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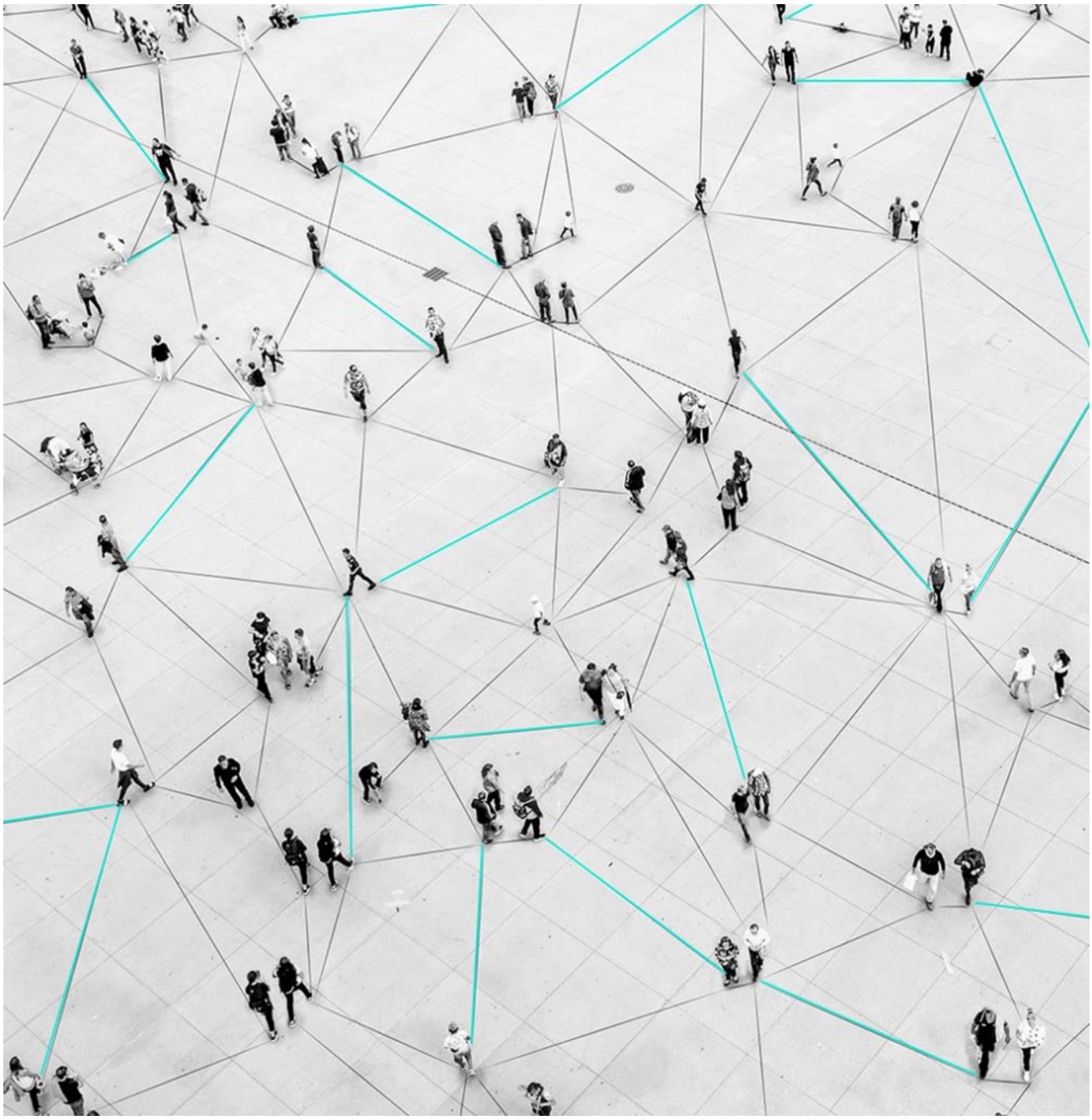
# Generative AI – Our Thoughts on Investment and Macro Implications



# Generative AI – Our Thoughts on Investment and Macro Implications

## Executive summary

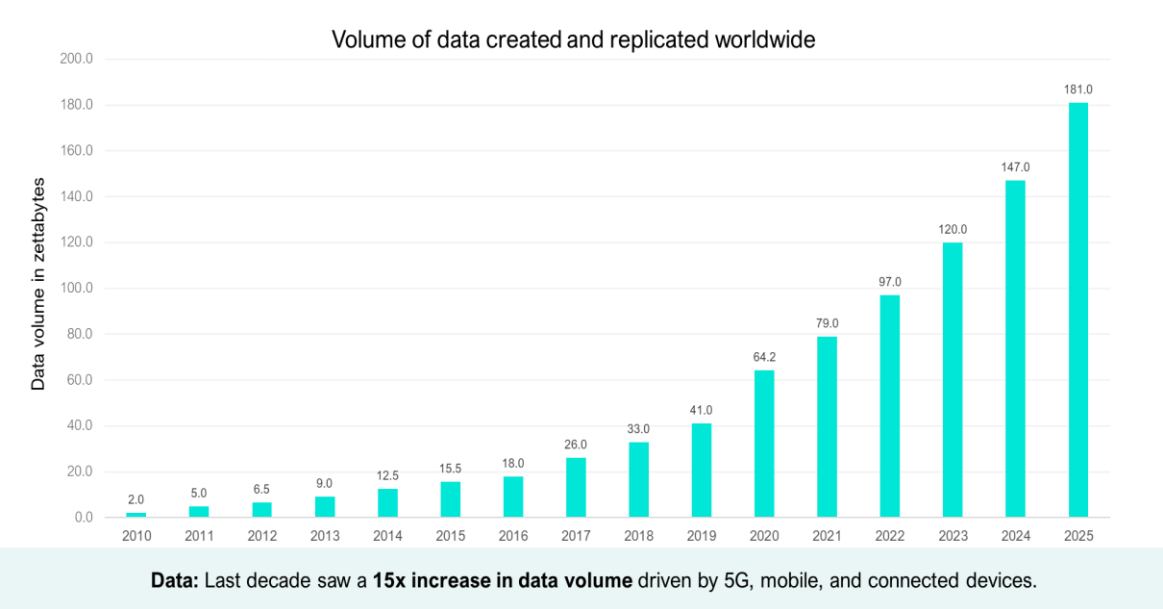

- Artificial Intelligence (AI) and its latest development, generative AI, is reaching an inflection point due to rapid increases in computing power, the availability of data, advances in machine-learning algorithms, and increased investment in AI research and development, which has helped accelerate progress.
- Generative AI could usher in a significant transformative technological change, laying the groundwork for possible disinflationary forces and future economic growth.
- Its application across a broad range of industries is likely to disrupt how many companies operate, which in all probability will create notable winners and losers.
- Groundbreaking progress can already be seen in its ability to enable human-level content creation across text, graphics, code, and multimedia.
- Investors will see opportunities across public and private markets and AI will be a new lens through which to evaluate both disruptive and incumbent businesses.
- Value should accrue throughout the AI-native technology stack, encompassing the creators of system-critical hardware, large language AI models, and business and consumer software applications.
- Incumbents that integrate AI effectively into business processes can benefit from cost savings, efficiency gains, and strategic insights, while consumer models that allow individuals to interact with AI capabilities on a range of devices could take first mover advantage.
- As with all fundamental technologies, AI can be used for good purposes or harmful ones. We are encouraged by rising engagement from policy makers, experts, and the public on finding ways to ensure that society benefits from generative AI while managing future risks.

# Introduction

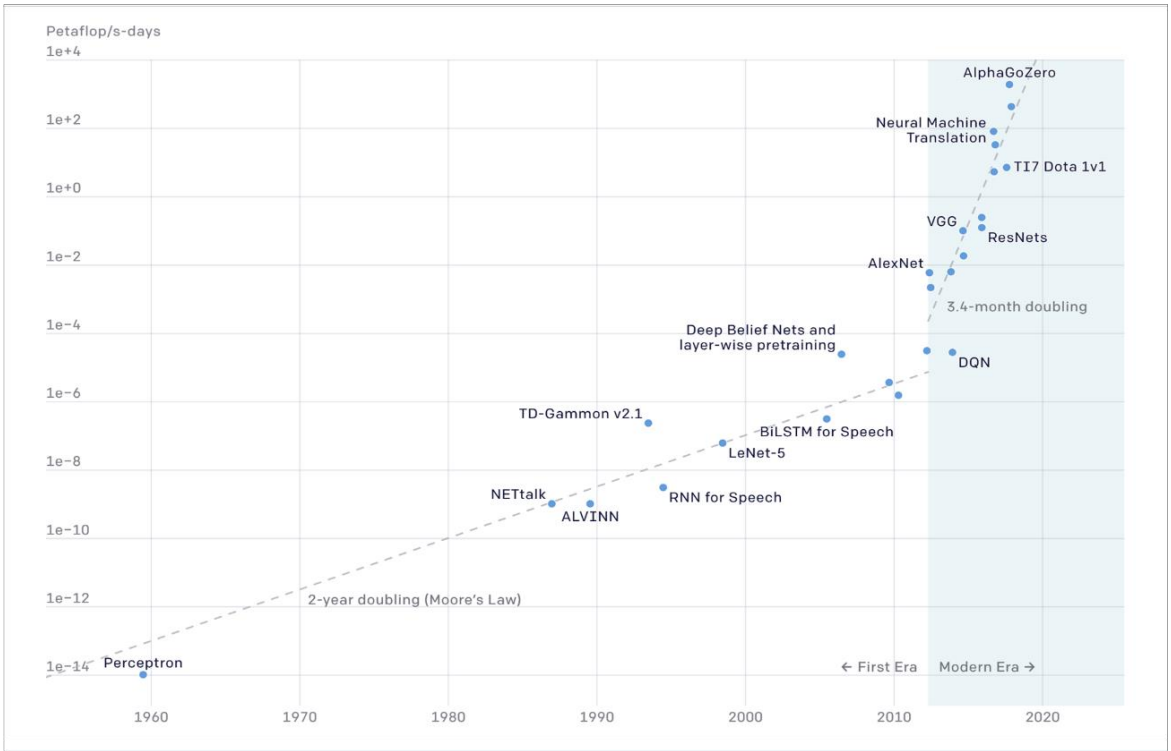
Whether we realize it or not, we are already living in a world of artificial intelligence – an unseen web of algorithms that control everything from our smartphones and our credit scores to the movie recommendations we see on Netflix.

While the science underpinning AI dates to the 1940s, the pace of progress has accelerated sharply due to greater data availability, increased computing power, and higher algorithmic sophistication. In the last decade alone, there has been a 15-fold increase in data volume driven by the rollout of 5G, mobile and connected devices.

These catalysts have laid the groundwork for increasingly large and complex AI models that can now mimic certain aspects of human intelligence. Machines can now generate content – be it text, graphics, code, or multimedia – on par with humans, real-time and on demand.



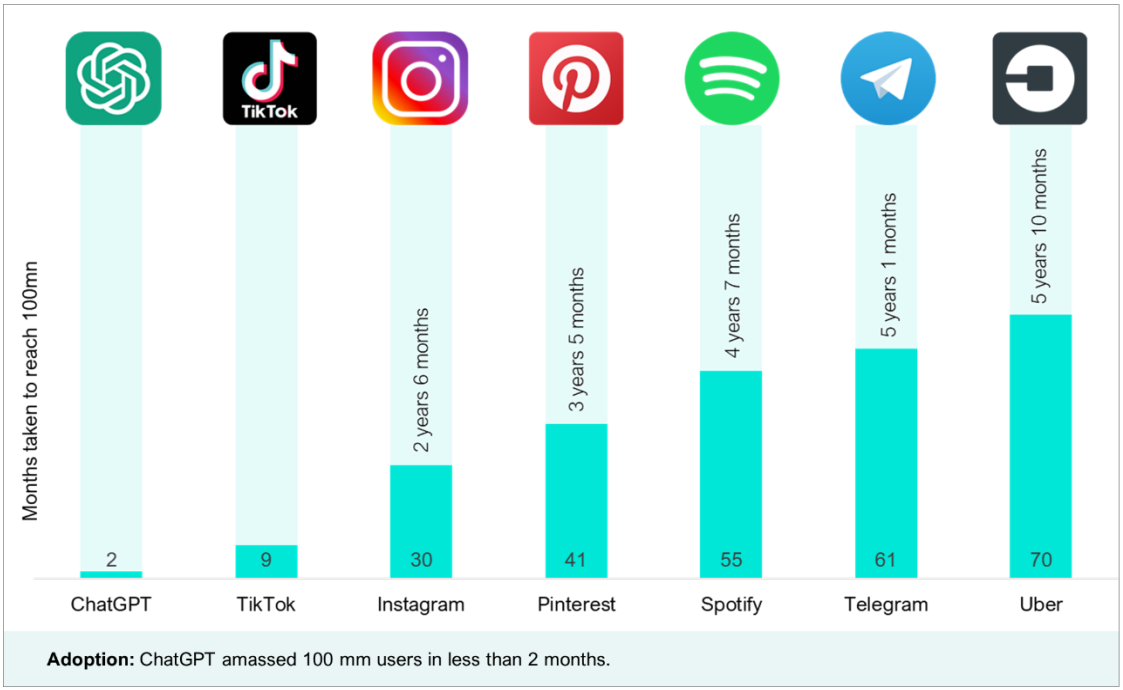

*Source: IDC, Worldwide IDC Global DataSphere Forecast, 2021-2026", May 2022*




**Compute:** Pre 2012, compute power used by large AI models tracked Moore's law, doubling every 2 years. Post 2012, compute usage has been doubling every 3.4 months.

*Source: OpenAI research "AI and Compute", May 2018*

Perhaps the most striking feature of AI today is its accessibility. Consumers can interact directly with AI tools, a radical pivot from just a few years ago when the goal was to seamlessly integrate AI into software applications. Case in point, OpenAI's chatbot ChatGPT amassed more than 100 million monthly active users within just two months. This outpaced even the most successful consumer internet apps (TikTok and Instagram), which took nine months and more than two and half years to reach the same level of adoption.




*Source: Goldman Sachs  Generative AI: The opportunities and threats of a technological revolution" May 2023*

In the past, only the largest incumbents – Google, Apple, Microsoft, etc. – had access to sufficient data and computing power necessary to run large AI models. Today, developers can access private APIs[1] (e.g., OpenAI, AI21 Labs) to build on foundational AI models, such as GPT. In many cases, these models are themselves trained on public data using open-source algorithms. And while the cost of training these models remains high, it is falling rapidly.

If past cycles of innovation have taught us anything, it is that tipping points tend to occur when a broad community of developers start building on open-source technology. It occurred when cloud computing launched a wave of software-as-a-service businesses. It occurred when Apple's App Store launched a wave of mobile phone apps, paving the way for many of the basic technologies we now use every day (Google Maps, Lyft, Uber, Instagram, etc.). And it is occurring again with generative AI built on top of large language AI models, such as Chat GPT.

The race is now on to bring generative AI to mobile devices, with a range of firms developing scaled-down versions to allow for AI-generated content to be accessed anywhere, on any device. This means that what was once only available through desktop and data centers will become a normal feature of everyday life. All eyes will be on Apple to understand when and how it will embed generative AI into iPhone's operating system.

[1] API is the acronym for application programming interface — a software interface that allows two applications to talk to each other. APIs allow users to extract/share data across organizations.

## Macroeconomic implications of generative AI

Generative AI tools can help knowledge workers significantly enhance their productivity. An example of this can be seen in the real world with the use of Codex, a tool based on GPT, which allows software engineers to code up to twice as fast. Goldman Sachs estimates that over a 10-year period, generative AI could increase labor productivity by approximately 1.5%, thereby boosting the global GDP by 7% or $7 trillion.

Although the magnitude of this effect is substantial, it aligns with historical precedents. Throughout recent history, the world has experienced a number of productivity booms, such as the post-war infrastructure boom of the 1950s, the introduction of personal computers in the 1980s, and the advent of the internet in the 1990s. Each of these events sparked productivity boosts of about 1-3%.

Given the wide range of potential applications for generative AI, we believe that it has the capacity to generate a comparable surge in productivity, the positive impacts of which could manifest across industries and everyday consumer applications. While prior technology-driven productivity booms unfolded slowly due to costly hardware requirements, generative AI is on track to being rapidly deployed through affordable distributed software expediting its implementation.

If generative AI succeeds in delivering productivity gains, it has the potential to counteract many of the inflationary pressures that are expected to contribute to ‘sticky’ inflation in the years ahead. We believe that we are moving from hyper-globalization and an endless supply of cheap labor to a world where structural labor shortages remain. These labor shortages are due to a host of converging forces, such as aging demographics in large parts of the developed world and onshoring of supply chains. Chronic underinvestment in commodities, particularly critical minerals essential to the clean-energy transition ahead, are also likely to increase costs of production.

We are moving from a world of disinflation to a period of higher and stickier inflation in the 3% plus range. Generative AI could emerge as a powerful antidote and counter-inflationary force if it leads to meaningful improvements in productivity. In this scenario we could see a period of greater economic growth and lower interest rates than otherwise would have been the case, likely a better environment for investors.

## Investment opportunities

We are in the early stages of the generative AI transformation, but businesses and investors across the world have seen glimpses of its potential. As applications develop and proliferate, the competitive landscape will be intense. Differentiating winners from losers will be complicated and require finding

inspired corporate management who understand how to invest in AI's potential. Private equity investors must identify founders who can create technical and data moats that leverage disruptive go-to-market strategies.

We know so far that generative AI can create original music, visuals, and text with no human input. In the enterprise context, generative AI can automate customer support, write code, and support designers and product managers. The rollout of AI programs and tools will be swift due to the widespread use of distributed software, the efficiency of cloud computing, and the user-friendly nature of the technology.

Given the ease of building powerful and disruptive applications through generative AI, we expect to see attractive investment opportunities across both public and private markets. These opportunities should accelerate as AI converges with other powerful trends, such as robotics and quantum computing. However, companies will need to allocate a greater share of their spend on AI if they expect to reap its benefits. By some estimates, corporate investment in AI could grow at a similar pace to software investment, approaching 1% of US GDP by 2030. Goldman estimates that generative AI alone could contribute an incremental total addressable market (TAM) of +$150bn to the global enterprise software market.

Value will accrue across the AI-native technology stack – from the computer infrastructure needed to power large AI models (e.g., newer/cheaper/faster chips) to AI models and APIs (e.g., large language models like GPT), to new enterprise and consumer software applications built on top of these models. This means that some applications will be new native-AI applications that create entirely new use cases. Others will become key features in existing software categories. (e.g., Search, CRM, HR, cybersecurity), as well as certain industry verticals (e.g., healthcare, advertising, media content).

Incumbents that effectively integrate AI may further enhance business opportunity. In past platform transitions, legacy business models often made it difficult for entrenched companies to compete with unencumbered start-ups. For example, in the early 2000s, cloud-enabled software-as-a-service companies disrupted perpetual license software companies because they were locked into a legacy paradigm and couldn't adapt. This is not the case with AI, where companies can efficiently utilize AI tools to improve user experiences and horizontally expand their business significantly.

For other incumbents, the advent of generative AI could be a threat that pressures margins and weakens competitive positions. We already see this at play with internet search companies like Microsoft and Google. According to news reports, Samsung is considering replacing Google with Microsoft's AI-enabled Bing as the default search engine on its devices. An estimated $3bn in annual revenue is at stake with the Samsung contract and an additional $20bn is tied to a similar Apple contract that is up for renewal later this year. Google is now racing to incorporate AI in a bid to maintain market share.

While investors are trying to assess the monetization potential of AI, many public-technology companies are already experiencing significant boosts in valuation.

We believe, however, that the power of generative AI has far-reaching implications beyond just the technology sector. Its potential is perhaps most clear within the healthcare space. Medical and biological data is notoriously complex. Roughly 97%[2] of healthcare data remains unused. AI can transform massive quantities of medical data to accelerate the pace of drug discovery, improve patient monitoring, identify at-risk patients, and enhance genomic interpretation. AI has the potential to radically improve how we all experience healthcare.

Investors should think more broadly what generative AI means for winners and losers across all industry sectors.

## AI and society

We believe AI holds enormous promise and can help solve many of the world's most pressing challenges. However, we also see reason for caution as the scope risk is difficult to predict or manage.

Some of the risks are known – job displacement, copyright infringement, disinformation, and deep fakes. But many are unknowable. Case in point – in 2017 researchers at Purdue University combined AI technology with MRI machines to decode neural signals in the human mind. This allows them to translate a person's private thoughts into a text output.[3] Mind reading may seem like an extreme example, but it illustrates how difficult it will be to anticipate future uses. Society does not have the regulatory or legal frameworks to manage these type of AI risks.

Indeed, advances in AI are now moving so fast that experts are struggling to keep up, and in some cases, even explain the outcomes. A YouTube video by Tristan Harris and Aza Raskin from the Center of Humane Technology is well worth watching as they discuss what they call AI's ability to learn at a 'double exponential rate'.

Click here to watch: Tristan Harris Congress Testimony: Understanding the Use of Persuasive Technology

At some point in the future, developers will generalize a learning algorithm and run it at the speed of a computer. This would create an AI capable of human intelligence but without human limits on memory or speed[4].

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[2] *https://healthtechmagazine.net/article/2022/12/ai-healthcare-2023-ml-nlp-more-perfcon*

[3] https://www.purdue.edu/newsroom/releases/2017/Q4/researchers-demonstrate-mind-reading-brain-decoding-tech-----.html

[4] *https://www.science.org/content/article/artificial-intelligence-learning-read-your-mind-and-display-what-it-sees*

Would a “super” AI be able to generate its own goals? (Probably.) Would those goals align with human interests? (Possibly.) If we succeed in aligning a super AI with human interests, then we have to ask, whose interests? What is the risk that a super AI is controlled by a malicious state actor? These are important questions for which there are no obvious answers.

Recent changes in generative AI illustrate the speed of advancement in this space. For now, we need to acknowledge its limitations while planning for future safeguards. A much stronger policy and regulatory framework will be required to ensure alignment with human interests and user safety. These discussions are just beginning in the public sphere and policy makers are beginning to explore certain guardrails, such as requiring sophisticated AI models to conduct a series of tests prior to being commercially released. The good news is that the industry is keen to engage now in increased regulation and in safeguarding and this will be important for its widespread and productive adoption.

There is no putting AI back on the shelf, so protecting against negative externalities will be hugely important. Cybersecurity businesses could be profound beneficiaries.

## Conclusion

We are in the early stages of an artificial intelligence revolution, driven by advances in computing power, data, and algorithms. Over the next decade, we expect to see a proliferation of new AI-enabled tools and applications, which can be rolled out quickly thanks to low-cost cloud computing and distributed software. This could have a swift and transformative effect on the global economy, boosting productivity, spurring innovation, and laying the groundwork for future economic growth. In doing so, AI could reshuffle the competitive order as it touches every industry and every business. Investors will need to consider the rate and scope of AI adoption in their assessment of macroeconomic trends and fundamental investment analysis.

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