accelerate experimentation and deployment of systems. Similarly, processor counts for each vertical are projected to grow at more than 50% CAGR over the forecast period. A broad set of novel and established HPC applications are expected to be ported and tested on Arm-based systems over the forecast period, fueling this anticipated growth.

TABLE 3

Arm-Based HPC Server Forecast: Revenues by Verticals (\$M)

(\$M)	2019	2020	2021	2022	2023	2024	2025	CAGR 2020 - 2025
Bio-Sciences	10	29	49	69	87	97	121	32.7%
CAE	12	36	62	83	104	117	146	32.4%
DCC & Distribution	3	9	17	21	27	30	37	32.3%
Economics/Financial	6	17	33	44	58	65	81	35.9%
EDA	2	5	9	12	15	17	21	33.7%
Geosciences	10	31	57	72	90	101	126	32.3%
Defense	11	34	57	83	107	120	150	34.5%
Government Lab	38	1,100	163	206	234	262	775	-6.8%
University/Academic	26	80	142	194	251	280	351	34.3%
Weather	1	4	8	10	12	14	17	31.3%
Other	10	29	53	63	77	86	108	30.4%
Total HPC Systems	128	1,375	650	856	1,061	1,186	1,932	7.0%

Note: December 2021 Forecast

Source: Hyperion Research, December 2021

TABLE 4**Arm-Based HPC Server Sales in Processors by Vertical (Number of CPUs)**

	2019	2020	2021	2022	2023	2024	2025	CAGR 2020 - 2025
Bio-Sciences	3,365	2,677	8,909	20,797	27,110	32,204	25,253	56.7%
CAE	4,116	3,261	11,273	25,127	32,619	38,748	30,384	56.3%
DCC & Distribution	1,055	835	3,091	6,420	8,324	9,888	7,754	56.2%
Economics/Financial	1,916	1,585	6,000	13,317	18,051	21,443	16,814	60.4%
EDA	550	443	1,636	3,520	4,643	5,515	4,325	57.8%
Geosciences	3,566	2,822	10,364	21,693	28,128	33,413	26,201	56.2%
Defense	3,809	3,096	10,364	25,102	33,429	39,710	31,138	58.7%
Government Lab	13,233	100,000	29,558	62,497	73,144	86,888	161,213	10.0%
University/Academic	8,975	7,286	25,818	58,911	78,345	93,066	72,978	58.5%
Weather	505	395	1,493	2,961	3,792	4,505	3,532	55.0%
Other	3,365	2,600	9,676	19,049	24,115	28,647	22,463	53.9%
Total HPC Systems	44,455	125,000	118,182	259,394	331,700	394,027	402,055	26.3%

Note: December 2021 Forecast

Source: Hyperion Research, December 2021

The forecast by system units highlights the strong growth among the bulk of the market, not just a handful of large-budget, high-profile systems with significant revenues. Financial institutions are expected to show the highest growth in Arm-based HPC system (by units) while Government Research is anticipated to exhibit the lowest, albeit still impressive, five-year CAGR. Since there are many more providers of Arm processors than x86 or Power processors, Hyperion Research expects a number of sites will choose to purchase multiple, small Arm-based machines for experimentation, driving up the number of systems sold over the forecast period.

TABLE 5**Arm-Based HPC Market by System Units (Number of Systems Sold)**

	2019	2020	2021	2022	2023	2024	2025	CAGR 2020 - 2025
Bio-Sciences	14	39	71	125	170	187	198	38.3%
CAE	18	48	90	151	204	225	238	37.9%
DCC & Distribution	5	12	25	39	52	57	61	37.8%
Economics/Financial	8	23	48	80	113	124	132	41.5%
EDA	2	6	13	21	29	32	34	39.2%
Geosciences	15	41	82	130	176	194	205	37.8%
Defense	16	45	82	151	209	230	244	40.0%
Government Lab	57	142	235	375	458	504	534	30.3%
University/Academic	38	107	205	353	490	539	572	39.9%
Weather	2	6	12	18	24	26	28	36.8%
Other	14	38	77	114	151	166	176	35.9%
Total HPC Systems	191	508	940	1,556	2,076	2,284	2,421	36.7%

Note: December 2021 Forecast

Source: Hyperion Research, December 2021

Geographically, EMEA is poised to exhibit the highest growth rate in Arm-based HPC server revenue over the forecast period, culminating in the anticipated acceptance of two exascale-class HPC systems based on Arm processors. However, from 2021 to 2024, North America is forecast to have the highest yearly spend for Arm-based HPC servers. Since there are a number of large Arm-based systems expected during this forecast period, a speed-up or delay in any of these could change the forecast dramatically.

TABLE 6**Arm-Based HPC Server Revenue by Geographies**

(\$M)	2019	2020	2021	2022	2023	2024	2025	CAGR 2020 - 2025	CAGR 2021 - 2025
North America	55	190	276	380	420	540	665	28.5%	24.6%
EMEA	31	85	134	211	272	344	813	57.1%	56.9%
Asia/Pacific	40	1,096	233	255	353	283	432	-17.0%	16.7%
Rest of World	2	4	7	10	16	19	22	40.6%	31.6%
Total	128	1,375	650	856	1,061	1,186	1,932	7.0%	31.3%

Note: December 2021 Forecast

Source: Hyperion Research, December 2021

Similar to the overall broader HPC market, the broader market for Arm-based HPCs is highlighted by the add-on on-premises storage, which is expected to exhibit the highest growth of any category (36.2% CAGR). Middleware, applications, and maintenance services are all expected to grow at similar rates, albeit significantly lagging add-on storage.

TABLE 7**The Broader Arm-Based HPC Market**

(\$M)	2019	2020	2021	2022	2023	2024	2025	CAGR 2020 - 2025
Arm-Based HPC Servers	128	1,375	650	856	1,061	1,186	1,932	7.0%
Add-on Storage (On-Prem)	52	179	247	354	446	507	839	36.2%
Middleware	15	69	78	103	128	145	240	28.4%
Applications	43	206	216	282	347	387	620	24.6%
Maintenance Services	20	83	98	125	152	165	267	26.4%
Total On-Prem	258	1,911	1,288	1,721	2,135	2,389	3,897	15.3%

Note: RIKEN chose Oracle for a large portion of their add-on storage rather than on-premises solutions in 2020

Note: December 2021 Forecast

Source: Hyperion Research, December 2021

MARKET CONTEXT: MARKET GROWTH DRIVERS

There are several factors driving long-term revenue growth rate projections across all segments of the HPC sector:

- The increasing use of HPC to address important problems and opportunities across all sectors (government, industry, and academia) will increase the frequency, number, and size of HPC system purchases.
 - The desire to have multiple exascale-class systems with prices over \$300 million is expected to provide very high growth at the upper end of the market, particularly in the Government sector.
- The expansion of AI-based capabilities into a wider range of HPC-related workloads will drive purchases of specialized systems in addition to more general-purpose systems.
 - The applicability of AI-based functionality into a range of traditional HPC workloads such as modeling and simulation will create the need for targeted HPC systems that can meet the rigorous demands of these specific computing applications.
 - Traditional enterprise IT datacenters are applying AI and HPDA to grow and optimize the outcomes of the business units they support and are utilizing HPC-enabled AI to provide the necessary infrastructure.
- New users adopting HPC-enabled AI capabilities will also drive growth through the HPC market. HPC infrastructure is increasingly being adopted by a broader customer base.
- The growing use of HPC capabilities built on hybrid on-premises/cloud architectures is driving both on-premises and cloud growth. This rapidly growing trend in the HPC sector is enabling traditional HPC on-premises computer centers to expand their range of hardware and software capabilities and related use cases, built on an integrated on-premises/cloud computing ecosystem.
 - Additionally, on-premises system procurements will continue to grow to support specialized architectures or key hardware/software features for a growing set of demanding workloads running critical R&D or production-level jobs, while ensuring high levels of compute capability and security.
- The rise of edge-to-data center architectures is creating new opportunities that can be addressed by HPC. New HPC-related use cases will rapidly develop that can take advantage of emerging and early deployment of IoT, 5G, and edge computing capabilities. These use cases will require performant distributed and HPC datacenter servers to address a wide range of new sensor/telemetry data in many formats and data transfer rates. Also required will be stringent real-time operational requirements for fast decision-making that can react to changing conditions or priorities, all while operating with high reliability and virtually no downtime.
- The emergence of use-case-specific architectures tuned to key workload requirements results in sites buying multiple systems instead of a single system. As more and more applications fall under the realm of general HPC computing, these applications require a specific collection of hardware and software to ensure their optimal performance. As a result, HPC servers are likely to increasingly be designed, built, and used for specific use cases, driving a proliferation in the number and composition of servers that will be purchased in the coming years.

METHODOLOGY

The forecasts in this study are based on a number of Hyperion Research information sources, including our technical computing systems quarterly census database, vendor results for the historical years, discussions with vendors and users on future business directions and expectations, end-user studies, and in-depth interviews with users.

The forecasts were developed based on Hyperion Research's technical computing systems forecast model, which targets compute servers. This model initially considers competitive segments (supercomputers, technical divisional servers, technical departmental servers, and technical workgroup servers), forecasting system unit shipments, revenue, and average sales price by industry/application segment. The forecasts include estimates for second-tier and new-entrant vendors selling into the HPC server market space.

The forecasts provided in this study include only server systems used in technical computing applications. Systems sold into commercial (nontechnical) applications and desktop technical computers are not included in this study.

Note: All numbers in this document may not be exact due to rounding.

Note: All monetary values shown in US dollars unless specified otherwise.

DEFINITIONS

Technical Computing (HPC)

Hyperion Research uses the terms *technical computing* and *high-performance computing (HPC)* to encompass the entire market for computer servers used by scientists, engineers, analysts, and other groups using computationally and/or data-intensive modeling and simulation applications.

Technical servers range from small servers costing less than \$5,000 to the large-capability machines valued in hundreds of millions of dollars. In addition to scientific and engineering applications, technical computing includes related markets/applications areas such as economic analysis, financial analysis, animation, server-based gaming, digital content creation and management, business intelligence modeling, and homeland security database applications. These areas are included in the technical computing market based on a combination of historical development, application type, computational intensity, and associations with traditional technical markets.

Competitive Segments

Hyperion Research defines four primary segments of the technical computing market delineated by system price points:

- **Supercomputers:** Systems purchased to support technical applications and sold for \$500,000+
- **Technical divisional servers:** Systems purchased to support technical applications and sold for \$250,000-\$499,999
- **Technical departmental servers:** Systems purchased to support technical applications and sold for \$100,000-\$249,999
- **Technical workgroup servers:** Systems purchased to support technical applications and sold for under \$100,000

Table 8

Vertical Descriptions

Vertical	Description
Bio-Sciences	Bioscience tasks: genomics, proteomics, pharmaceutical research, bioinformatics, drug discovery
CAE	Manufacturing workloads: finite element analysis, structural analysis, computation fluid dynamics
DCC & Distribution	Digital media tasks: rendering, animation, video editing and production, high-end gaming servers
Economics/Financial	Economic analysis: portfolio management, economic modeling, forecasting, financial analysis
EDA	Electrical/electronic tasks: chip design, system modeling, system development and testing
Geosciences	Earth resources–related applications: seismic analysis, reservoir modeling, GIS, mapping
Defense	National security applications: surveillance and signal processing, encryption, geospatial
Government Lab	Government-funded research and development institutions that do not offer degree programs
University/Academic	Scientific research and engineering efforts conducted at institutes of higher education
Weather	Weather-related tasks: atmospheric modeling, meteorology, weather forecasting
Other	Any technical computing workloads not otherwise specified by the previous definitions

Note: These are the verticals used for the purposes of the Arm forecast. There are additional verticals used in other Hyperion Research data and documents (e.g., Chemical Engineering, Mechanical Design), but those were negligible in this study.

Source: Hyperion Research, 2021

About Hyperion Research, LLC

Hyperion Research provides data-driven research, analysis and recommendations for technologies, applications, and markets in high performance computing and emerging technology areas to help organizations worldwide make effective decisions and seize growth opportunities. Research includes market sizing and forecasting, share tracking, segmentation, technology and related trend analysis, and both user and vendor analysis for multi-user technical server technology used for HPC and HPDA (high performance data analysis). We provide thought leadership and practical guidance for users, vendors and other members of the HPC community by focusing on key market and technology trends across government, industry, commerce, and academia.

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