The Customer

Barefoot Networks is the industry pioneer in programmable, high-performance network switch ASICs. Starting with a vision to dramatically accelerate the adoption of new network protocols by bringing user programmability to the leaf and spine layer of networks, they created the now open source P4 programming language, language compiler, and Tofino, the world’s first user-programmable Ethernet switch ASIC. The world’s fastest switch chip at the time of its introduction, Tofino delivers 6.5Tb/s throughput while delivering power consumption and cost equivalent to fixed-function switch chips. An expanding ecosystem is now growing around P4 with the strong support of hyperscalers. By staying focused on their vision, Barefoot Networks has become the catalyst for networking industry transformation.

The Challenge

Building on the breakthrough success of Tofino, Barefoot set an aggressive goal to design, verify, and tape out their next-generation switch ASIC in only 15 months. Such a schedule is unheard of in an industry known for massive chip designs with multi-year development schedules. The new 7nm ASIC would have double the number of placeable instances as the 16nm Tofino chip, using virtually all the area available within the photomask reticle. Creating this chip would push the development team and their tools to face new challenges, not all of which were fully understood at the start of the project.

One such challenge was timing signoff. Using conventional tools and methods on Tofino, a single full-functional timing signoff run required a full week to complete on their server farm. Dozens of runs would be required to achieve timing closure for the design—and to make matters worse, the move to 7nm would cause a 50% increase in turnaround time for each run because of more advanced and complex delay calculations and timing analysis algorithms.

Initial analysis showed that the new design would require double the amount of compute resource to execute, which Barefoot installed. But even that turned out turned out to be insufficient by half for a more accurate, flat timing signoff approach. Facing the prospect of either another massive infrastructure upgrade or suffering 4-week timing signoff turns that would blow out their development schedule, a new approach as urgently needed—an approach that would cut analysis runtime by 5X, an approach that would take Barefoot to the cloud.

The Solution

While cloud-based software applications commonly serve many business functions across large and small companies, it is still a novel approach for electronic design. For Barefoot, many unknowns complicated the consideration: security, licensing, expertise, setup time, and real-world usability. Also, for timing analysis specifically, would the design tools support the massive scalability that the cloud promises, or would there be tool limitations that would throttle the expected benefits? The initial fear was that this would add risk to their project rather than remove it.

Key Challenges

- Cut static timing analysis time by 5X on a massive, reticle-limited ASIC
- Leverage the power of the cloud with no previous cloud experience
- Make day-to-day or even hour-by-hour changes to license provisioning

Cadence Solutions

- The Cadence® CloudBurst™ platform delivered immediate access to the cloud using a web browser with no software setup nor cloud expertise required
- The Cadence Tempus™ Timing Signoff Solution delivered the unique capability to distribute an STA job across multiple, separate machines

Results

- Timing run turn-around reduced from weeks to days enabling rapid progress
- Reduced risk in the most critical project phase—right before tapeout
- Rapidly adapted to increased compute requirements with no capital expense outlay

Accelerating Tapeout with the CloudBurst Platform and the Tempus Timing Signoff Solution

Barefoot Networks and Cadence

March 2019
Seeing the Cadence Cloud announcement in mid-2018, and already engaged with Cadence in many aspects of the new design, Barefoot called in Cadence experts to help dissect their concerns and determine if a cloud solution would meet their objectives.

Security was addressed first. On top of the state-of-the-art security intrinsic to hyperscale cloud providers, Cadence provides additional layers of third-party security applications, employs industry best practices, and performs penetration testing. Cadence follows the Cloud Security Alliance (CSA)-recommended controls and routinely conducts independent penetration testing to proactively comply with changes in the security landscape. By using this layered approach, Cadence Cloud provides security above many traditional datacenters. In fact, TSMC has recognized the robustness of the Cadence security measures by approving Cadence Cloud for use by mutual customers.

Licensing, expertise, setup time, and real-world usability are valid concerns and there is not a one-size-fits-all approach. Recognizing this, Cadence has introduced its cloud portfolio with three solutions: The Cloud-Hosted Design Solution, Palladium® Cloud Solution, and Cloud Passport Model. Collectively, these tools provide users with the flexibility to manage cloud access themselves or have Cadence manage it; move entire projects to the cloud or just serve peak needs; and enable a choice of cloud providers, including Amazon AWS, Microsoft Azure, and Google Cloud.

However, optimal productivity and performance for Barefoot would require an unprecedented level of flexibility. Given that the project’s compute needs for the timing signoff problem would not be fully understood until deep in the project schedule when maximum stress would be felt to get to tapeout, Barefoot needed a cloud-based solution that could respond to their changing needs on a day-to-day or even hour-by-hour basis.

Anticipating the need for that type of usage model, Cadence was already well into the development of a fourth cloud solution, one that has since been announced as the Cadence CloudBurst Platform. The CloudBurst platform is a secure, entirely web-based portal into the Cadence Cloud that users can employ to send peak jobs into the cloud. No local software installations, VPN setup, or other IT involvement are required. Initial provisioning is ready only a couple days after receipt of order, and subsequent license increments or decrements are performed through a web browser and take place with immediate effect, with no interaction from Cadence required.

Seeing the ideal fit for their requirements, Barefoot signed on as a lead customer for the CloudBurst platform, but there was still the critical question of whether the timing analysis jobs could tap the full power that the computing platform now provided. That depended on the suitability of the Cadence Tempus™ Timing Signoff Solution to cloud-based analysis.

The Tempus Timing Signoff Solution is the fastest static timing analysis (STA) tool in the industry today, with unique distributed processing and cloud capabilities enabling hundreds of CPUs to quickly complete even the largest designs. With full foundry certification and a comprehensive set of advanced capabilities, the cloud-ready Tempus Timing Signoff Solution is delivering SPICE-accurate results to hundreds of customers across a broad range of design types: from the largest 7nm designs, to high-volume mobile designs, and mixed-signal chips on mature processes.

By tightly coupling design implementation with timing signoff, the Tempus Timing Signoff Solution speeds timing convergence throughout the design flow and greatly reduces the time to design closure. Every Tempus timing job is naturally multi-threaded for faster execution on multi-CPU servers. But the Tempus solution also has the unique capability to distribute an STA job across multiple, separate machines to deliver significantly faster runtimes and less memory per machine. With this distributed STA approach, the tool can take full advantage of cloud-scale computing.

With the cloud delivery system and right tool in place, it was time to execute. Barefoot selected a leading cloud computing provider and uploaded their ASIC data. A single STA view of the ASIC totaled approximately 200GB. Using standard upload methods, it took about 13 hours to upload to the cloud. However, with the CloudBurst platform’s express upload capability, the entire STA view was transferred in only two hours. Also, the data transfer inherited the same security mechanisms inherent to the CloudBurst platform. Data was encrypted throughout the transit and rest. There was no need for additional encryption from the customer. All encryptions and security features were up-to-date with industry best practices.

Using the CloudBurst platform, Barefoot was able to perform a full-functional, flat signoff run in about 36 hours using 272 virtual central processing units (vCPUs) split across multiple server instances, each equipped with either 1TB or 2TB of memory. Taking advantage of the cloud’s computing capacity, they would often run up to nine flat timing analysis jobs in parallel, spread across 2,448vCPUs. During such times of peak demand, a single cloud provider zone was sometimes unable to meet the total vCPU needs. When this occurred, the Cadence CloudBurst team quickly configured the cloud delivery system to enable multiple cloud provider zones to meet the demand, enabling Barefoot to make progress at a critical project juncture.

Conclusion

With a powerful cloud-based STA solution based on the CloudBurst platform and the Tempus Timing Signoff solution, Barefoot was able to verify multiple design iterations and tape out their massive design in record time. They did this with no previous cloud expertise, no software installation, and no capital expense. They were able to adjust their license usage on a run-by-run basis with no required interaction with Cadence. With the STA problem solved, Barefoot could finish their tapeout and continue to pursue their vision of transforming the networking industry.