DELL Technologies

ElectronicDesign

The Pulse of the Semiconductor Market

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Market Research Report

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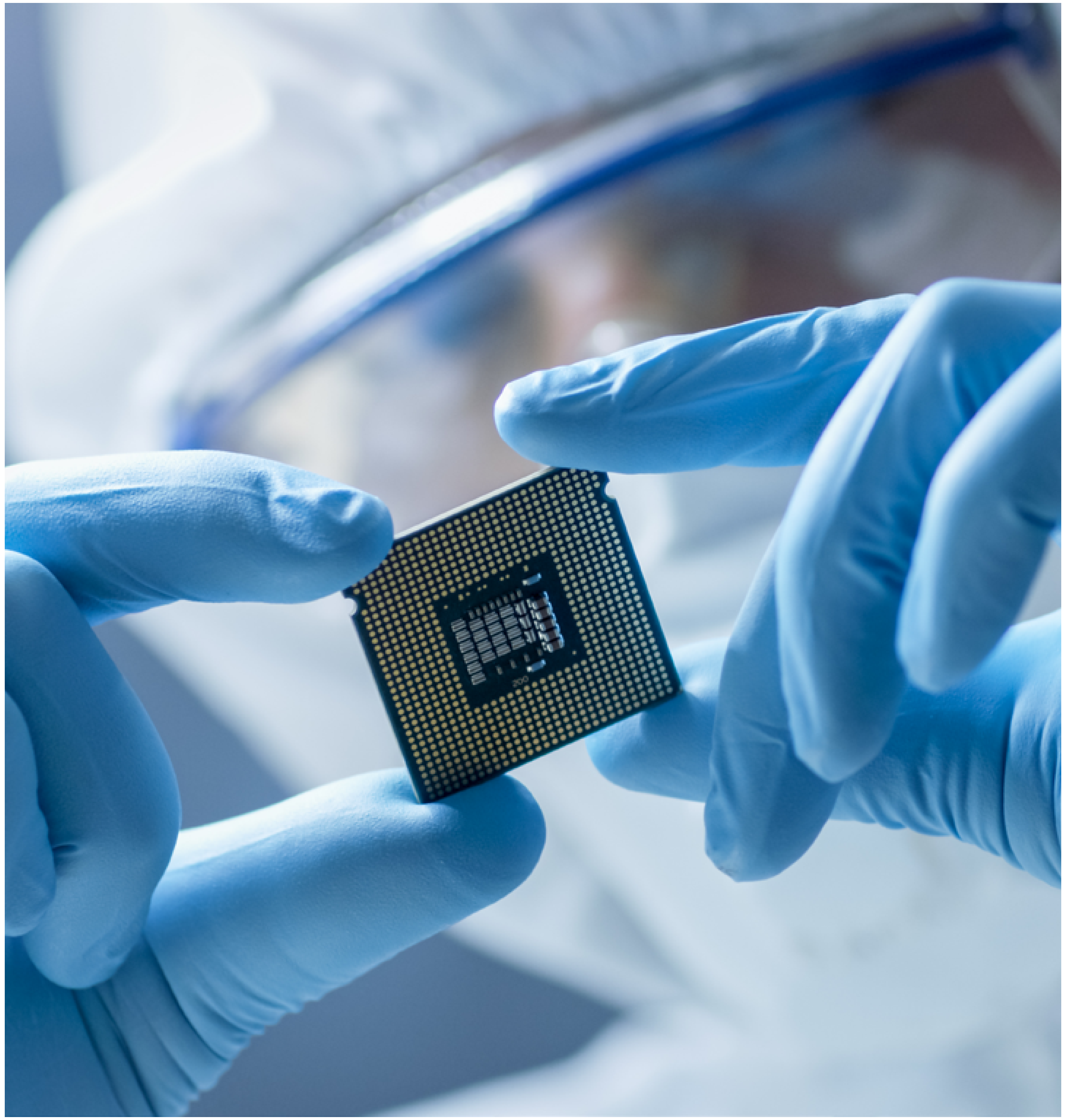
Introduction

The semiconductor market has fared well against pandemic-related changes that began in 2020, but it's not without its challenges. Moore's Law is hitting the limits of physics, the pool of experienced designers is in decline, and the demand for consumer electronic devices has skyrocketed far past the rate of production. Moreover, the disruption of global supply chains and economic downturn has added to those challenges by putting pressure on industry fundamentals, temporarily closing manufacturing plants, disrupting day-to-day business, and reducing chip deliveries in the short term.

For the most part, semiconductor companies mobilized quickly to understand and respond to the near-term effects of these disruptions. Massive digital acceleration is underway by consumers and enterprises as more people stay home for both work and play and increase their reliance on technology. This is driving a surge in demand for chip-based products and solutions that power our hyper-connected society. With that in mind, Dell Technologies recently fielded a study in collaboration with Endeavor Business Media to gain insight into the semiconductor industry through the thoughts of engineers.

The Pulse of the Semiconductor Market Study posed a series of questions to *Electronic Design* users centered on engineering disciplines, tools, designs, storage and more. Together, the information paints an overall view of the industry, where it shines, what it lacks, and what the future holds. To that end, there is an opportunity for a surge in innovation while significantly reducing semiconductor time-to-market. The key lies with the adoption of new design technology, tools and cloud services, while at the same time mitigating security issues.



Companies, Their Location and Industries

Based on the survey responses, a majority of semiconductor-based companies are headquartered in North America and employ anywhere between 1 to 200 engineers, making them significantly smaller than those employed by larger corporations. A good portion of those engineers are also tasked with design initiatives, such as upgrading existing designs and building new chip architectures, as well as technical debt, or past projects that require maintenance. While companies with a larger workforce can offer their services to more clients, they tend to be limited in their knowledge base as engineers become SMEs (subject matter experts) within their respective departments. There's no need for them to branch out from compartmentalization, which can limit their overall effectiveness in other disciplines.

FIGURE 1 Company Size (number of employees) of Sampled Respondents

1 to 200	55%
201 to 500	8%
501 to 1,000	7%
1,001 to 10,000	11%
10,001 to 20,000	3%
20,000+	11%
Don't Know	4%

That said, larger engineering firms have more resources and repositories available for their engineers, tend to work on more high-profile projects, and have benefit packages and increased job stability for veteran and novice engineers alike. On the other hand, engineers employed with smaller firms usually gain an increased knowledge base as they are tasked with more responsibilities.[1] Some may work heavily in the design phase, but also have a hand in client interaction, taking field measurements and creating project presentations. Interaction with other companies also provides engineers with valuable insight on how those companies function in terms of product innovation, problem-solving, and networking. This also leads to higher employee turnout with an increase in qualified engineers that are applying and retaining jobs, leading to increased company revenue.

According to the survey data, most of those engineering firms' annual revenue falls to $10 million or less, with employees garnering $162,000 on average. Companies in this bracket are predominantly in the design field, updating proven designs and creating new architectures for next-generation ICs that will power the latest smartphones, wearable medical devices, and IoT platforms. Beyond design, these engineers are responsible for constructing the silicon wafer (via bonding or etching) and test the design before it heads to the manufacturers. In order to bring the new architecture from idea to product, they rely on the latest tools to get the job done, a significant part of which is done via software.

FIGURE 2 Company Annual Revenue of Sampled Respondents

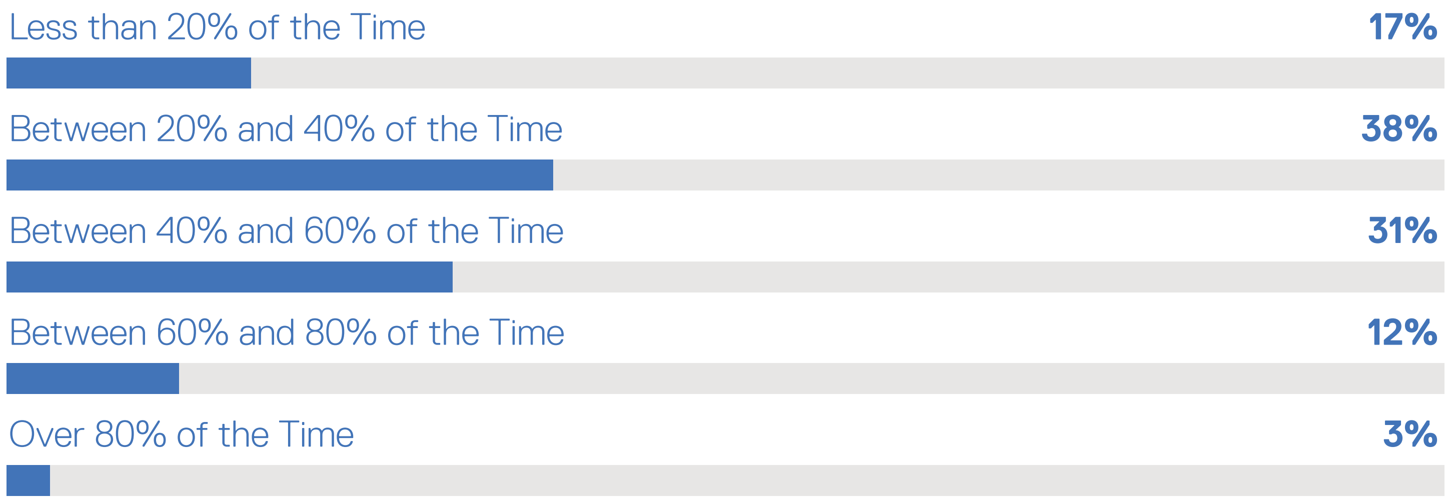
Less than $10 Million	43%
$10 Million to $100 Million	18%
$100 Million to $1 Billion	9%
$1 Billion and Above	15%
Don't Know	16%

[1] civilengineeringacademy.com/the-differences-between-working-for-a-large-vs-small-engineering-company

Design Tool Trends and Challenges

As the semiconductor industry has given focus to the IoT/IIoT (Internet of Things/ Industrial Internet of Things) sector, more engineers are updating or creating new ICs that can handle the dynamic connected platforms with greater compatibility and efficiency. The demand for connected devices continues to grow yearly and with that comes increased complexity in their designs, which is often prevalent when scaling to smaller, faster chips.[2] New architectures make the design process challenging, and although some aspects can be mitigated with local design tools and compute resources, others will come at a cost.

FIGURE 3 Frequency of Design Reuse of Sampled Respondents



One of the main challenges in semiconductor design is the automation system that controls wafer fabrication throughout its many steps, which must continuously change to handle the ever-evolving demands placed on semiconductors themselves. This puts pressure on automation systems to continuously tune the fabrication process and its numerous steps. One of the ways to mitigate that issue is to employ EDA (Electronic Design Automation) tools, which help to streamline the process from schematic to fabrication. These tools can also help with bottlenecks and scalability issues based on input parameters of the IC design and available materials.

Every semiconductor firm, large or small, relies on some form of EDA toolset to rise to the challenge of new IC designs. These tools work together through the design flow, allowing engineers to analyze, simulate, and validate ICs before they hit production. Currently, there are four companies that control 90% of the EDA tool market, which includes Synopsys, Cadence, Mentor Graphics (a Siemens company) and Ansys.[3] As it stands, the same four also own much of the intellectual property for those tools needed for chip design, meaning semiconductor companies have to pay to license those tools before the design phase, or pieces of it, can begin. Surprisingly, large IC companies—including Nvidia, Samsung, Apple, and Qualcomm—take advantage of those offerings for in-house chip development, while others prefer to use in-house or open-source software suites, such as OpenCores and Open Circuit Design.

Another way for semiconductor companies to quickly get their new ICs to market is through design reuse, meaning they build on an existing design that brings added functionality, increased power efficiency, and better heat management. Companies such as AMD and Intel routinely reuse existing designs throughout their series of chips, with each iteration adding more benefits over the previous implementation. Thirty-eight percent of semiconductor firms use the practice between 20% and 40% of the time until a new generation of ICs are slated in the pipeline.

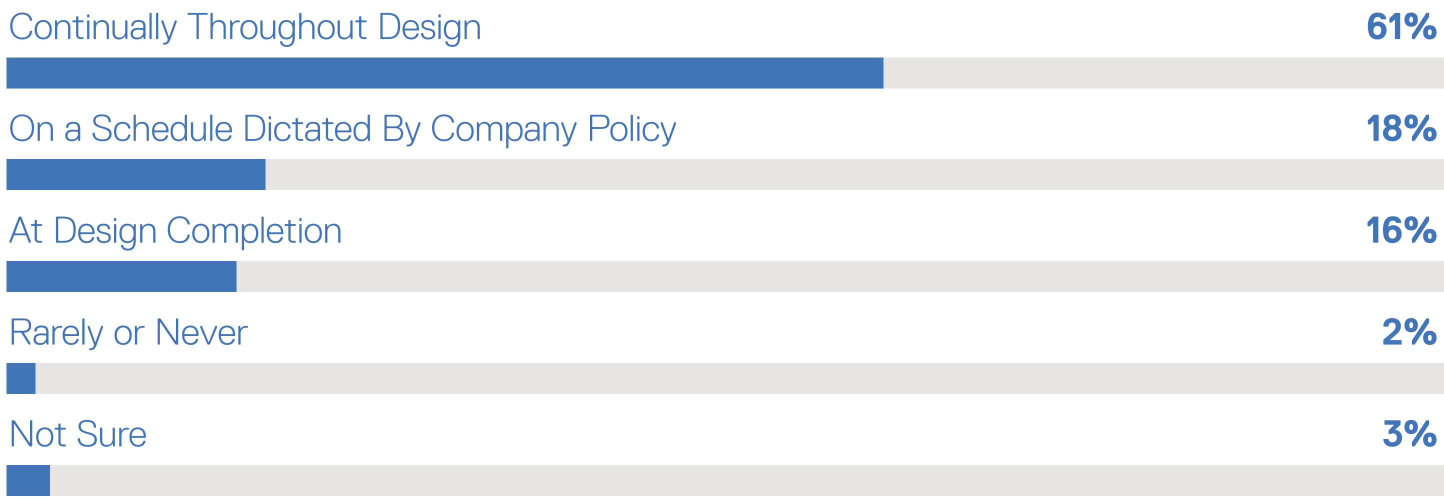
[2] irds.ieee.org
[3] www.ft.com/content/8ed73acb-1aa4-4a98-875a-a372ba960cda

Data Storage Trends

The global semiconductor revenue expected in 2021 comes in at a hefty $527.2 billion, and those numbers will continue to grow exponentially over the coming years. Consumers rely on electronic devices daily, which makes semiconductors—and, more importantly data—a significantly valuable commodity.[4] It's important to note that many different forms of data are utilized by the semiconductor industry, including transient data (information created in an application session, then discarded after use), archived data (information stored for the possibility of future use), IP auditing (IP assets, risks and opportunities), disaster recovery (retrieving lost data), and more.

FIGURE 4

Frequency of Data Archiving of Sampled Respondents



While all forms of data are a valuable commodity in the semiconductor industry, archived data is worth its weight in platinum and is highly sought after by hackers, rival businesses, and foreign governments. Considering its value, data must be stored appropriately. Over 60% of semiconductor firms archive data continually throughout the design process, making it easy to perform upgrades to designs when needed or to flesh out any bugs that might arise over the years. The prominent method of storing that data is done via local data center infrastructure—air-conditioned areas with server repositories, data storage, and networking solutions.

Moore's Law has given rise to more complex IC designs, and with the design growth comes increased storage needs in both capacity and performance. To that end, most companies have moved beyond traditional platter drives for data storage in favor of faster, more robust and heat efficient Flash technologies, such as SSDs, NAND, NVMe, M.2 platforms. These storage solutions also offer lower power requirements and are less prone to failure over their platter counterparts.

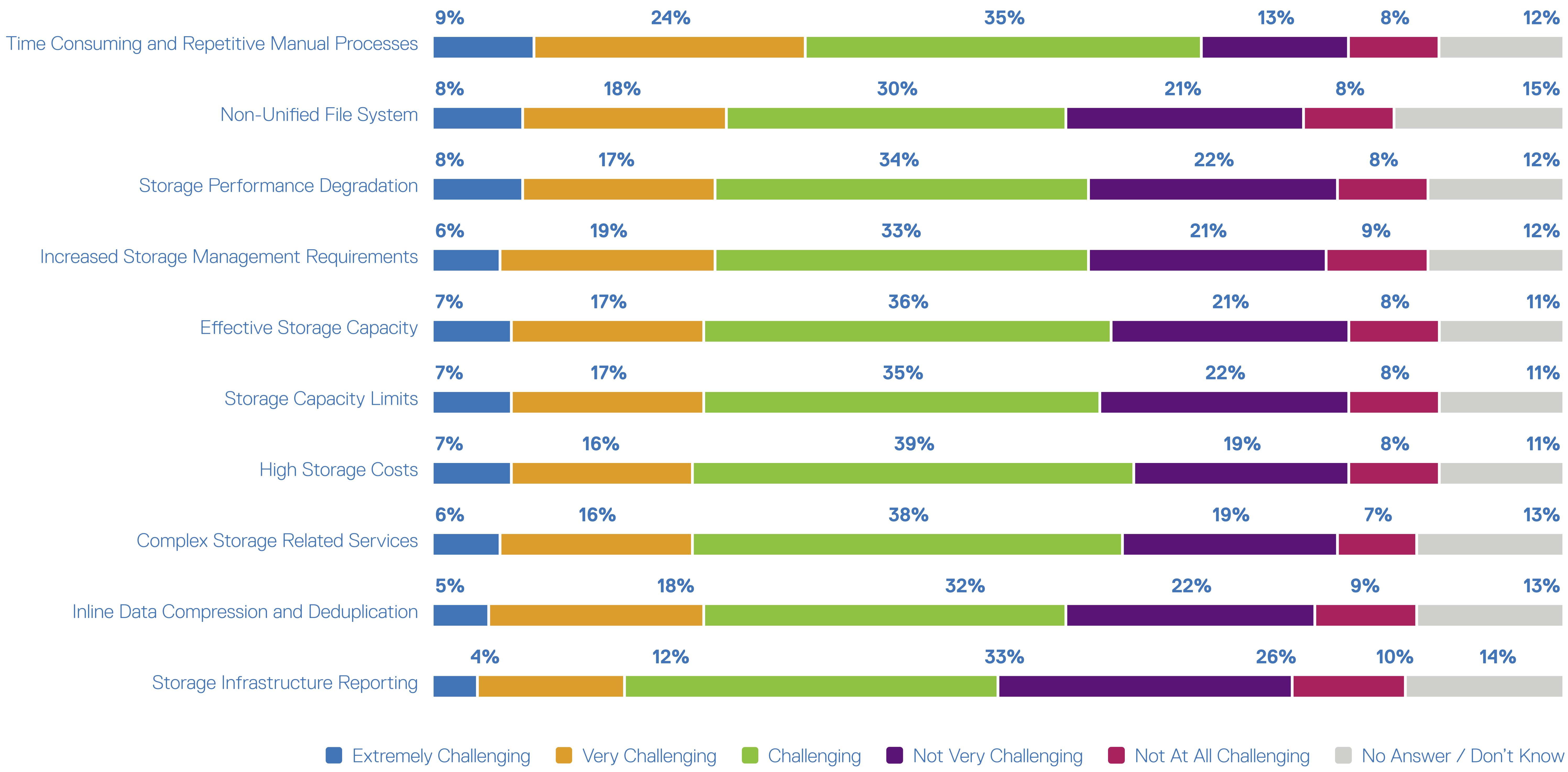
Managing that stored data is another beast altogether, as 32% of companies report that storing and managing the data is a time consuming and manually repetitive process. Designs, simulations, analytical data and other information can be a challenge to manage and store properly on any scale, and as designs grow in complexity, that challenge increases. Some companies have turned to automated management systems driven by artificial intelligence (AI) to help mitigate those issues.

[4] www.statista.com/topics/1182/semiconductors

FIGURE 5

Ratings of the Challenges of Storage Factors from Sampled Respondents

Base: All respondents (n varies from 115 to 119).



Migrating to the Cloud

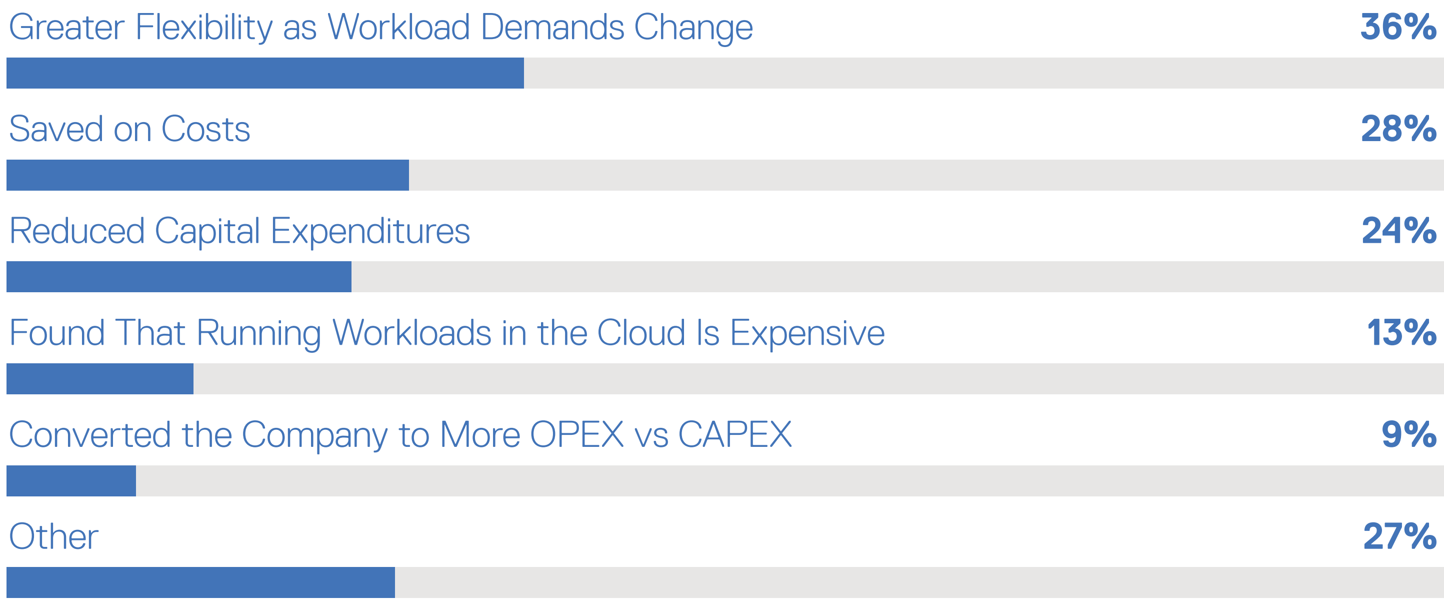
Legacy storage architectures are headed toward obsolescence as the amount of data produced through next-generation designs are hitting the proverbial wall in terms of sheer capacity and scalability. Although it's still a relatively new platform, some companies are looking at utilizing the cloud to store and manage data. The cloud is described as a vast network of remote servers around the globe that are linked together and operate as a single ecosystem. These servers are designed to store and manage data, run applications and deliver content or services such as productivity software, content streaming, mail, social media and more.

FIGURE 6 Adoption of Cloud Migration for Semiconductor Workloads of Sampled Respondents

We Adopted Cloud Services Some Time Ago	11%
On a Schedule Dictated By Company Policy	9%
We Have Moved Most Workloads to the Cloud	21%
We Are Currently Planning to Move Some Workloads to the Cloud	15%
We Are Not Planning to Move Workloads to the Cloud	41%
We Have Shifted Our Workloads in Another Way	4%

But isn't the cloud the same as traditional local data center solutions? Yes and no; the cloud is hosted on remote storage servers that can be accessed anywhere via the internet, while local data centers can only be accessed on a network. Both store data, but each is accessed

FIGURE 7 Benefits of Cloud-Based Workloads of Sampled Respondents



differently. Data stored on the cloud can be hosted on a single server, or sliced into pieces and placed on several storage platforms. There are also three types of cloud platforms—public, private, and a hybrid solution—with each having their advantages and drawbacks.

Private clouds are those that run on the company's own infrastructure and are usually firewalled and physically secure from outside access. Although this option provides significant financial benefits, they must still be supported, managed, and eventually upgraded when they reach their hosting limit. Public clouds alleviate the responsibility and management of data storage as they are run as a service. Companies and individuals pay to host their data on public clouds, which can get expensive depending on the amount of information, egress costs, and its management. Security of public clouds is handled by both parties, but require subscribers to ensure their data sets and applications are secure.

Hybrid clouds refer to a mixed computing, storage, and service environment that's created using on-premises infrastructure, private cloud services, and a public cloud. The hybrid solution brings increased security for proprietary data that's stored privately, while granting access to readily available information deemed noncritical. This platform is designed for companies that need to adapt to changing workloads, separating critical and noncritical information, big data processing and more.

There is no right or one-size-fits-all cloud solution when it comes to the semiconductor industry; some may prefer one model over another, or remain with traditional storage infrastructure altogether until a change is needed. In fact, 41% of companies surveyed state they are not planning to move workloads to the cloud, while 21% have only moved some. Those that did make the move found the benefits of cloud-based storage offered greater flexibility as workload demands changed. Others experienced cloud deployment issues, with 28% reporting that the public cloud was not as secure as those hosted on-premises. Others had issues with running multiple simulations in parallel or finding applications that were hosted on public cloud domains.

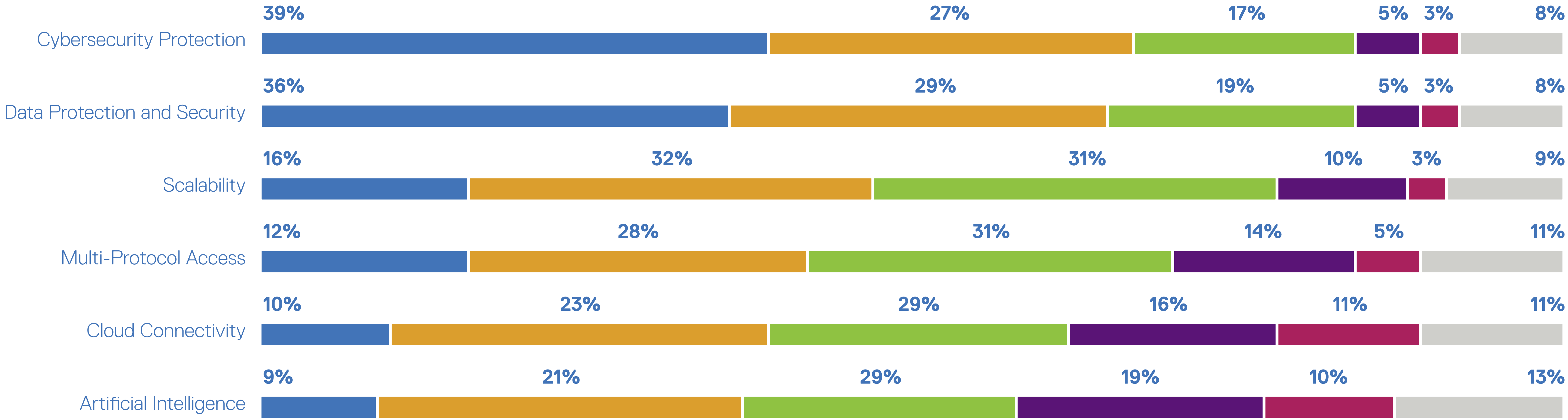
FIGURE 8 Cloud Deployment Issues of Sampled Respondents

Security Issues and Fears

One aspect the survey respondents agree on when it comes to storage solutions is security, and 66% of those companies state cybersecurity protection is an important attribute. This includes safeguards against ransomware, a form of attack that typically encrypts data until a ransom (or price) is paid, as well as data destruction or deletion. The same for DoS (Denial of Service) attacks, which prevent legitimate users from accessing information systems, devices or network resources. Local data center infrastructure allows companies to secure and retrieve intellectual design property and implement a recovery plan in the event of hardware failure. Fifty-eight percent of companies have a DR (Disaster Recovery) plan, which requires a local data center and remote site to restore lost or corrupted information, in place should such an event occur.

FIGURE 9

Importance of Attributes for Design Storage Solutions of Sampled Respondents



We also live in an age where it is common for entities to take hold of that data and encrypt it for ransom via cyberattack, only releasing the data once the ransom is paid.[5] This was evident in the recent Colonial Pipeline attack, which was forced to shut down until the $5 million in ransom was paid. Strangely enough, only 37% of semiconductor businesses reported implementing a ransomware protection plan in the event of successful cyberattacks.

Security is a crucial factor for any storage medium, whether it is local or stored in the cloud, as the fear of hacking or data compromise is a real-world contention and global threat. Both public cloud providers and users are responsible for the level of protection that is needed based on any given application. Limiting visibility, access and control are key in a cloud environment and more providers are furthering security through attribute-based encryption (ABE), including CP-ABE, KP-ABE, FHE and SE algorithms.[6] While these added features are not a catch-all, the security included with many public and private cloud providers does limit unwanted intrusion.

FIGURE 10 The Number of Sample Respondents Who Have a Company Disaster Recovery/DR Plan

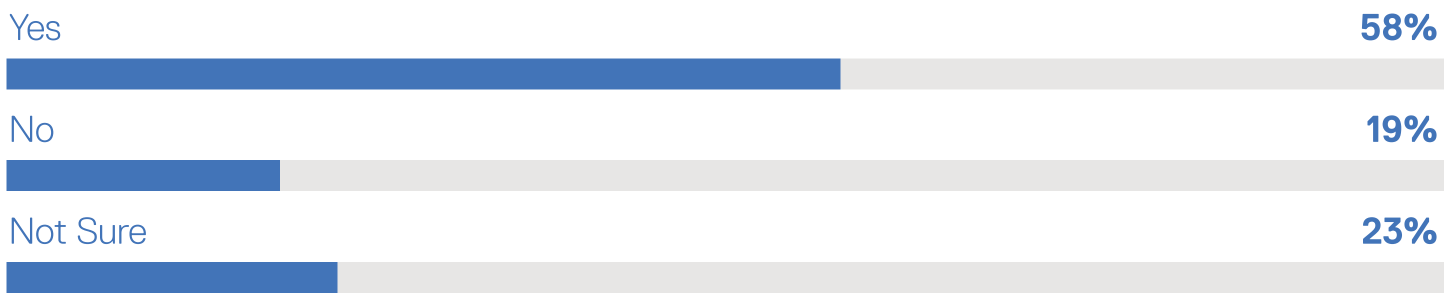
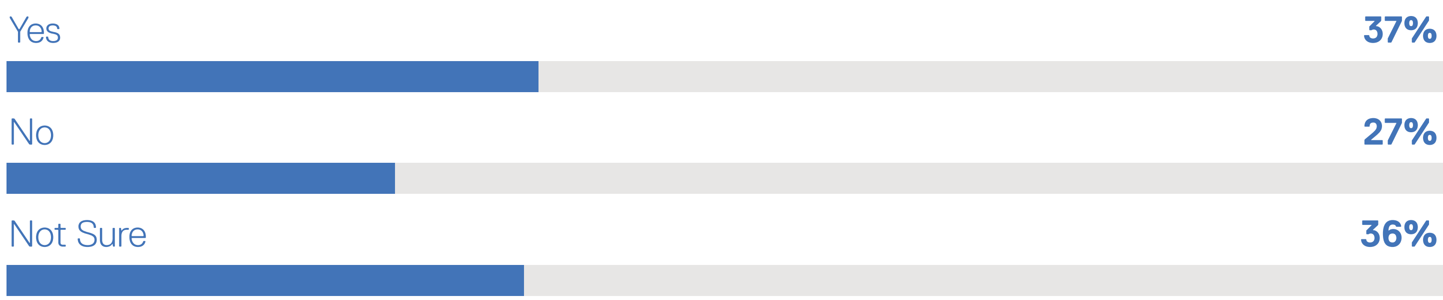


FIGURE 11 The Number of Sample Respondents Who Have a Company Ransomware Protection Plan for Design Data



[5] www.cnbc.com/2021/06/07/us-recovers-some-of-the-money-paid-in-the-colonial-pipeline-ransom-officials-say.html

Predicted Future Trends

Future trends in semiconductor design and manufacturing have some companies looking to further reuse previous designs with the flexibility of entering new markets with an increased focus on security within a cloud environment. Some companies are already leveraging the latest tools for further innovation—such as 5G for high-performance mobile devices and the IoT to implement cost-effective semiconductors and open-source hardware and software—changing the way companies think about design. Currently, there are a number of open-source EDA repositories that cover everything from PCBs to FPGAs that companies can take advantage of, and the list continues to grow.[7] Others prefer to use in-house, proprietary tools or licensed platforms from other companies, as they offer industry standards with added support in the design chain. Semiconductor firms are also developing new solutions to broaden the markets with new ICs that are driving everything from autonomous vehicles to sensors in satellites.

Continued innovation and access to the latest EDA tools can make an impact on short-term trends with viable and proven systems in the long-term. Technologies such as AI and machine learning with a reduction in required nodes—cloud connection, redistribution or end points—could also become a reality as the technology is adapted for use in both local and cloud environments.[8] Of course, innovation in design tools and infrastructure is expected to play a leading role as consumers continue to increase demand for the latest mobile devices, IoT/IIoT applications, autonomous vehicles and more. Key challenges will also play a major role in the advancement of the semiconductor industry, including time-to-market, as some product launches fail to meet their launch dates. Costs are another factor as supply chains continue to stagnate, and prices for materials and labor continue to surge.[9] How companies will mitigate those issues and leverage current technologies will ultimately drive future innovation within the semiconductor industry.

[6] dl.acm.org/doi/10.1145/3398036
[7] semiwiki.com/wikis/industry-wikis/eda-open-source-tools-wiki
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