GE Research: A hybrid solution for managing many moving parts

CASE STORY

A small auto shop with a steady stream of customers might struggle occasionally to coordinate repair schedules so that every vehicle gets serviced and back on the road in a timely fashion. But when you're operating at the scale of a global technology company like GE, the scope of this logistical problem can become staggering—requiring the efficient pairing of thousands of repair tasks with an equally large number of tools and resources.

GE researchers have been grappling with this challenge for a few years now. "Power turbines, jet engines, and medical equipment are highly engineered products that require regular servicing to maintain their safety and peak performance," said Austars Schnore, a Senior Principal Engineer and Edge Architect at GE Research. "Our customers see these assets as an integral part of how they make money, and part of our job in sustaining these assets is to reduce the customer's downtime while controlling our costs."

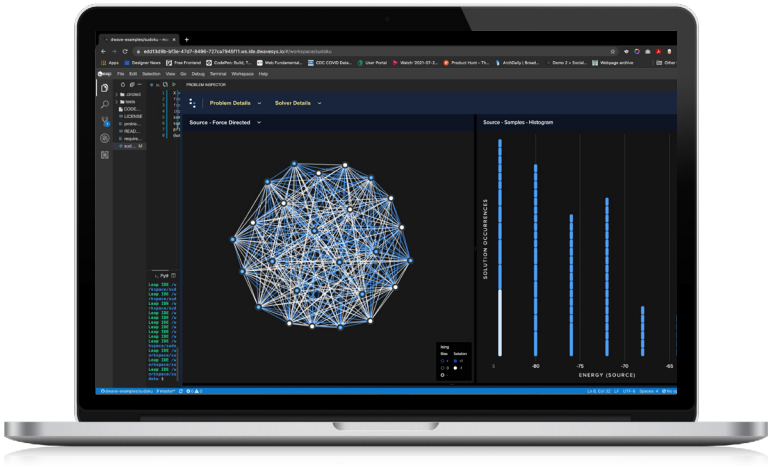
> ***"If a repair facility had 15,000 repair tasks and 6,000 repair-related assets, and each repair task required just 3 sets of assets, the logistical planning could involve choosing an optimal solution from a staggering 106,500 different possibilities."***

Consider a scenario in which a hypothetical facility has 15,000 repair tasks on the docket. The same facility may have a total of 6,000 repair-related assets, including 3D printers, skilled personnel, repositories of spare parts, and more. If each repair task can potentially be addressed with three distinct sets of assets, the logistical planning of all these repair tasks could involve choosing an optimal solution from a staggering 106,500 different possibilities.

As members of GE's Forge Lab, Schnore and Annarita Giani, a complex system scientist at GE Research focused on quantum computing for industrial applications, are involved in exploring opportunities to deploy promising new technologies in real-world applications. For this particular resource management problem, quantum computing showed immense potential. Using the **D-Wave Advantage™ quantum computer and the hybrid solver service (HSS) in Leap™**, their team was able to begin wrangling logistical problems of unprecedented complexity.

Resource management challenges of this scale can quickly surpass the capabilities of even the most advanced quantum computing system. To address this, Schnore and Giani employed a strategy called 'perfect embedding' that allows them to constrain the complexity of the problem being answered. As a demonstration, they created a use-case that mimicked the volume of resources an actual industrial service repair shop manages on a daily basis. Working with a scenario of 2,615 repairs and 31,000 repair-related resources the use-case allowed for two options for each maintenance task.

Using one of D-Wave's hybrid solvers, the DQM (discrete quadratic model) solver, they were able to go after GE-scale logistics problems, such as the scenario described above with 15,000 repairs and 106,500 potential workflows. A quantum-only solution would have required a computer with nearly 45,000 qubits of processing power, far surpassing the ~5,000 qubits of the Advantage system. "But we were able to use this hybrid approach to get an answer, which is phenomenal and amazing," says Schnore. "The answer is so large that it's really hard to tell whether it's right or wrong—but we do know that it meets the constraints. This poses one of the challenges of quantum computing, given a solution it is hard to verify. Our next step is to think how to validate such solutions."



This work is still in the demonstration stage, but the GE team sees this as strong proof that quantum technology has already evolved from a promising tool for the future to a viable solution to real-world business problems. "The question frequently comes up: when can we think of using quantum computing in industrial applications?" said Schnore. "Our efforts with Advantage and the hybrid solver service that D-Wave provides have changed our answer to 'why wait'... or, 'can you afford to wait?'"

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