Ansys

Rockley Photonics Improves Verification Capabilities Using Ansys Lumerical on Amazon EC2

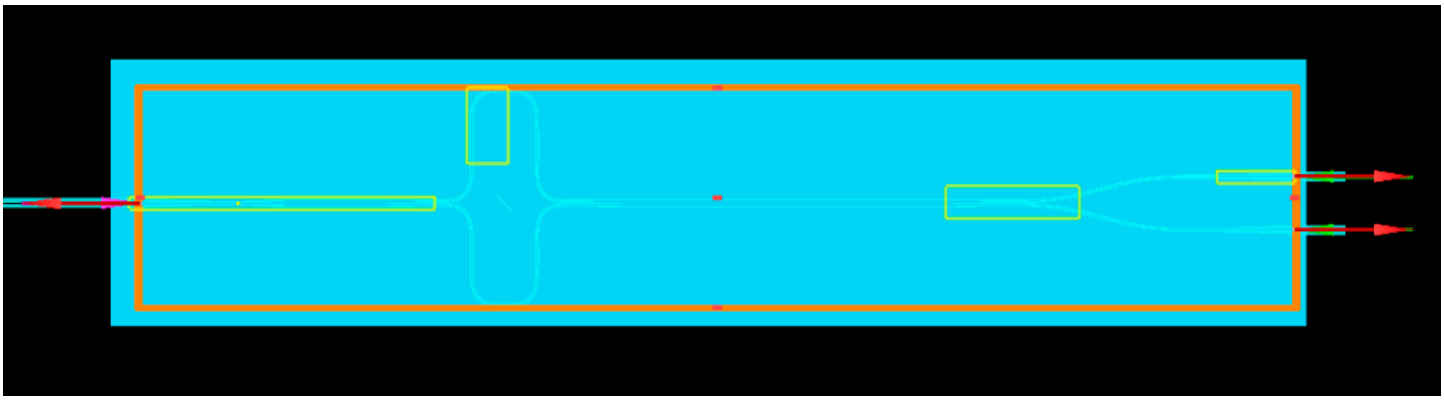

Figure 1. Device A: one of two large-scale designs simulated by Rockley using Ansys Lumerical software running on Amazon's Elastic Computing Cloud (EC2)

Challenges

Rockley embraces the ever-growing trend towards increased complexity for photonics circuits, but many effects integral to the operation of the circuit are presently insufficiently considered during design and verification, such as stray light interference or impacts of nonuniform temperature or stress fields in the photonic integrated circuit (PIC). These effects can be compounded as circuit complexity increases. Unfortunately, current circuit design methodologies based solely on system-level simulation with LVS are unable to capture such effects.

To date, conventional engineering know-how provided engineers a way to work their way through a solution to generate layouts. But this approach is no longer practical as layout complexity grows, necessitating large-scale physical simulations of the entire photonic circuit. The growing cost of fabricating and packaging today's devices and growing time-to-market demands warrants efforts to improve verification. The impact of letting design errors slip through the cracks is significant. If a fault makes it to silicon, the cost of a re-spin will be expensive. More importantly, the increased time to market can have an immeasurable impact on market share and brand reputation.

Yi Zhang, PIC lead at Rockley, stated, "Errors that reach fabrication and are found on silicon can be costly and time consuming." To date, Rockley has tackled the problem by working to improve design rule checking (DRC) and layout versus schematic (LVS) approaches. However, due to the complexity and urgency of upcoming designs, Rockley identified that more must be done to reduce risk. To verify that a design is "first time right," they explored the use of large-scale physical simulations using the finite-difference time-domain (FDTD) method. According to Yi Zhang, "The capability to run large-scale physical simulations using the mature and approximation free FDTD method gives us a new level of confidence at tape-out."

Given that the FDTD method is inherently runtime and memory intensive even for small layouts, Rockley approached Ansys Lumerical to explore high-performance computing (HPC) solutions for two of its largest layouts (Figures 1 and 2). Simulating the entire design via a physical FDTD simulation is time intensive, and typical desktop or workstations are insufficient for both runtime performance and memory capacity. HPC delivers aggregated computing power in a way that significantly improves performance, thus allowing designers to simulate significantly larger photonic designs and explore more variants of the same design in a shorter timeframe.

Ansys Lumerical's HPC Solution on Amazon EC2

Rockley considered several HPC solutions to accelerate large-scale simulations, but in the end, the company decided to go with a CPU-based cloud solution on Amazon Web Services (AWS) powered by Lumerical's FDTD. This decision was driven by the accuracy and runtime performance of Lumerical's FDTD coupled with its amenability to HPC computing, as well as the cost-effective flexibility of Amazon's cloud solution.

Amazon's Elastic Computing Cloud (EC2) provides a secure, resizable computing capacity with an easy-to-use web interface. EC2 offers a convenient way to buy compute time on demand and makes it possible to access multiple large servers, paying only for the actual time used. Such flexibility is attractive to Rockley, as they require massive computing resources for only a short duration during the development cycle.

Further, due to the flexibility of Lumerical's FDTD, jobs can be greatly sped up by running large simulations using several servers concurrently. The cost can be like running on one server for a longer period. Lumerical's high-performing FDTD works seamlessly with EC2 and can be launched in minutes. Only a few steps are needed to launch a typical FDTD simulation, including the creation of a virtual private cloud, the activation of security and license management, and the definition of a launch template. A cost-effective solution runs Lumerical's FDTD engine on Amazon Linux without a graphical interface. Simulation files are stored in S3 to remove the need for costly transfers to and from the cloud. Flexible "cloud pack license" options offered by Lumerical for its FDTD engines make this solution even more attractive, as it enables cost-effective large-scale computing for critical periods of the design cycle.

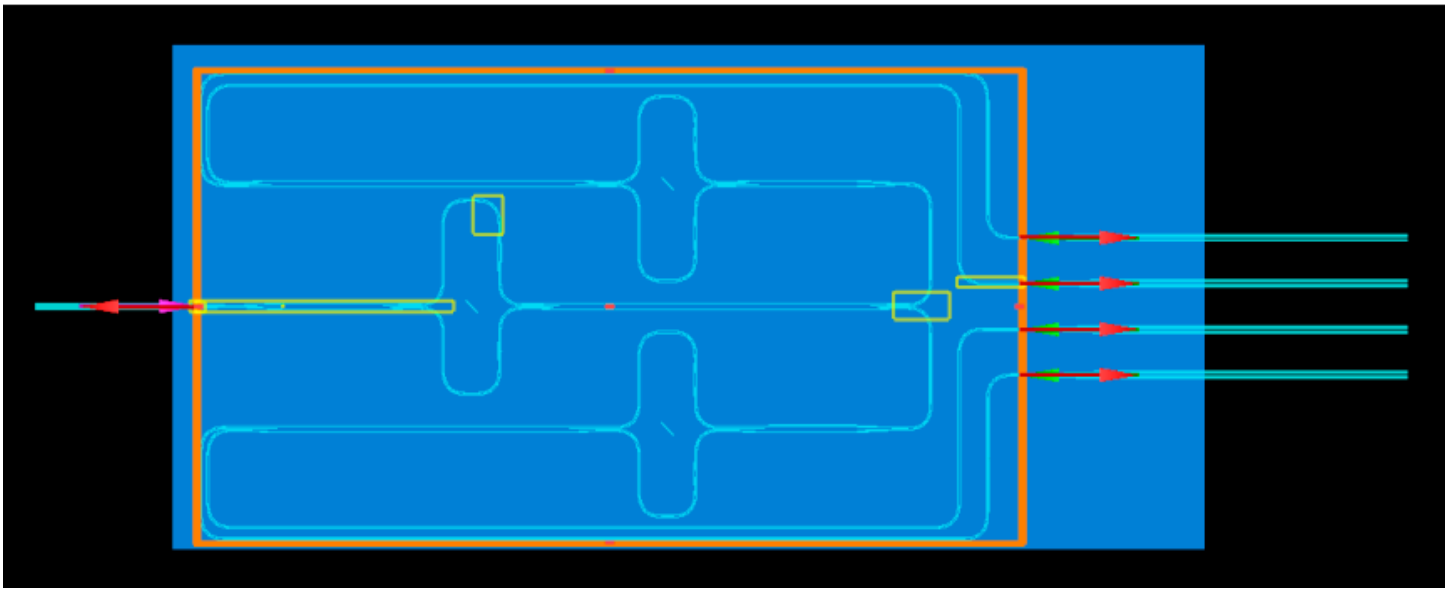

Figure 2. Device B: one of two large-scale designs simulated by Rockley using Lumerical software running on EC2

Results

Rockley conducted multiple 2D and 3D single time-domain simulations for devices A and B (Figures 1 and 2, respectively) thus allowing for the extraction of high-resolution spectra. The scale of the simulations was significant for FDTD given the size of the designs, with the layout of device B being approximately 6 mm2. EC2 was used to run simulations on up to 16 cutting-edge Xeon Platinum processor-based servers, distributing each job across 576 cores. A variety of hardware configurations was explored, enabling Rockley to choose the optimal configuration for their business and engineering needs. In some cases, spot pricing was used to realize 80-90% discounts over on-demand rates. Results for all configurations are provided in Table 1.

** Spot instances were used*

Device	RAM	Elapsed runtime (h)	Cost ($)
A	15GB	19	27*
A	15GB	5.7	177
A	42GB	53	72*
A	42GB	14.8	460
A	42GB	10.5	485
A	42GB	8	490
B	64GB	119	925
B	64GB	<75hr	<200*

Table 1. Simulation results for various EC2 configurations

Lumerical's HPC solution using Amazon EC2 provided Rockley with a solution that is scalable, cost effective, and flexible. Rockley was able to confirm the correct functionality of its large-scale photonics devices, thus reducing the risk of re-spin and time-to-market delays. Without Lumerical's solution, this level of verification would not have been possible as the runtime on conventional hardware would be unreasonably long. Further, the cost of procuring dedicated hardware would not be justifiable for a task needed only intermittently for a small portion of the design cycle.

Describing the impact of Lumerical's HPC solution, Yi Zhang stated, "Lumerical's FDTD CPU-based HPC approach proved to be the fastest and most cost effective. The turnaround of a large physical simulation fits in well with our design schedule and budget. Its compatibility with commercial cloud computing resources enables further scalability at critical times."

/ Company Description

Rockley Photonics is a world leader in the development of highly integrated photonic/electronic devices, based upon high-volume manufacturing in its proprietary large-waveguide platform. This platform offers many benefits over existing solutions, including higher density, better manufacturing tolerance, improved optical power handling, and an efficient photonic integrated circuit (IC) interface. Rockley's drive for innovation provides a clear step forward from the relatively immature state of existing photonic design and manufacturing methodologies.

ANSYS, Inc.
Southpointe
2600 Ansys Drive
Canonsburg, PA 15317
U.S.A.
724-746-3304
ansysinfo@ansys.com

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