

Oppenheimer Thematic Research

# Generative AI

## Next Waves & What It Means For Investors

December 7, 2023



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### KEY TAKEAWAYS

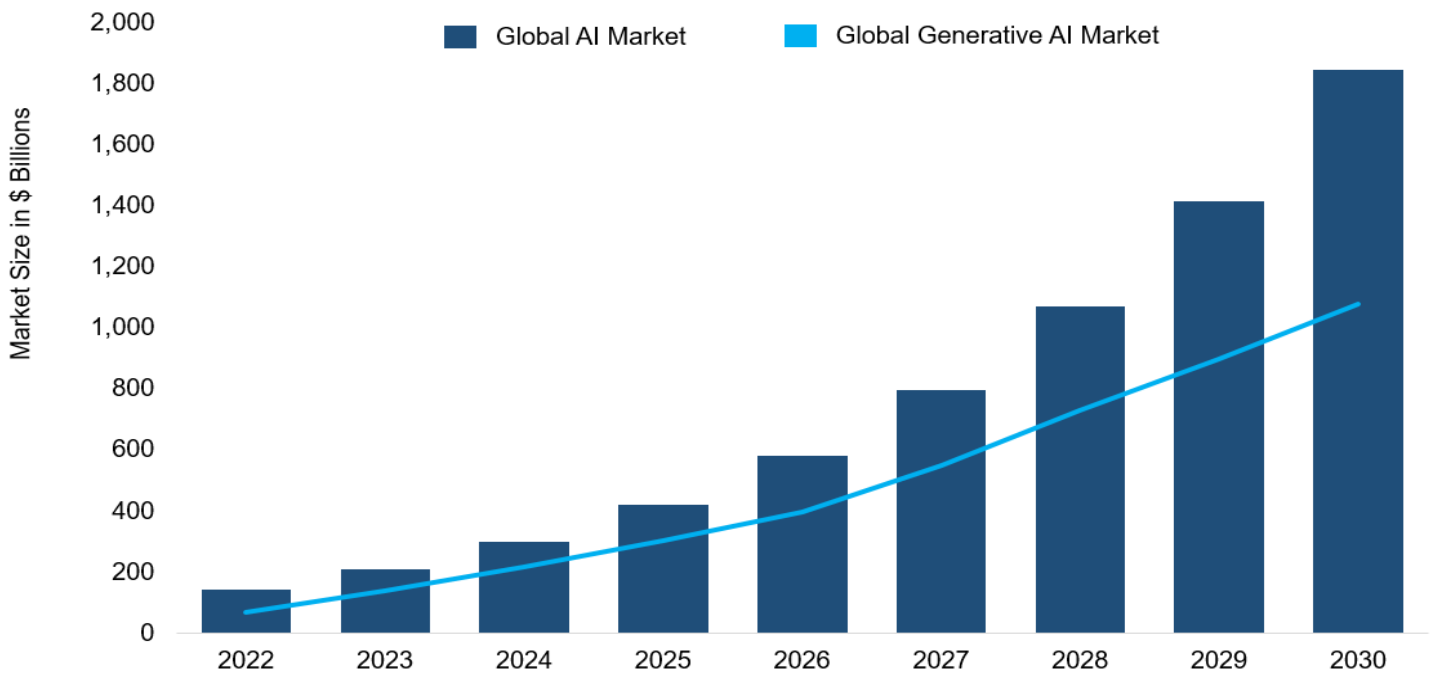
- Generative AI will be the nexus of new tech investment and innovation, offering high potential to unlock growth, creativity, and efficiency, and to drive competitive advantage.
- It's the shiny new thing and for good reason: creativity was long thought to be uniquely human. It turns out it isn't. The addressable opportunity for generative AI is massive with potentially positive implications for the broader economy.
- We see generative AI unfolding in three waves: infrastructure, software, and industry end-markets.
- Though infrastructure demand is not exactly undiscovered at this stage, the push toward AI "everywhere" suggests further near-term tailwinds.
- In software, MSFT arguably has the "oceanfront" property, but early leaders are also emerging in vertical software.
- In end-markets, coders and marketing departments are among the early adopters; however, not many companies have been able to adopt generative AI at scale. Major consulting firms aim to change that, backed by \$10B in announced investments to help clients use the technology.
- For Oppenheimer research, generative AI is a new investment factor that forms part of the investment case, but it's not *the* investment case. Similar to previous tech eras, generative AI offers new investment opportunities and a high likelihood of non-linear progress, requiring investor agility.

### Our House View

Oppenheimer believes generative artificial intelligence is a durable, long-term theme capable of significantly changing the way we work and live, and of catalyzing significant shifts in tech spending and the broader economy. What is striking about the generative AI theme is its size, duration, and reach, not to mention its pace of advancement. The global generative AI market is forecast to reach \$1.8T by 2030 and to add \$4.4T in annual value to the global economy through productivity gains (source: McKinsey). Sizing the market is less about the generative AI market and more about the business value that AI can unlock.

Identifying where in the generative AI value chain real value can be captured and discerning hype from reality will be critical. Oppenheimer sees AI investment opportunities that span the value chain, from early winners, to less obvious supporting players, to incumbents innovating to capitalize on imbedded positions with faster-adopting client sets.

**Exhibit 1: Global Forecast of AI and Generative AI**



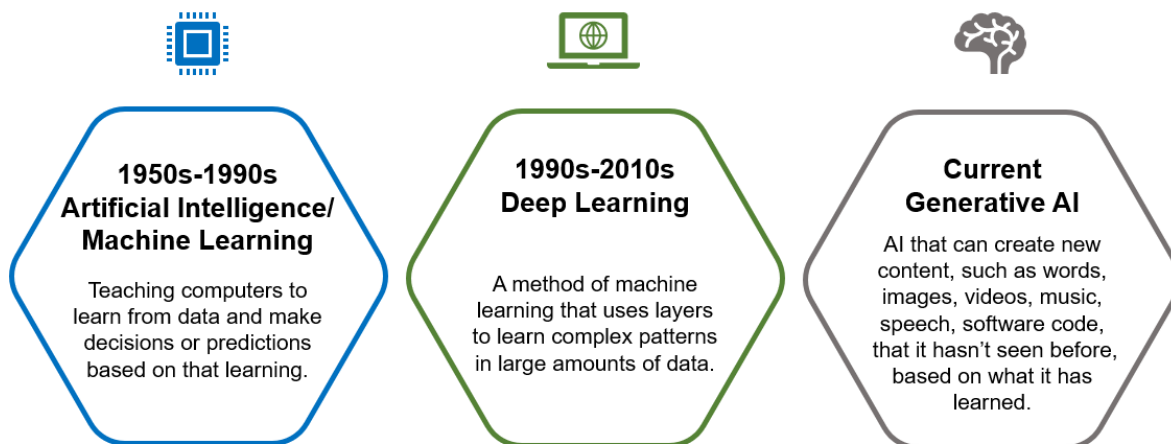
Source: Oppenheimer & Co., Statista, Bloomberg

Generative AI has the potential to impact revenue growth, margins, required investment, and competition. Companies that can harness AI effectively will give themselves a fundamental business advantage and expand their market opportunity.

**What Is Generative AI and Why Is It Important?**

In plain language, generative AI is algorithms that can create new, original, tailored content based on what it has learned. It can create words, images, videos, music, speech, and software code. This creative capability is a significant leap forward because it has long been assumed that creativity is uniquely human. Model iterations, performed on 1 billion unique monthly active users globally for ChatGPT alone, will produce further progress with vast potential. Generative AI can also interpret very complex patterns in data.

**Exhibit 2: Defining Artificial Intelligence**






Source: Oppenheimer & Co. Inc.

Generative AI is like having a very smart full-time intern. How smart? In the case of ChatGPT, an intern who has an IQ of 147, 99.9th percentile, is able to pass the US medical licensing exam and the bar exam, and the capabilities of a Wharton MBA, and an entry-level (level 3) software developer at Google. Your generative AI “intern” can help you accomplish more, but it needs very specific directions and a good deal of supervision. Its work is generally very good, but it is prone to occasional, surprising errors, so it must be double-checked carefully.

**“If successfully deployed, generative AI could enhance productivity and economic growth, supportive of higher valuations on risk assets.”**

By raising one’s ability to get work done more efficiently and effectively, generative AI has the potential to supplement productivity and long-term GDP growth. This comes as welcome news to the US, which faces labor market headwinds from lower birth rates, retiring baby boomers, and deglobalization. As a result, we believe it is more likely than not that in the decades ahead, developing nations will experience stronger growth than in the prior two decades as a result of AI-driven productivity gains. While there is much that is still unknown, an investment implication of generative AI is higher growth, which is typically accompanied by higher valuations on risk assets. The global generative AI market is forecast to reach \$1.8T by 2030. Consulting firm McKinsey estimates that generative AI can add \$4.4T annually in value to the global economy through productivity gains.

**Exhibit 3: Early Uses of Generative AI, Company Departments**

 <p><b>Marketing</b></p>	 <p><b>IT</b></p>
<ul style="list-style-type: none"> <li>• Copy writing</li> <li>• Email summarization</li> <li>• Note summarization</li> <li>• Co-pilots for marketing campaigns</li> <li>• Content generation and image fillers</li> <li>• Segment creation, among others.</li> </ul>	<ul style="list-style-type: none"> <li>• Co-pilots for developers</li> <li>• Case summarization</li> <li>• Assist for Search</li> <li>• Low level agent deflection</li> <li>• Text to workflow</li> <li>• Text to code, among others</li> </ul>
 <p><b>Customer Service</b></p>	 <p><b>HR</b></p>
<ul style="list-style-type: none"> <li>• Chatbot creation</li> <li>• Messaging</li> <li>• Service report summations</li> <li>• Customer care suggestions</li> </ul>	<ul style="list-style-type: none"> <li>• Summarize survey results</li> <li>• Summarize performance reviews</li> <li>• Create job descriptions</li> <li>• Summarize resumes</li> <li>• Digital assistants to help candidates</li> <li>• Summarize feedback from recruiting videos</li> <li>• Summarize skills and make suggestions to employees and managers about future classes</li> </ul>

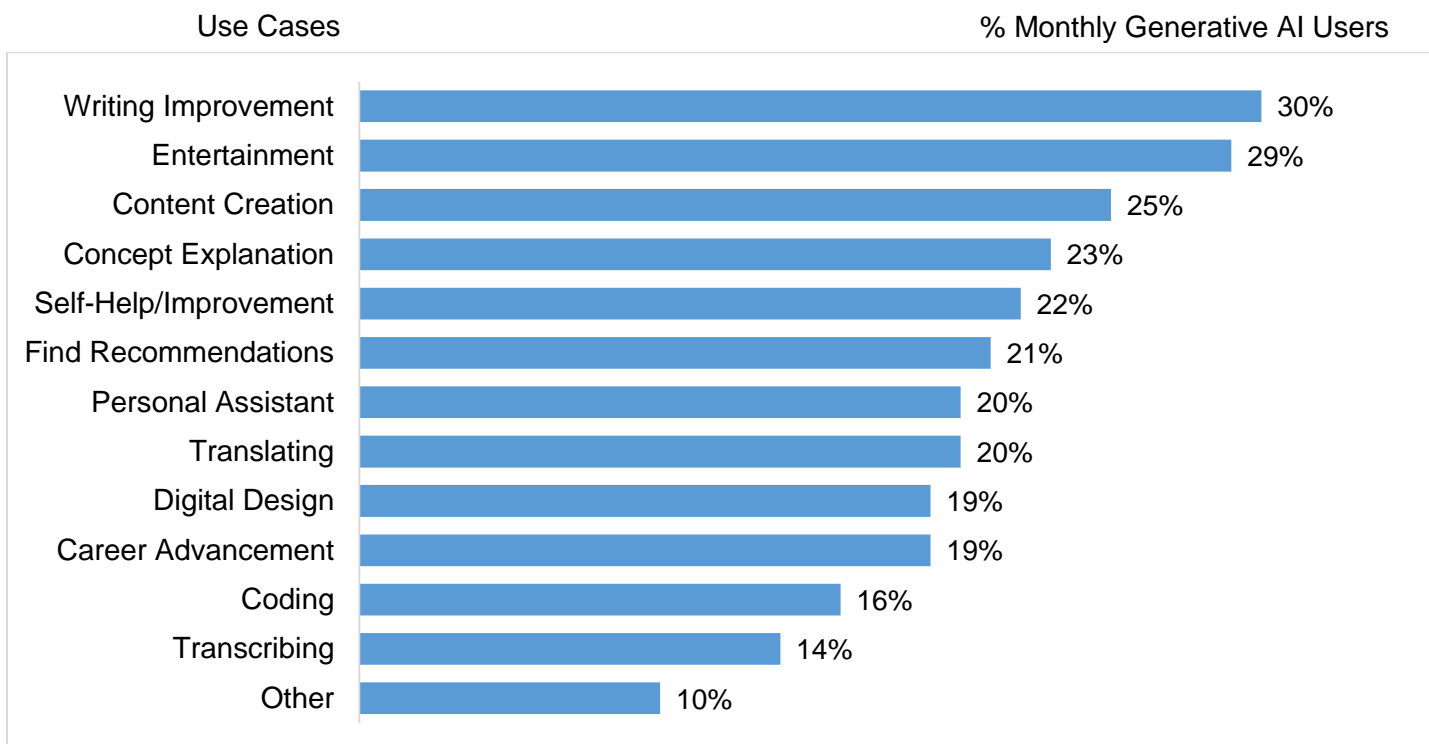
Source: Oppenheimer & Co. Inc.

The surge in AI interest has ignited concerns about automation and job losses. Will AI replace humans in the workforce? Historically, new technology has, on balance, added jobs, but has displaced workers who have not re-skilled for new market requirements. Much will depend on the pace of change and people’s willingness to prepare and re-skill. We believe AI enablement will occur over a long, and potentially less job-disruptive, time frame. In the near term, we believe AI will augment and not replace workers. A recent study by the European Central Bank suggests that AI could reduce wages. AI is currently generating jobs, in particular for young and highly skilled workers. At this stage, publicly available data in the US suggests there is massive growth in AI jobs. In 2022, there were 519 job postings calling for generative AI skills. Through September, there were 10,113 generative AI job postings (source: Lightcast).

“Generative AI likely won’t replace your job, but it is plausible that people with generative AI skills will.”

Each month, one billion people globally use ChatGPT, and it’s just one of many generative AI chatbots. How are consumers engaging with generative AI? Writing improvement is the most prevalent use, followed by entertainment and content creation. ChatGPT has distanced itself from peers in usage, but for most categories the winners have yet to be decided.

**Exhibit 4: Consumer Uses of Generative AI**



Source: Activate 2023 Consumer Technology & Media Research Study (n=4,023). Adults ages 18+ who use at least one generative AI application once per month. Oppenheimer & Co. Inc.

**Exhibit 5: Oppenheimer’s Top 10 Predictions on Generative AI**

**Prediction**

- 1. SECOND WAVE OF AI BENEFICIARIES TO EMERGE BEYOND INFRASTRUCTURE**  
Companies Exposed/Ways to Express: When we filter for high analyst conviction, technically strong, and thematically sound: ADSK, BSY, NET, PTC, SHOP, AMZN, SNOW, MCO
- 2. SAAS & VERTICAL SOFTWARE WINNERS: CODE DEVELOPMENT, CONTENT CREATION, CUSTOMER SERVICE, INDUSTRIAL DESIGN, MARKETING AUTOMATION, VERTICAL LEADERS**  
Companies Exposed/Ways to Express: Code development: MSFT (GitHub Copilot, ChatGPT), AMZN (CodeWhisperer), NOW (Assist). Content creation: ADBE (Firefly). Content/commerce: SHOP (Sidekick). Customer service: CRM (Genie), FRSH (Freddy AI). Enterprise: MSFT. Industrial design: ADSK & PTC (Generative Design), ANSS (Ansys SimAI). Marketing automation: ADBE (Sensei Gen AI), BRZE (Sage AI), CRM (Genie). Entrenched vertical SaaS leaders: GWRE, VEEV
- 3. SOFTWARE: ANALYTICS, DATA, SECURITY, AND INFRASTRUCTURE WILL BENEFIT FROM AI, AIDING IN SCALING RATHER THAN REPLACING**  
Companies Exposed/Ways to Express: Data: SNOW. Cybersecurity: CRWD, PANW
- 4. AI FOR INDUSTRIAL APPLICATIONS AND THE BUILT ENVIRONMENT WILL BECOME A MAJOR INVESTMENT THEME.**  
Companies Exposed/Ways to Express: BSY (infrastructure language), ROK (industrial automation), WM (recycling automation)
- 5. AI WILL PROLIFERATE “EVERYWHERE,” IN OUR VIEW**  
 From data centers, to enterprise, all the way to the edge and devices. Rapid performance improvements could produce sustained demand for GPU accelerated architectures. The GPU replacement cycle will be a focal point.  
Companies Exposed/Ways to Express: Compute: NVDA. AI networking/connectivity: AVGO, MRVL. Power: MPWR
- 6. INFRASTRUCTURE AI STOCK LAGGARDS WILL NARROW THE GAP**  
Companies Exposed/Ways to Express: CCOI, EQIX
- 7. BRAND NEW PRODUCT CATEGORIES AND CAPABILITIES WILL EMERGE, LEVERAGING NEW TECH AND AVOIDING INCUMBENT COMPETITION**  
 Examples: LLMs, virtual video, ML ops, property tech, human process automation, enterprise search tools
- 8. THE COST OF RUNNING GENERATIVE AI MODELS WILL CONTINUE TO DECLINE**  
 Companies will likely shrink the data sets that models run on based on what most consumers need and as innovations reduce the cost of computing.  
Companies Exposed/Ways to Express: GOOG, META, AMZN, MSFT. Positive for many privates.
- 9. IN BIOTECH, GENERATIVE AI WILL TAKE TIME TO DEVELOP**  
Companies Exposed/Ways to Express: MDNA, SLP
- 10. RECRUITING, LEARNING, AND ROBOTICS PROCESS AUTOMATION WILL FACE STRUCTURAL PRESSURE FROM AI, IN OUR VIEW**  
Companies Exposed/Ways to Express: Learning: CHGG, SKIL. Robotic Process Automation: PATH

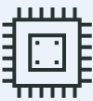


Source: Oppenheimer & Co. Inc.

## How We See Generative AI Unfolding in Selected Sectors and the Investment Implications

Like platform shifts before it, generative AI creates investment opportunities. Generative AI is in the land-grab phase, attracting capital and competition, and not everyone will be a winner. A hard lesson learned from prior tech cycles is that people tend to overestimate the effect of technology in the short run and underestimate its effect in the long run. One thing is for certain: the advent of large language models (LLMs) requires data, computing, and power at a very significant scale, reflected in exponential growth in GPU sales.

## Infrastructure and Internet

### Exhibit 6: Infrastructure and Internet Companies That Stand to Benefit

SECTOR/ OPPENHEIMER ANALYST	BEST AI IDEAS
 <p><b>Semiconductors &amp; Components</b> Rick Schafer</p>	<ul style="list-style-type: none"> <li>• <b>Nvidia</b> is our top AI idea in the semiconductor sector.</li> <li>• Other top AI-exposed companies include <b>Broadcom</b> and <b>Marvell</b> who lead in AI networking/ connectivity.</li> <li>• <b>Monolithic Power</b> is a somewhat sneaky AI play, as it provides the majority of 48V power for leading accelerators including those from <b>NVIDIA</b> and <b>Google</b>.</li> <li>• <b>Honorable mention is Perform-rated AMD</b>, a wild card in the AI space looking forward. In 2024, AMD should see its first material accelerator sales.</li> </ul>
 <p><b>Cloud &amp; Communication Services</b> Tim Horan, CFA</p>	<ul style="list-style-type: none"> <li>• <b>Microsoft</b> is well-positioned to dominate the enterprise AI market by leveraging its shrewd AI investments in OpenAI (LLM), Azure (AI/GPU-optimized infrastructure), proprietary data from 1.5B-user Windows/Office/Teams and 100M developer Github ecosystem, and network effects from first-party apps.</li> <li>• <b>Cogent</b>: Provides fiber and internet networks for AI.</li> <li>• <b>NICE</b>: Can use AI to automate and digitize customer interactions</li> <li>• <b>Equinix</b>: Increased demand for AI cloud compute can drive pricing power, leading to revenue acceleration in 2H24E and beyond.</li> <li>• <b>RingCentral</b> is most at risk, in our view, as <b>Microsoft</b> will use TEAMS to attack RingCentral’s market segment.</li> </ul>
 <p><b>Internet</b> Jason Helfstein</p>	<ul style="list-style-type: none"> <li>• <b>Google</b>: Largest proprietary data owner on what much of the world does on the Internet. Invented LLMs, owns a top-5 cloud provider, has significant cash, profitability, and a track record of patience.</li> <li>• <b>Amazon</b>: Largest cloud provider, largest database on shopping activity in most countries, early innovator in digital assistants.</li> <li>• <b>Meta</b>: Largest proprietary data owner on social activity. Launched open-source LLM, owns top-5 cloud provider, has significant cash, profitability, and patience.</li> </ul>

Source: Oppenheimer & Co. Inc.

**Semiconductors and Components**—Many in the industry see a day when “everything” with a processor is accelerated. Early AI investments are centered on training models in the datacenter. Datacenter is a \$1T installed base. The combination of the slowdown (death?) of Moore’s Law and architecture shift to accelerated (heterogeneous) computing will drive semiconductor investments over the next several years. New generations of accelerators bring order of magnitude-type performance boosts every one to two years. By comparison, traditional (CPU-centric) compute sees performance double every two years (at best). AI inference from core to edge is seen as a much larger opportunity (vs. training) long term. We believe there will be more performance-optimized servers, PCs, smartphones, autos, and countless other edge devices fueling AI-inspired innovation.





**Cloud & Communications**—Cloud computing and communications will experience dramatic innovation, expanded service offerings, and heightened competition, catalyzed by generative AI technologies making all software and services "cognizant." The cloud is a once-in-a-century general purpose technology (like electricity), and AI is its killer app. AI shows all the classic signs of disruptive technology, which many first dismiss as novelty, like the iPhone was "inferior" to cell phones because it lacked a physical keyboard, was expensive, and initially was available through one carrier (AT&T).

Microsoft is in the lead to become the "operating system" of this new wave, supported by the findings from our inaugural generative AI CTO survey, due to its unified AI/cloud infrastructure, large stake in OpenAI, and proprietary data, that enables easy monetization through ubiquitous first-party apps with billions of users (i.e., Windows, LinkedIn, and Office), while simultaneously providing a neutral platform for others to economically build their own offerings. However, over time, as the ecosystem matures, the emergence of new players like Nvidia and various IaaS start-ups will challenge the dominance of the big three cloud providers (AWS, Azure, GCP). This competition is likely to foster a more diversified and competitive cloud infrastructure marketplace, leading to better pricing, service quality, and innovative offerings.

**Internet**—We see four avenues for value creation in AI: 1) The cost to license a LLM will be low or free, but the margin will be generated through processing the data (MSFT, AMZN, GOOGL). 2) Companies will charge for connections to the consumer through "advertising" (AMZN, GOOGL, META) or the App Store equivalent. 3) Companies who have proprietary data will generate better generative AI results: For Google, it's its index of the entire Internet; for META, it's its data on consumer activity; for UBER, it's a better understating of where you want to go or what you want to eat, etc. 4) Productivity can be improved by automating human interactions, such as customer support and advertising.

## Software Applications

### Exhibit 7: Software Companies That Stand to Benefit

SECTOR/ OPPENHEIMER ANALYST	BEST AI IDEAS
 <p><b>SaaS/Applications Software</b> Brian Schwartz</p> <p><b>Vertical Software</b> Ken Wong, CFA</p>	<ul style="list-style-type: none"> <li>• <b>Adobe:</b> Launch of Firefly has delivered on monetizable value-add for users.</li> <li>• <b>Autodesk, PTC, ANSYS</b> (industrial design): Deep moat, specialized labor force likely keep competition at bay. Visually compelling like <b>Adobe</b>, which has seen massive AI multiple expansion.</li> <li>• <b>Shopify:</b> We see potential for commerce SaaS to boost GMV with AI-powered purchase recommendations, which would indirectly drive revenue and co-pilot to accelerate site creation.</li> <li>• There continues to be investor debate around the impact of generative AI on website builders (<b>Wix, Squarespace</b>, and <b>Shopify</b> to a lesser degree). Commoditizes website creation, resulting in a race to the bottom.</li> </ul>
 <p><b>Analytics, Data, Security and Infrastructure Software</b> Ittai Kidron</p>	<ul style="list-style-type: none"> <li>• <b>CrowdStrike:</b> Leading cybersecurity vendor using its large inflow of endpoint and cloud data to create enhanced security products and take share. The company has already launched a dedicated GAI co-pilot function (called Charlotte AI) as an add-on product and is charging \$20/endpoint/year for it, providing ~20% uplift to the core endpoint product.</li> <li>• <b>Snowflake:</b> Will be one of the two neutral and cloud-based data lakes with AI/ML application development frameworks. With the proliferation of AI/ML applications, we shall see greater need for data storage (ML/LLM models running on top), and a material increase in analytic engines and workloads.</li> <li>• <b>Palo Alto:</b> As the largest end-to-end cybersecurity provider, Palo Alto benefits from running AI/ML models on its security data to provide cutting edge analytics and insights to its customers. Additionally, GAI embedded features can expand co-pilot capabilities.</li> </ul>

Source: Oppenheimer & Co. Inc.

**SaaS/Applications Software**—The greatest controversy we hear from investors is around the commoditization of AI capabilities and timing and magnitude of potential monetization. The overwhelming majority of corporates are baking AI

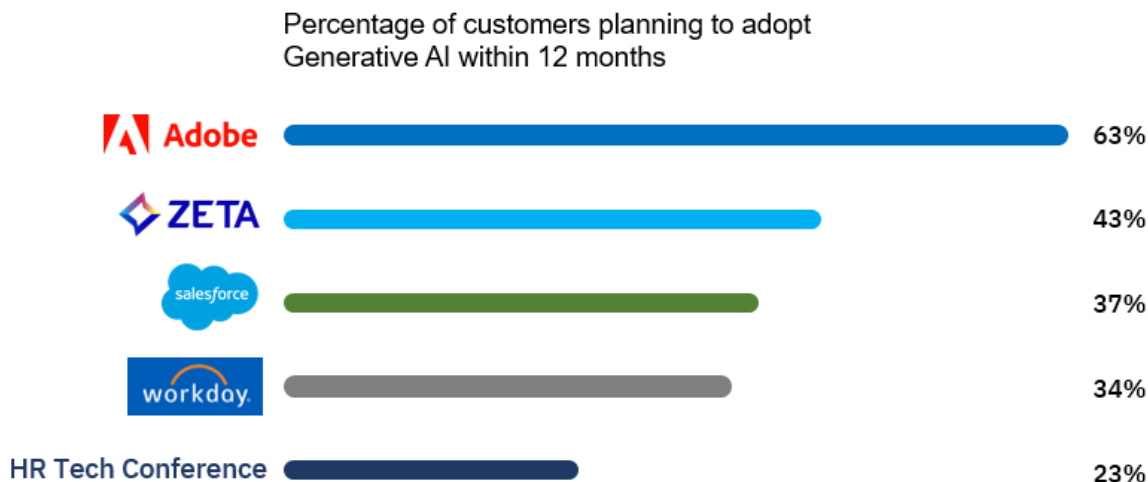
functionality into the platform (at no cost) to drive engagement, and collect data to enable product iteration. Initially, monetization will come through upselling to high-end SKUs to access greater functionality, and more direct revenue with modules once value-add is proven out. At this juncture, customers are curious about the potential productivity benefits, but are lukewarm on adding costs (partially macro driven, one imagines).

According to our generative AI CTO survey, only 6% of the survey respondents are willing to accept more than 30% price increases for AI-embedded products, and 64% of respondents indicated a willingness to pay less than 15% more for this type of technology. None of the horizontal SaaS/application software vendors could garner more than a single digit share of the vote in terms of the suppliers most likely to gain the largest share of the future AI spend at the organization. The results indicate that providers should not expect AI to be a large monetization engine for growth anytime soon since it appears companies do not yet have a strong grasp of the potential positive impact of AI in their business.

Customers also still harbor concerns around security, reliability, and vendor differentiation. While this is happening, the technology is likely to commoditize as new suppliers enter the market and as the largest application software suppliers exert the power of incumbency and entrenchment in the central IT departments at enterprise organizations to compete on price. SaaS/application software suppliers should continue to rely on new market opportunities and product development for improved customer acquisition and installed-base monetization activity as AI technology supports the value proposition, price increases, and internal business cost optimization. We see co-pilot tools streamlining the web onboarding process, and increasing the velocity of website creation which should boost the overall TAM long-term.

Our recent field checks across the software industry indicate that marketing departments have been one of the first areas of the organization to adopt generative AI solutions. Personalizing digital content to match customer behavioral intentions remains a priority investment in marketing IT budgets. Generative AI use cases, such as email creation, summation, and content creation, are helping to accelerate marketing campaigns and generate a faster time to value.

**Exhibit 8: Software That Buyers Plan to Adopt Early**



Source: Oppenheimer generative AI CTO survey

**Analytics, Data, Security and Infrastructure Software**—AI and machine learning (ML) have been implemented in the infrastructure and cybersecurity software industry for years and used for a range of use cases from automation to data pattern discovery and more. With the advent of generative AI, we see a systemic shift in the amount of investment and innovation around traditional AI/ML and generative AI that can impact the industry in multiple ways.




Looking more specifically at the impact of generative AI, we note the following. First, we see a significant improvement in employee productivity across the board with the introduction of co-pilot capabilities. This will address a multi-year shortage in trained talent that has plagued the industry. Second, we see near-term revenue opportunities as stand-alone



tools are enhanced with GAI features/capabilities, and long-term revenue opportunities as vendors make broader investments in incorporating LLMs deeper into their decision engine and automation fabric. Last and longer term, we believe generative AI can drive greater industry consolidation as customers look for platforms that bring data and decision-making closer together. Deeply integrating AI/generative AI will require significant resources, and vendors that fall short are at risk of falling behind or being acquired.

## Selected Industry End-Markets

Exhibit 9: Selected Industry End-Market Companies That Stand to Benefit

SECTOR/ OPPENHEIMER ANALYST	BEST AI IDEAS
 <p><b>Sustainable Growth &amp; Resource Optimization</b> Colin Rusch Noah Kaye Kristen Owen, CFA</p>	<ul style="list-style-type: none"> <li>• <b>Aptiv:</b> Leveraged to operating system for autonomy as well as the software development environment.</li> <li>• <b>Bentley Systems:</b> AI will require an infrastructure language. Bentley Systems is building that language, with knock-on platform utilization benefits.</li> <li>• <b>Corteva:</b> AI is a key enabler for genetic engineering, and we believe Corteva’s GE portfolio is underappreciated relative to peers.</li> <li>• <b>Deere:</b> Was first to natively connect its machines with on-board sense-and-act. As the dominant market player and largest installed fleet, Deere also benefits from a training data advantage.</li> <li>• <b>Rockwell Automation:</b> Leader in leveraging AI for industrial automation, from design to manufacturing process improvement.</li> <li>• <b>Waste Management:</b> AI is a key enabler of Waste Management’s sustainability investments in recycling automation, which should structurally boost profitability.</li> <li>• <b>Honorable mention is Perform-rated Tesla:</b> Leader in AI application and data collection on autonomy and robots.</li> </ul>
 <p><b>Exchanges, Information Analytics and Asset Management</b> Owen Lau, CFA</p>	<ul style="list-style-type: none"> <li>• <b>Moody’s:</b> Proprietary datasets (i.e., credit data, know-your-customer data, ratings data, ESG data) and long history of data frameworks. New AI product: “Moody’s Research Assistant.”</li> <li>• <b>Nasdaq:</b> Anti-financial crime software leverages AI and ML to quickly and more accurately identify check fraud.</li> </ul>
 <p><b>Biotechnology</b> Hartaj Singh Frank Brisebois</p>	<ul style="list-style-type: none"> <li>• <b>Simulations Plus:</b> A “picks and shovels” company that is currently profitable and serves the drug industry by helping orchestrate simulated clinical trials.</li> <li>• <b>Honorable mention is Perform-rated Moderna:</b> Has been investing in software and hardware tools for more than 10 years to help automate mRNA drug material generation and time-to-clinic. Very involved in AI and currently using proprietary software tools to develop new drug candidates for example personalized cancer vaccines.</li> </ul>

Source: Oppenheimer & Co. Inc.

**Sustainable Growth & Resource Optimization**—We view AI as a critical enabling technology for accelerating learning cycles across our sustainable growth & resource optimization coverage universe and as one that will have a multi-layered impact on R&D cycle time, infrastructure resilience and longevity, manufacturing density and efficiency, as well as witnessing the initial transformation of the transportation, mining, and agriculture markets due to autonomous vehicles. By leveraging predictive analytics and simulations into faster product development cycles, technology developers can accelerate down the cost curve significantly faster and de-risk commercialization of emerging enabling technologies. While relatively few of our companies will be AI developers, many are looking to leverage AI in their organizations, and nearly all will be impacted by it. Finally, the growth of critical infrastructure supporting AI will drive demand for clean, efficient, and resilient energy solutions, which benefits a large portion of our coverage.

We see AI in buildings as an opportunity to utilize information and controls to improve people’s experiences and productivity in an energy-efficient manner. Consultant Deloitte estimates there will be 4B connected IoT devices in commercial buildings by 2028, thus increasing the degree of connectivity between edge sensors and devices, systems, building automation controls, and the enterprise, which enables big-data collection, analysis, and outcomes management in cloud-native platforms. The use of AI and common data models across building systems should drive faster innovation cycles, streamline experiences, and lead to better integrated outcomes.

At the system level, we see growth in connected HVAC and other building systems that collect data and compile it into reports to identify usage trends, system status, and past performance. This informs preventative maintenance, identifies malfunctions faster, and identifies components, specs, and source parts for repairs. At the enterprise level, we see advanced building management systems incorporating AI, using real-time tracking and automatic data analytics to generate solutions for improving energy consumption, asset performance, maintenance operations, and occupant satisfaction and well-being. Tools like digital twins will help optimize design, installation, and service.

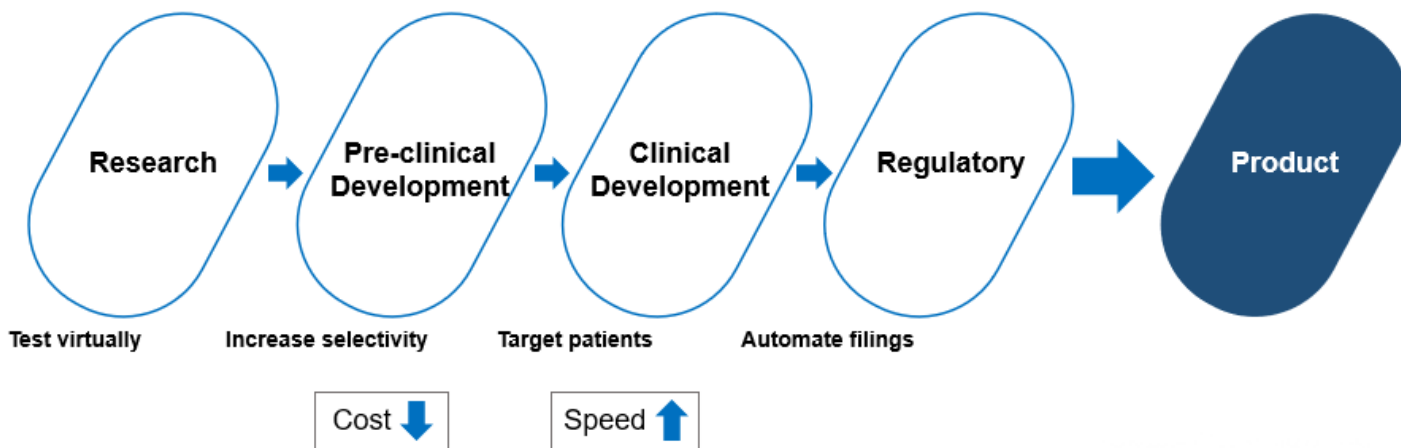
**Exchanges, Information Analytics and Asset Management**—Generative AI can deliver significant benefits for conducting research, managing risk, and ensuring compliance. Additionally, generative AI can reduce time in data collection of non-standard and unstructured data while increasing efficiency. For the companies in our sector, generative AI offers the potential to reduce costs, increase efficiency, and, over time, augment revenue potential. Importantly, AI is only as good as the input data, a core element to train AI models, and the companies in our sector are endowed with vast pools of proprietary data.

As an example, Moody’s has a significant amount of ratings, know-your-customer, and ESG data to build its generative AI research tool called Moody’s Research Assistant. It is a chatbot similar to ChatGPT, but the algorithm is trained by Moody’s proprietary data, and the tool is specifically for capital markets and investment professionals to shorten research time. This product is in partnership with Microsoft, and Moody’s is testing this out with major clients. The company is gathering feedback and is on track to monetize it as a stand-alone product.

Early adopters are also using generative AI for fraud detection. The amount of money laundering globally is estimated to be \$2-\$5T. Nasdaq’s anti-financial crime software helps financial institutions detect fraudulent checks, and its software can view images of deposited checks and compare signature, logo and other characteristics of similar checks deposited across different channels (e.g., ATMs, branches, mobile, etc.). By leveraging AI and ML to identify gaps between checks and a jump in a check’s sequence numbers, financial institutions can quickly and more accurately identify check fraud.

**Biotechnology**—Drug development is a long, arduous, and expensive process. By harnessing AI in the right way, biotech companies can shorten the time frame from research to approval and develop drugs less expensively. This should help patients, companies, and investors. It typically takes at least 10 years to develop a single new drug. Cost estimates range from a few hundred million dollars to over a billion for each new drug.

**Exhibit 10: AI Applications Across the Value Chain of Drug Development**



Source: Oppenheimer & Co. Inc.

AI can impact each step across the value chain of drug development.

*Step 1: Research*—Historically, test compounds were randomly synthesized or derived from natural products. Now scientists can go way beyond the hundreds of millions of compounds in existing drug “libraries” by using AI to create virtual compounds. New proteins can be created as well that never before existed in nature. This is happening right now.

*Step 2: Preclinical development*—Scientists can increase selectivity by choosing better targets for experimental drugs by mining existing genomic databases. Coupled with virtual compounds, scientists can create new datasets to train on, to create chatGPT for the chemical world.

*Step 3: Clinical development*—At this stage, 90% of test compounds fail. We can improve this by targeting the right patients. Companies can also use simulated control arms instead of placebo arms in clinical trials. This means:

- Fewer patients acting as guinea pigs
- Fewer patients wasting time on placebos
- Faster clinical trial results
- Less expensive trials

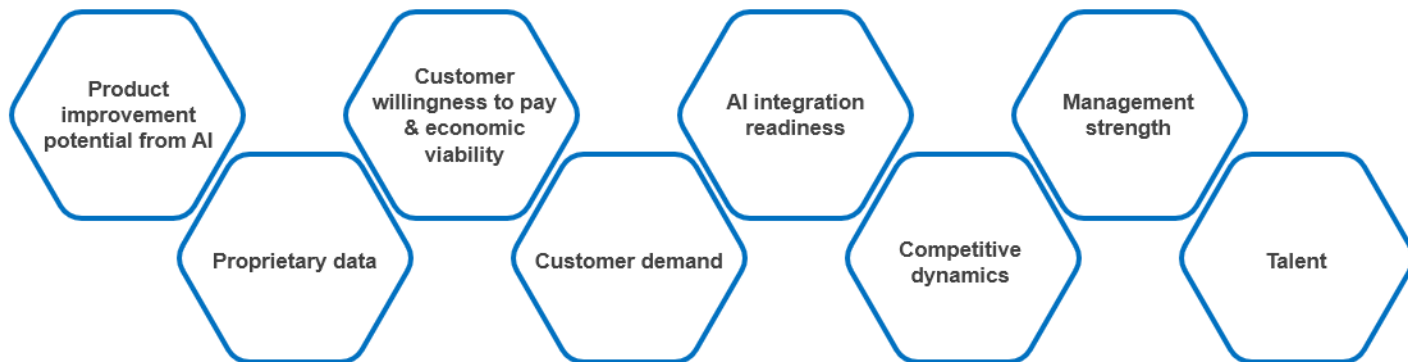
*Step 4: Regulatory approval*—The typical new drug application is 10,000 pages long. Companies are already using AI to streamline the communication process with the FDA and foreign regulators to facilitate the submission process.

In sum, AI can be transformational in biotech drug development. But it won’t have an overnight impact, as we see it. Even though there are indeed a dozen or so AI-produced drugs working their way through the process, the greater impact will be to use AI in every step of the drug development process to enhance efficiency.

**We Believe the Investment Implications of AI Will Be Idiosyncratic; However, the Winners Will Have Several Things in Common**

There is massive attention on compute and infrastructure, and they are critical ingredients to build successful AI tools. However, when the same tools are available to everyone, the key differentiating factor is unique and proprietary data that can train models to develop specific purpose-built solutions. Additionally, companies will have a head start and the potential to pre-empt encroachment if they have a history of utilizing structured data and market entry requires greater industry expertise (example: highly regulated sectors).

**Exhibit 11: Framework for Evaluation of AI Impact on Companies**

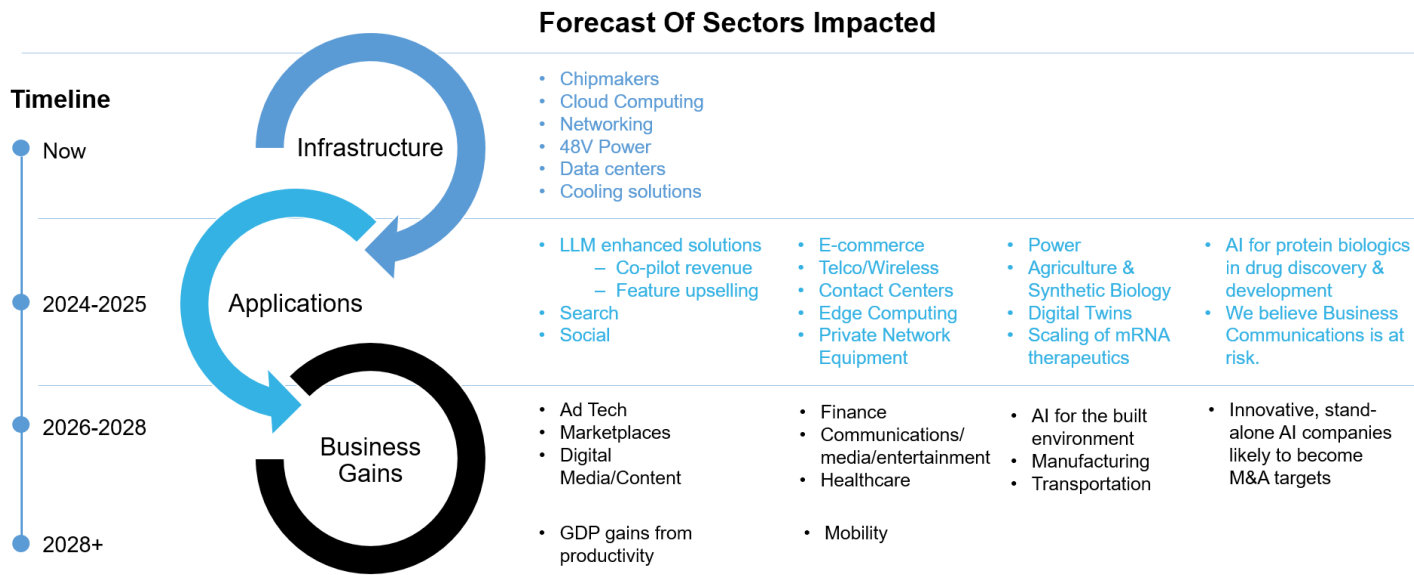


Source: Oppenheimer & Co. Inc.

## We See the Impact of AI Unfolding in Three Waves

The first wave is on the input side, infrastructure, which is moving rapidly ahead. We see increased demand for hardware/software and infrastructure to perform AI training and inferencing. This includes GPUs (NVDA, AMD), cloud services, networking equipment, power, datacenters, cooling equipment (AI produces 4-5x the amount of heat per chip), and, somewhat later, edge networks.

Exhibit 12: Where Will Value Accrue?



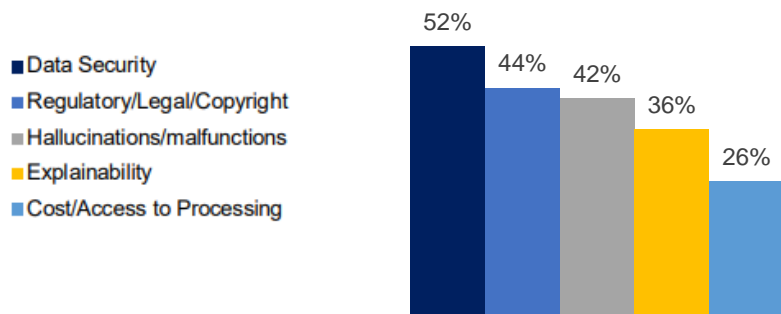
Source: Oppenheimer & Co. Inc.

The second wave is on the output side: software applications, beginning with embedded solutions with an installed base sold to early-adopter client types. This phase may move more unevenly—faster for consumer applications, faster for imbedded workflow incumbents, faster for early adopting functions such as marketing, and more slowly for de novo application software. Based on Oppenheimer’s generative AI CTO survey, many companies do not have a strong grasp of the potential impact of AI technologies on the business and are still in a learning phase about the technology.

The third wave is business gains. The adoption cycle is likely to be more gradual than rapid, because organizational change can be slow and concerns will need to be overcome (see Exhibit 13). Since AI is a derivative of the underlying data, companies with proprietary datasets have the potential to create value. However, this also takes scale and execution. Along the way, generative AI will catalyze second-order impacts to energy/grid modernization, resources, mobility, healthcare, consumer leisure time, and education, among other areas.

**Exhibit 13: Generative AI Implementation Concerns**

**What are your biggest concerns about implementing Generative AI? (n=50)**



Source: Guidepoint Expert Network, Oppenheimer & Co. Inc. Survey

“We believe what we're seeing today is the first innings of what can happen across companies and industries that will play out over the course of decades.”

**Our data collection points to significant opportunities across sectors**

- **Agriculture and Synthetic Biology:** Traits today are a \$55B market, but we believe there is significant upside (i.e., 3-5x+) when the technology unlocks genetic diversity of plants. We note this assessment represents a single application.
- **Autonomous Driving:** ~\$1/mile of driver time points to a \$3.17T opportunity in the US based on 2022 vehicle miles traveled (VMT).
- **Cooling Solutions:** Of energy consumption in data centers today, 40% is for cooling solutions, a \$15B market. As AI spurs growth of high-compute data centers with rack densities ranging between 30-100kW, data center cooling solutions will need to evolve beyond traditional air cooling solutions (which have a limit range of 15-25kW/rack), toward an extended thermal chain including both air and precision liquid cooling. These dynamics should drive a high-single-digit to low-double-digit market CAGR through 2030.
- **Data Center:** \$1 trillion installed base. We believe inference adoption multiplies this opportunity.
- **Digital Twins:** Market researchers Gartner estimate digital twins could be \$183B market by 2031; within infrastructure engineering, the total addressable market is closer to \$30B.
- **Power:** Peer-reviewed research in *Joule* estimates that by 2027, AI servers could consume between 85-134 TWh of electricity annually, about 0.5% of the world's current electricity use. The buildout of renewables to meet this electricity demand could cost ~\$50-100B.
- **Risk and Compliance:** The transition to generative AI tools won't happen overnight, in our view. In the compliance field, 5% expect widespread adoption within the next year, 45% within the next 1-3 years, and 38% within 3-5 years (source: Moody's Analytics survey).
- **Software: SaaS and Vertical:** On the cost side, executives at covered companies believe generative AI could arguably reduce their internal costs by 20-30% if they leaned into AI across the organization.
- **Software: Analytics, Data, Security and Infrastructure:** It is fairly early to accurately quantify the market opportunity. Narrowly, we estimate that the implementation of co-pilots could add 2-5 points of growth long term to

any vendors. Other GAI implementations beyond this (LLM-enhanced solutions, for example) are harder to quantify.

- **Training:** Redesigning workflows and training the AI workforce is a massive opportunity. In the past 12 months, the major consulting firms have announced AI investments in excess of \$10 billion.

### Different Competitive Dynamics vs. Other Platform Shifts




Generative AI differs from past platform shifts because big tech firms start in an unusually strong position with first-mover advantages, vast amounts of proprietary data, access to high-speed compute, capital, talent, and imbedded positions with a large base of customers. We see a dual-track race underway between data-rich, big tech incumbents and innovative start-ups that can play in more targeted industry verticals and capital-light areas leveraging open source models. Unlike previous technology cycles which took years to integrate, AI can be rapidly incorporated into existing products, allowing for quicker deployment. AI’s rapid advancement may create future products that are not plausible today.

**“Big Tech starts in an unusually strong position, but they will need to grow capital spending to capture AI workloads.”**

**M&A is likely to increase.** As new innovations gain traction in the marketplace and incumbents look to accelerate their development and leverage new capabilities, we expect to see a wave of strategic investments followed by consolidation. Companies that don’t recognize the benefits or the threat of potential disruption risk being on the wrong side of change.

**What we’re watching.** To gauge how the AI market is developing and what lies ahead, we will be looking at certain mile markers.

### Exhibit 14: Generative AI Market Development Indicators

 <b>Early GenAI Market Indicators</b>	 <b>Product Progress</b>	 <b>Evidence of Efficiencies</b>
<ul style="list-style-type: none"> <li>• CTO spending plans</li> <li>• Cloud hyperscaler capital expenditures and NVIDIA data center revenues</li> <li>• Monolithic Power growth</li> <li>• Computing choke points and supply constraints.</li> <li>• Geopolitical developments.</li> <li>• VC investments and leading startup activities</li> <li>• Regulatory &amp; legal developments</li> </ul>	<ul style="list-style-type: none"> <li>• AI product roadmaps &amp; new monetizable AI solutions.</li> <li>• Product introductions/upgrades including migration to subscription models, and product cost declines.</li> <li>• Customer trends: Number of GenAI customers, retention, NPS scores.</li> <li>• Uptake, utilization, reviews on Microsoft office 365 CoPilot</li> <li>• Investments in talent and tech.</li> </ul>	<ul style="list-style-type: none"> <li>• Margin impact of GenAI initiatives.</li> <li>• Cycle times on new product development and cost curve declines.</li> <li>• In biotech, we look for companies that are showing early signs of effectiveness in using computational methods to decrease time to commercial product or increase probability of success.</li> </ul>

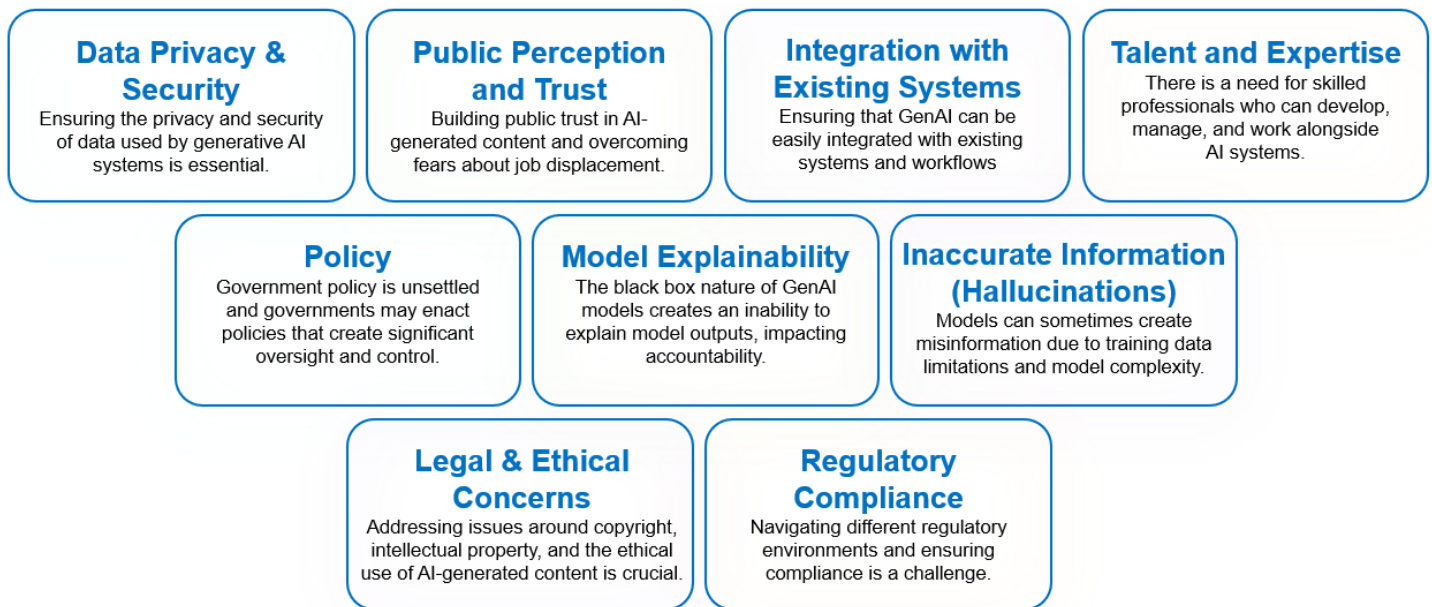
Source: Oppenheimer & Co. Inc.



We will also be monitoring potential risks. As is true in many tech cycles, up-front capital investment is required before one can earn a return. At this nascent stage of the generative AI cycle, the magnitude of spending is very large relative to the revenues generated. While near-term visibility on capital investment appears to be high, the replacement cycle for GPU-accelerated architectures is uncertain. This dynamic will have a bearing on chip orders for 2025 and beyond. The telco overbuild of optical fiber during the Internet bubble comes to mind and is a potential risk corollary to consider. Additionally, the utilization of GPUs to generate customer value from rapid investment remains an open question. It also highlights the importance for incumbents and start-ups to shift focus from infrastructure to creating tangible value for end-customers.

**Hurdles.** While AI may seem like an unstoppable force, it will need to clear some hurdles to reach its full market potential. We see a number of issues, risks, and uncertainties that could have an important bearing on the pace of adoption and the development of the market.

**Exhibit 15: Generative AI Risks & Uncertainties**

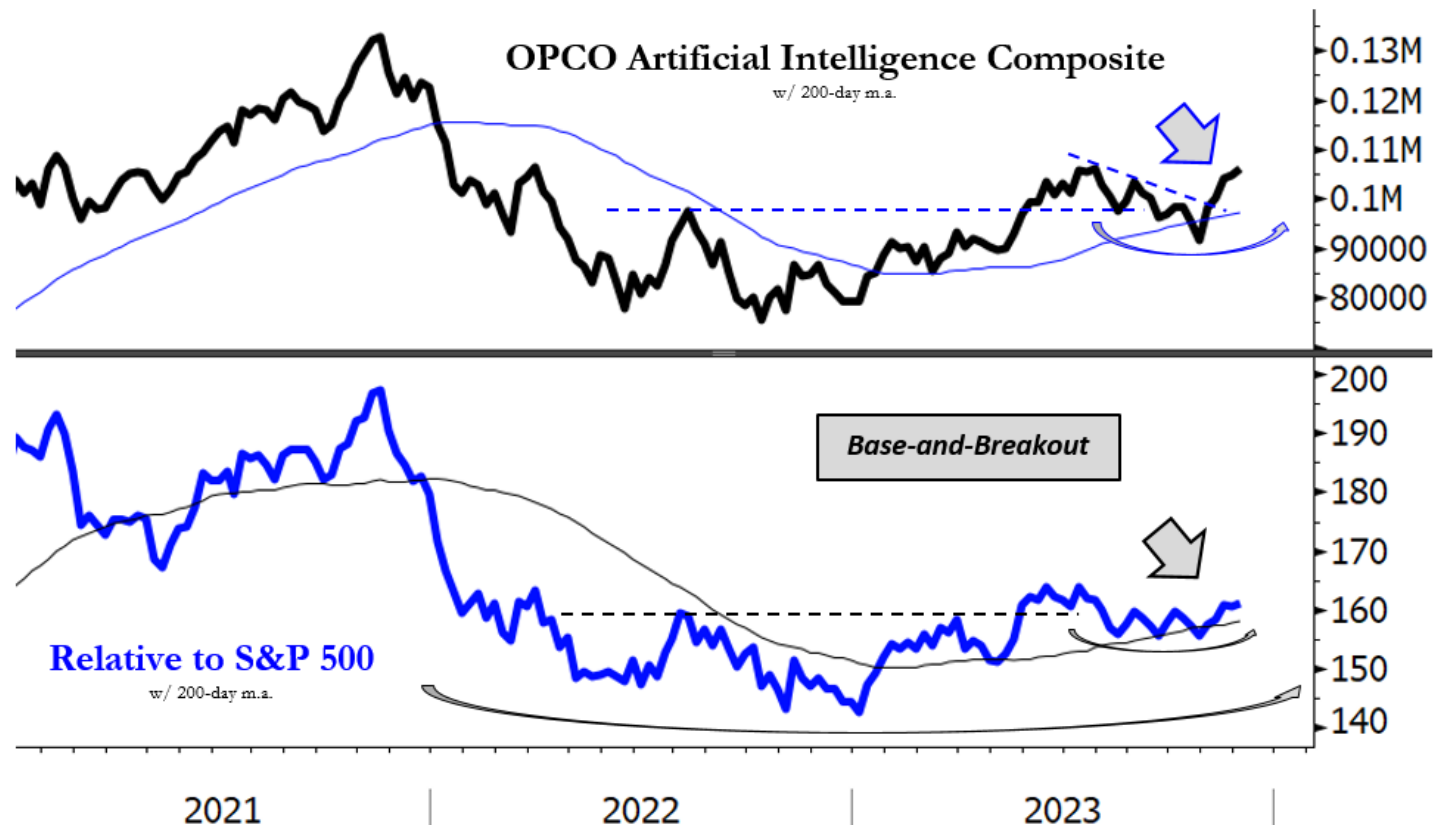


Source: Oppenheimer & Co. Inc.

## Technical Analysis: AI-Related Stocks

The next leg of the bull cycle that began in October 2022 is under way and should carry the equity market higher into the first half of 2024, in our view. Thematically, growth remains an attractive portfolio option given its exposure to both large-cap leadership and SMID-cap rotation. We're especially bullish on stocks that stand to benefit from artificial intelligence because an equal-weighted composite of OPCO's coverage is early in the process of reversing its 2021-22 decline. The broadness of bottom-up strength adds to our conviction and leads us to believe industry leadership should continue to emerge over the coming months and quarters.

**Exhibit 16: OPCO AI Composite, and AI Composite Relative to S&P 500**



.TEMP U Index (Temp) Line Chart Weekly 21NOV2018-01DEC2023 Copyright© 2023 Bloomberg Finance L.P. 01-Dec-2023 16:19:13

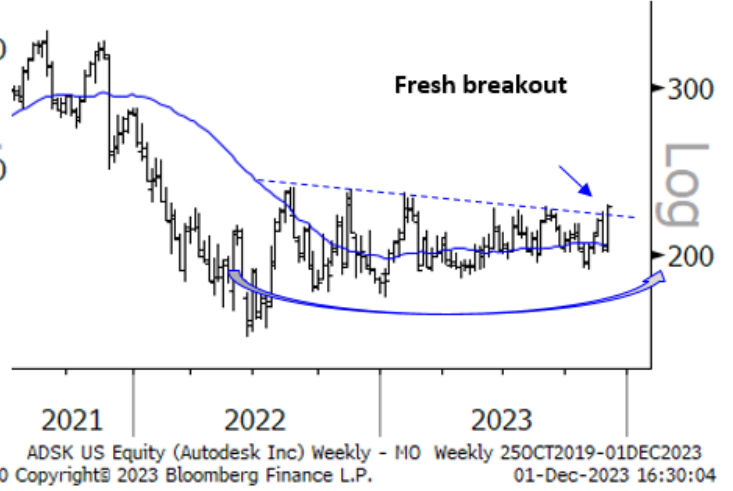
Source: Oppenheimer & Co. and Bloomberg. Equal-weighted composite. Note: These results cannot and should not be viewed as an indicator of future performance.

Exhibit 17: Technical Analysis: Top Eight AI-Related Outperform-Rated Stocks

**Cloudflare, Inc. (NET): Buy**



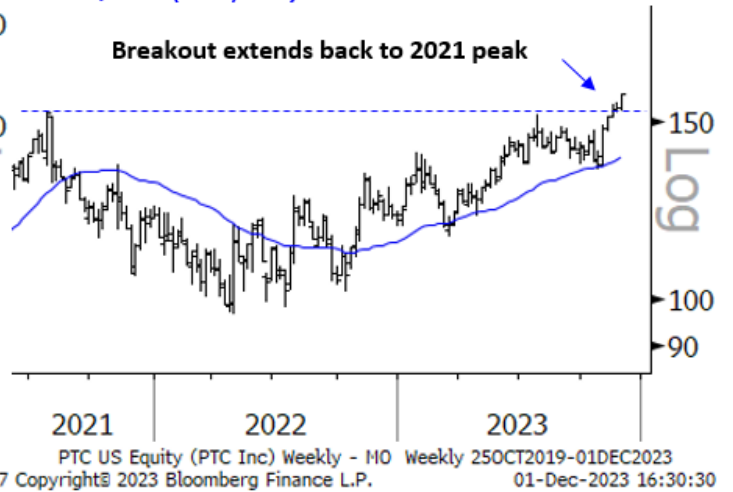
**Autodesk, Inc. (ADSK): Buy**



**Shopify, Inc. (SHOP): Buy**

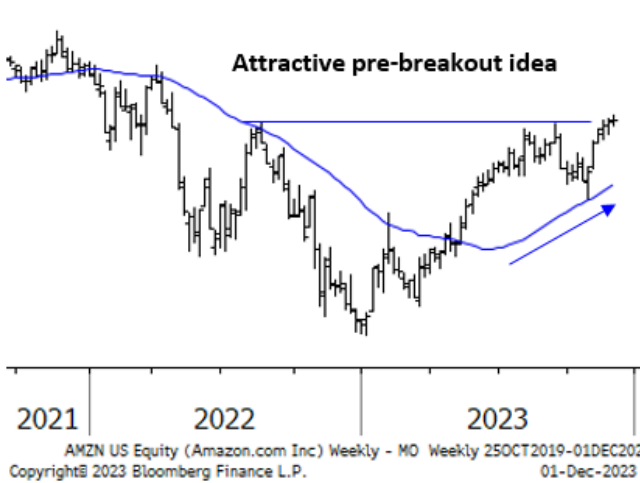


**PTC, Inc. (PTC): Buy**

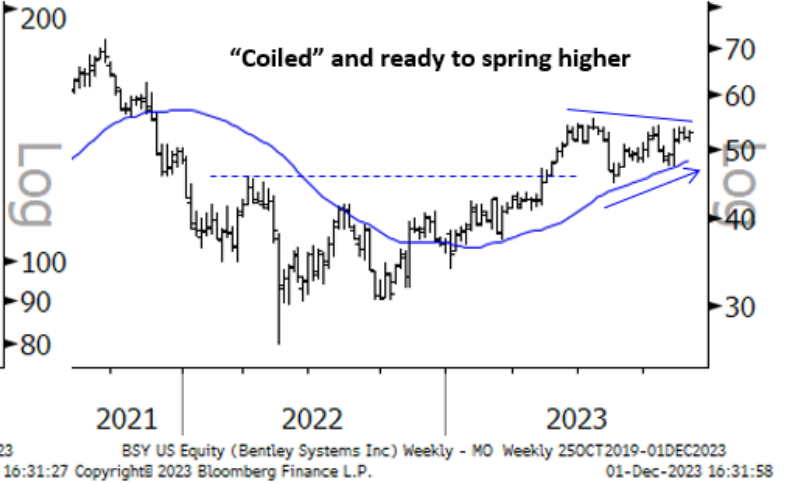


Source: Oppenheimer & Co. and Bloomberg.

**Amazon.com, Inc. (AMZN): Buy**



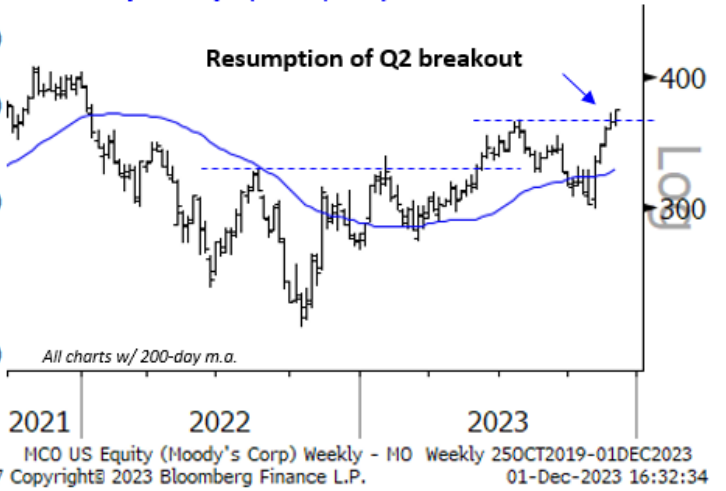
**Bentley Systems, Inc. (BSY): Buy**



**Snowflake, Inc. (SNOW): Buy**



**Moody's Corp. (MCO): Buy**



Source: Oppenheimer & Co. and Bloomberg.

See important technical analysis disclosures in the Disclosure Appendix at the end of this report.

## Exhibit 16: Selected Recent Oppenheimer AI Research & Survey Data

### DEEP-DIVE REPORTS

- Migration to Cloud Edge - AKAM, FSLY, NET Deep Dive, 10/18/23, [Link](#)
- Cloud Computing & AI Presentation, 9/14/24, [Link](#)
- Generative AI Deep Dive: Recent Trends, Key Questions, and Technology Explained, 7/12/23, [Link](#)
- Stocks for a Warming World: Expanding HVACR Coverage (Pages 52-58), 3/27/23, [Link](#)
- The Food Chain Enabling AI's New Gold Rush, 3/9/23, [Link](#)
- Microsoft and OpenAI Create Artificial Intelligence's "iPhone Moment", 1/18/23, [Link](#)

### SURVEYS

- Inaugural Oppenheimer Gen AI CTO Survey, 10/15/23, [Link](#)
- Adobe: Fashionably Late to the AI Party; Rating to Outperform, 10/26/23, [Link](#)
- Service Now: 3Q Preview: Mostly Positive Trends, 10/19/23, [Link](#)
- Workday: Customer Survey: The Business Costs Optimization Cycle Has Room to Run for Workday; Positive Trends, 10/10/23, [Link](#)
- Salesforce: Customer Survey and Partner Checks Point to Mixed Trends Ahead for Salesforce, 9/28/23, [Link](#)

### RELATED REPORTS

- AWS re:Invent 2023, AI in Focus, 12/1/23, [Link](#)
- Daily Chip Clips, 12/1/23, [Link](#)
- Marvell Technology Group: All In On AI, 11/30/23, [Link](#)
- OpCo's AI Summit Debrief, 11/24/23, [Link](#)
- Nvidia: Datacenter Dominates/Enter Enterprise, 11/22/23, [Link](#)
- AI Update: Two Steps Forward, One Step Back, 11/21/23, [Link](#)
- Upgrades, 11/21/23, C3.ai, [Link](#), Cloudflare, [Link](#), DigitalOcean, [Link](#)
- Blockchain and AI Summit Recap and Convergence Outlook, 11/17/23, [Link](#)
- Roblox: Takeaways from Roblox Investor Day, 11/16/23, [Link](#)
- Microsoft Ignite: Futuristic AI Moves Past Concept Into Reality, 11/15/23, [Link](#)
- Simulations Plus Investor Day: A Proven Leader in a Growing Biosimulations Market, 11/15/23, [Link](#)
- Autodesk: AI Shines at AU; Macro Still Casting a Shadow, 11/14/23, [Link](#)
- Monolithic Power Systems: Notes from the Road, 11/13/23, [Link](#)
- Moderna: Digital Investor Day: Long-Term Investments Starting to Deliver Benefits, 11/8/23, [Link](#)
- Meta Platforms: Meta Connect: Showcased New AI Messaging Tools, AI Image Generation, a Precursor to AI-generated Ads & AI Assistant, 9/27/23, [Link](#)
- Moody's: Proprietary Data Adds Moat to GenAI, 8/9/23, [Link](#)
- AI Accelerates Cloud CAPX and Revenue Growth; NVDA Illustrates the Magnitude, 7/24/23, [Link](#)
- Unity Software Introduces New AI Features to Unity Create, 6/28/23, [Link](#)
- Hubspot: AI Being Built Into The Foundation Of The Platform, 5/26/23, [Link](#)
- Corteva: Secular Growth Drivers in Place, Initiate at Perform, 4/5/23, [Link](#)

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