MORGAN CREEK
D I G I T A L
ALTERNATIVE THINKING ABOUT INVESTMENTS

Welcome to Morgan Creek Digital's digital asset update. It is comprised of a thought piece from our team. We hope you find this content interesting. Please let us know if you have any comments or questions or if you would like to speak to a member of the [Morgan Creek Digital team](#).

Why Groq?

Introduction

We are excited to share details on a recent investment, Groq, Inc. "Groq" or the "Company"). The Company completed its Series D offering and raised $640M at a $2.2B pre-money valuation. Groq was founded in 2016 by former Google employees and seeks to power the next generation of artificial intelligence ("AI"). More specifically, Groq has built a language processing unit (LPU) inference engine for low latency and energy-efficient performance that caters to customers running large language models (LLMs) and other generative AI applications. In addition, Groq, which is based in San Francisco, has partnered with Aramco Digital to build the world's largest AI data center in Saudi Arabia.[1] As the company expands its operational footprint in the Gulf Cooperation Council (GCC), Groq is expected to open more offices and data centers.

Morgan Creek Digital Thesis

Our investment thesis on the "ABCDs" of the internet seeks to combine the power of Artificial Intelligence (A), Blockchain Technology (B), and the associated Chips (C) to unlock value from Data (D). Groq emphasizes the intersections between these pillars. For instance, Groq develops ASIC (application-specific integrated circuit) chips, referred to as LPUs, that aim to increase performance and lower the latency in LLM training and other high-performance computing applications. The intersection of AI and Chips, among other investment criteria and merits, is why we believe Groq is a compelling opportunity.

Why Groq? Team, Tech, TAM, Traction

Team: John Ross and the broader Groq team possess deep AI training and operational knowledge. We believe the addition of Sunny Madra, as a result of the acquisition of Definitive Intelligence, will support GroqCloud's scaling efforts, providing enterprise-grade AI accelerators for managing language model applications with significant compute and memory bandwidth requirements.

Technology: Groq's products leverage a *proprietary tensor architecture* and large-scale interconnection network called tensor streaming processing. The architecture uses a hierarchical network design, called Dragonfly topology, to enhance network efficiency by balancing traffic across multiple links (a group of routers functions as a single virtual router to enhance the network's effective radix or number of direct connections or links that each network node has to other nodes in the system), reducing network cost and diameter.

Key Features of Proprietary Tensor Architecture Include[2]:

- **Global Communication Fabric**: The backbone consists of a bandwidth-rich communication infrastructure that allows low-latency connection between Tensor Streaming Processors (TSPs).

- **Global Memory:** Each TSP contributes 220 MiBytes of logically shared (refers to the amount of memory or data storage that is shared among different parts of a system, measured in MiB, a unit of digital information storage equal to 1,048,576 bytes) but physically distributed SRAM, forming a scalable global memory system.

- **Software-Controlled Networking:** A method of networking that maintains deterministic communication and removes latency by applying software for flow and routing control. There are no traditional buffers for routing deadlock prevention, instead, packets are scheduled in advance, preventing resource contention. This approach simplifies network design by reducing packet overhead.

- **Scalability:** The system supports up to 10,440 TSPs, with over 2 TeraBytes of global memory accessible in under 3 microseconds.

- **Deterministic Operation:** By using static scheduling instead of dynamic contention for network resources, the system achieves consistent performance. Forward Error Correction (FEC) is used on every link to maintain reliable network communication, correct simple errors, and detects uncorrectable ones. (The system employs N+1 redundancy, with a spare node available for fault recovery, and incorporates error correction to maintain reliability)
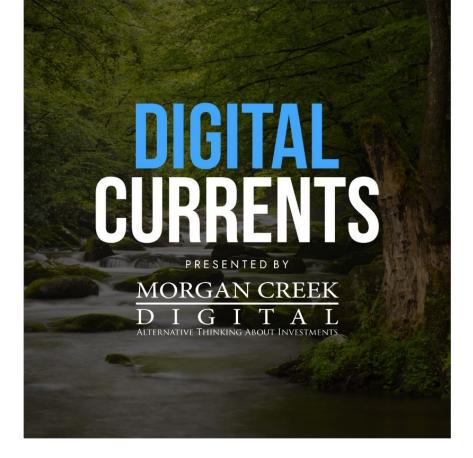
In summation, TSP relies on the organization or grouping of routers by long links, to deterministically distribute traffic across the network. Unlike conventional networks that spread packets across available paths to balance the load, this system spreads 320-byte vectors across C2C (core-to-core) links using non-minimal routing to balance traffic. More simply, this approach improves load balancing and speed. For example, Groq's LPU can generate over 500 tokens[3] or words in about one second, compared to nearly 10 seconds for Nvidia's GPUs.

TAM: We believe that specialized processors servicing AI inference will continue to thrive as AI models become more complex and the demand for high-fidelity and low-latency computing grows. For example, AI training has doubled every ~3 months since 2012, according to OpenAI.[4] Computing in AI has grown by more than 300,000 times—a rate of increase that far exceeds what would have been expected based on Moore's Law alone, which would have yielded only a 7x increase over the same period.[5] In short, GenAI is boosting the demand for high-performance AI chips in data centers, with AI applications expected to extend to PCs, smartphones, and other devices in the long term. By 2028, over 50% of workload accelerators in data centers will be custom ASICs, and more than 25% of new servers will include these accelerators.[6] As mentioned earlier, Groq's partnership with Aramco Digital to create global AI inference centers by 2025, serves as an example.[7]

Traction: Groq plans to expand its LPU supply creating substantial inference capacity for joint ventures with enterprise and nation-state infrastructure providers, generating material annual recurring revenues. Based on our travels to the Middle East and independent research, we believe Saudi Arabia and the UAE are in a competitive race to dominate the AI and data center sectors in the Gulf, driven by both economic ambitions and political goals. Saudi Arabia is rapidly expanding its data center market, with significant investments such as a $5.3 billion deal with Amazon Web Services.[8] The UAE, a long-time leader in this space, is home to the largest data center hub in the region and continues to invest heavily in digital infrastructure. Both countries view data centers as crucial to their economic growth, with AI expected to significantly contribute to their economies by 2030.[9] Additionally, Saudi Arabia and UAE aim to influence global AI policymaking while reducing dependence on foreign tech infrastructure. However, challenges such as workforce shortages, high cooling costs, and evolving regulatory environments pose obstacles to their ambitions, creating potential opportunities for innovation.

Onward and Upward!

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[1] https://wow.groq.com/news_press/groq-raises-640m-to-meet-soaring-demand-for-fast-ai-inference/

[2] https://wow.groq.com/wp-content/uploads/2023/05/GroqISCAPaper2022_ASoftwareDefinedTensorStreamingMultiprocessorForLargeScaleMachineLearning-1.pdf

[3] Decoder, Groq's AI Chip Turbo Charges LLMs and Generates Text in Near Real-Time, February 2024

[4] MIT Technology Review, Computing Power Needed to Train AI, December 2019

[5] Ibid.

[6] https://www.gartner.com/en/documents/5407464

[7] Provided by Groq Management

[8] https://www.reuters.com/technology/amazons-aws-launch-saudi-arabia-data-centers-invest-over-53-bln-2024-03-04/

[9] https://www.diplomaticourier.com/posts/saudi-arabia-and-uaes-race-for-ai-data-center-dominance

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those associated with traditional investments.

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