The next era in power electronics

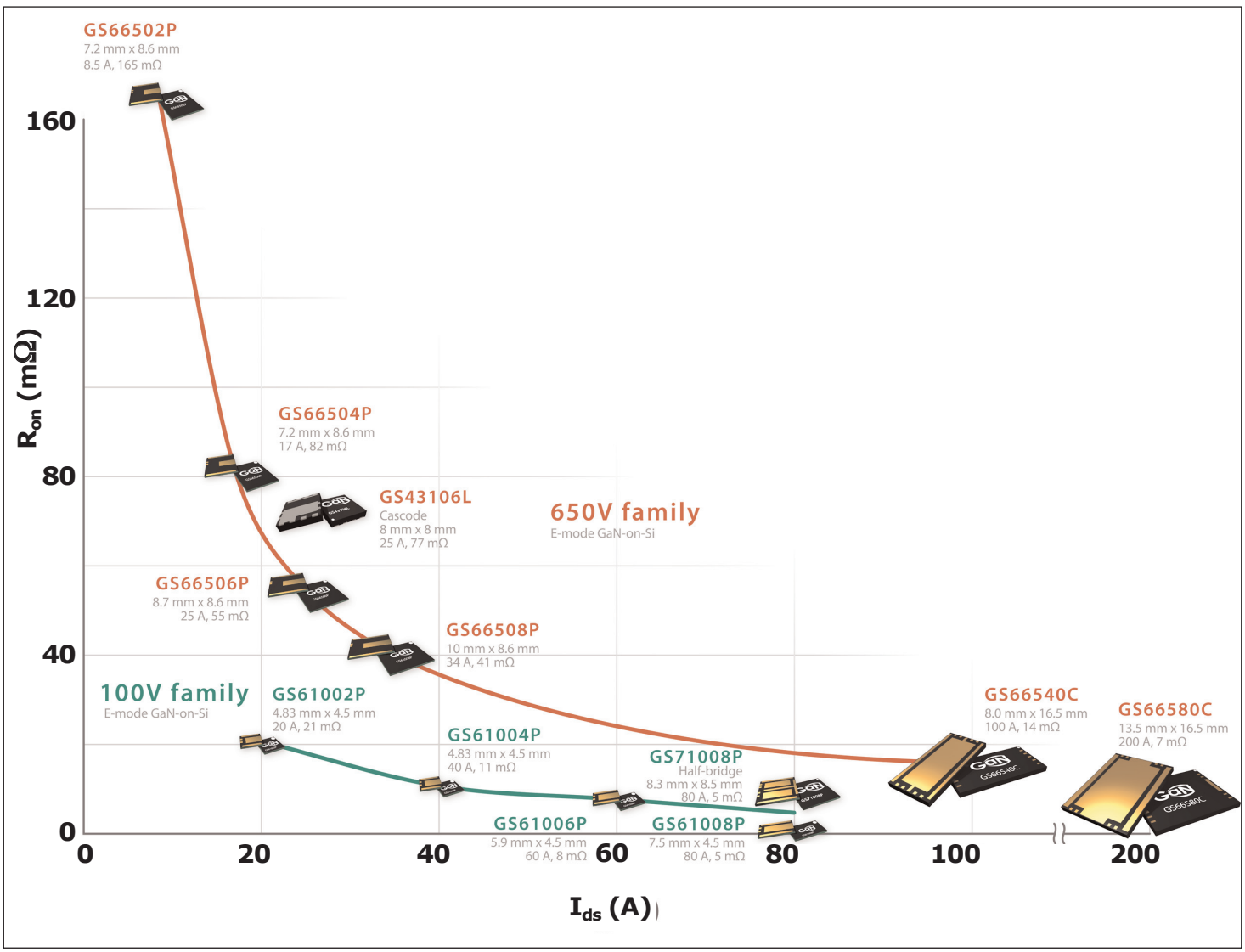
Mike Sherman of Chrysalix EVC explains how gallium nitride can cost effectively meet the demands on size and efficiency of power electronics devices.

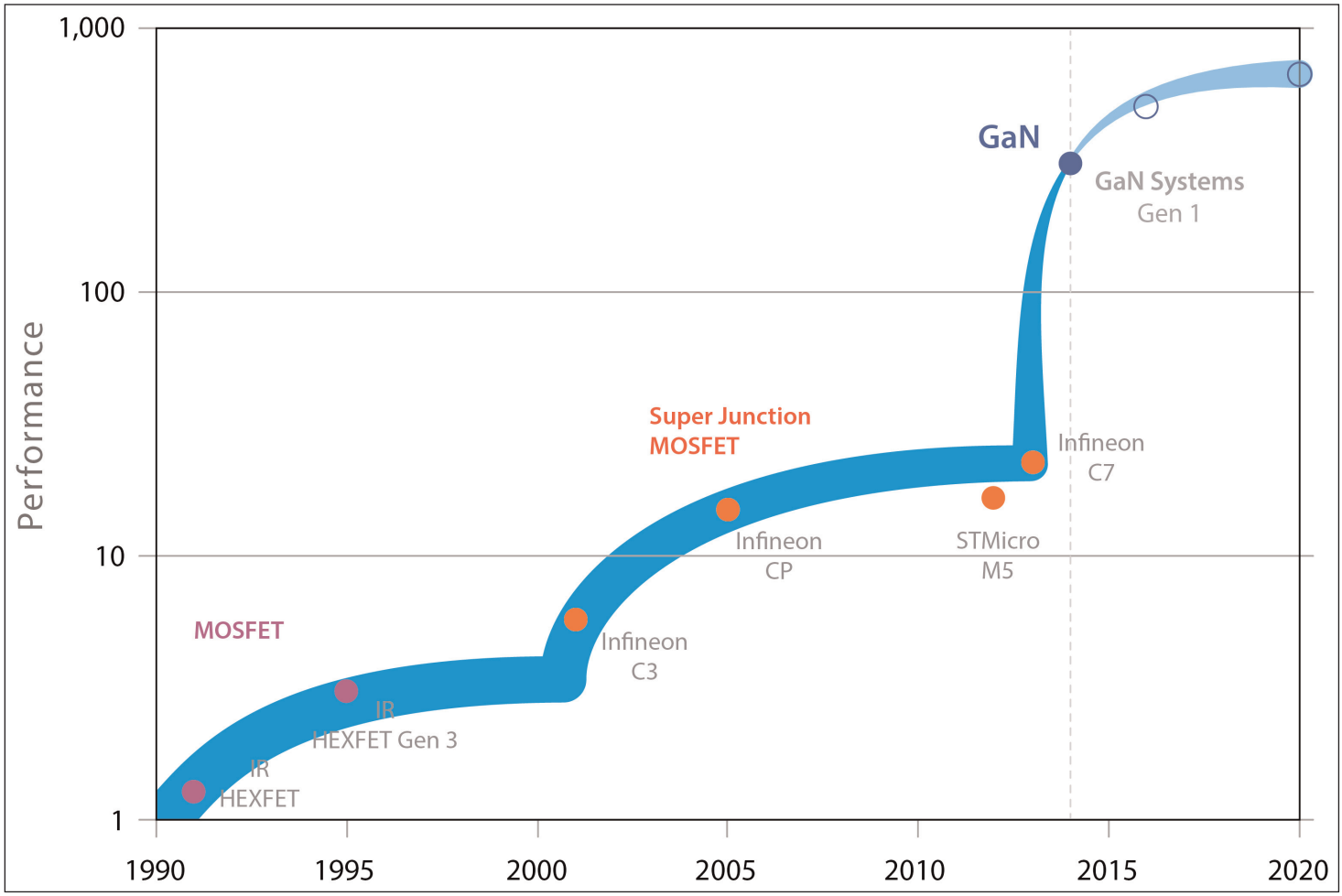
It is estimated that 10% of all the power generated around the world is lost as heat through inefficient power conversion — that is, when electric energy is converted from one form to another, such as between AC (alternating current) and DC (direct current), changing the voltage or frequency, or some combination of these. To put this in perspective, the scale of this loss is more than double the world's total installed capacity for non-hydro renewable electricity generation.

Today, the vast majority of power conversion is accomplished using silicon switches. These devices are used virtually everywhere that power is consumed, and they are spreading rapidly with the electrification, computerization, and connectivity of all the devices in our daily lives — from smartphones and TVs to electric vehicles (EVs) and data centers.

Everyone is familiar with Moore's law, which correctly predicted that computer microprocessor performance would increase at a steady exponential rate, doubling approximately every two years. However, this is not so for power conversion.

Power electronics have typically followed a step-change





function, with new materials platforms and topologies yielding major improvements in performance only every 10-15 years or so. International Rectifier achieved market dominance with the silicon-based MOSFET transistor in the 1990s, followed by Infineon, which claimed the dominant position with the Super Junction MOSFETs in the 2000s. As the performance of those technology platforms is topping out, the market now stands poised for the next big shakeup.

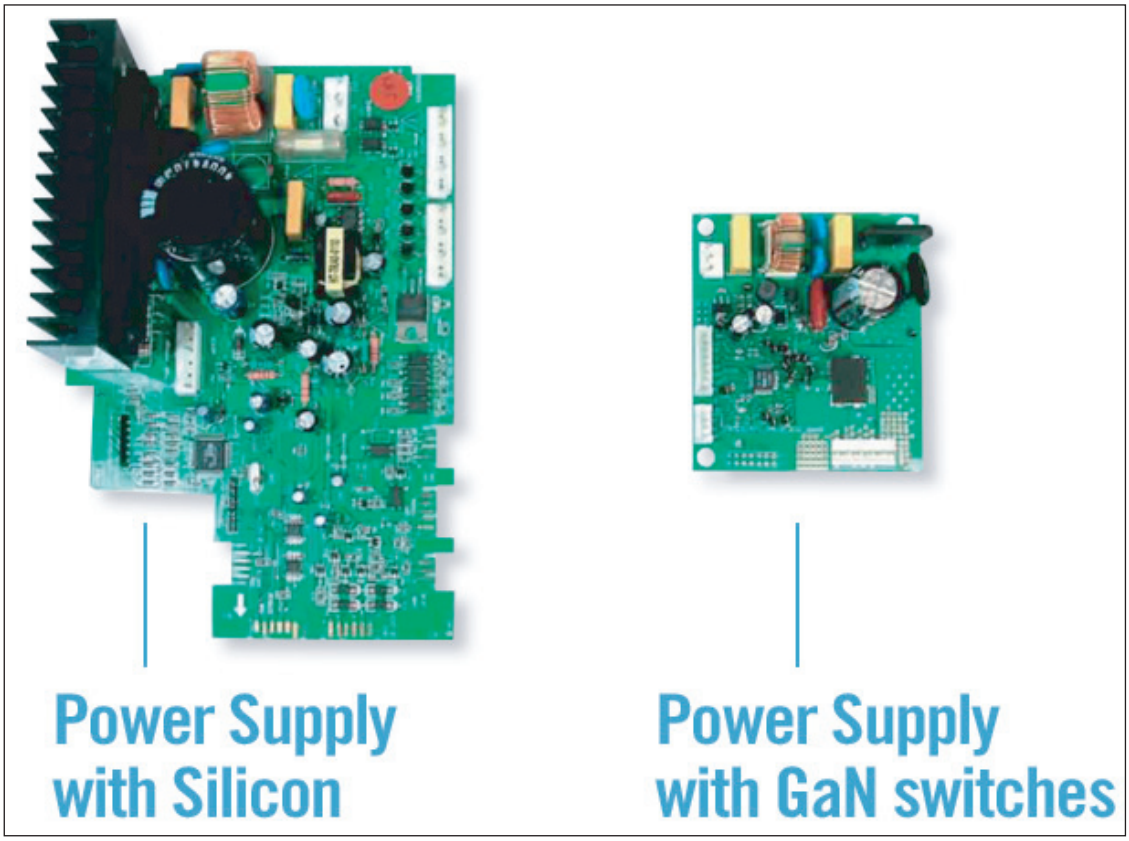
Gallium nitride (GaN)-based transistors appear to be increasingly positioned to take that top seat and disrupt the $15bn power transistor market. GaN is a very hard, mechanically stable, wide-bandgap semiconductor material with high heat capacity and thermal conductivity. The GaN materials platform has been increasingly commoditized through its application into RF antennas and LEDs, and a handful of companies are now coming out with power devices.

Why does this matter? GaN has the potential to eliminate 50% to 90% of the losses in power conversion. Moreover, it can reduce the size and weight of power modules by up to 75%, significantly reducing system bill of materials (BOM) costs while dramatically improving performance. GaN switches also operate 1000x faster than silicon switches and they have 10x better resistance per area and 40x better overall performance.

In energy-hungry applications such as data centers, this step change in performance is long overdue. In order to keep up with the pace of processor innovation and the explosion of cloud computing demands, data-center designers now need to put 1.5x the power conversion in the same space, and have run out of options to accomplish this. Similarly, major automotive manufacturers are challenging their designers to halve the size of their onboard vehicle chargers and dramatically increase power electronics efficiency to meet their cost, range, and performance roadmaps. This same size and efficiency demand is consistent across industries, and GaN is seen as the only cost-effective solution capable of meeting these rising performance demands.

One of the clear leaders in realizing this potential is Chrysalix portfolio company GaN Systems. Launched earlier this year, GaN Systems' product portfolio addresses roughly $10bn of the total $15bn market for power transistors. About $5bn of that market, in industrial and transportation applications above 50A (such as motor drivers, industrial power supplies, EV charging systems, and centralized solar inverters), appears to be uniquely addressable by GaN Systems' proprietary high-current technology.

Since launching its products this spring, GaN Systems has begun sampling programs with more than 50 customers across the electronics, manufacturing, EV, renewables, and Internet services industries, representing $2bn in product applications, or roughly 20% of the serviceable addressable market.



These customers are evaluating GaN Systems for a wide range of applications, from more efficient data centers and solar inverters, to thinner TVs, smaller, more powerful motors, longer-range EVs, and a multitude of other consumer, enterprise, industrial and transportation applications. Anywhere that efficiency, size, weight, cost and performance are important, GaN has a compelling value proposition.

Also, GaN Systems is uniquely positioned to unlock that potential, with the broadest product range, best performance, and easiest integration into customer applications with advanced driver and packaging technology. The company's innovative Island Technology results in devices that are approximately four times smaller, four times more efficient, and one quarter the cost of traditional silicon design approaches.

Over the last few months Chrysalix has helped GaN Systems to build an expanded world-class commercial team with the addition of seasoned industry executives in marketing, product management, business development, and applications engineering. Chrysalix is also instrumental in bringing on the additional leadership of Jim Witham as CEO in March.

GaN Systems was recently named as one of EE Times' Silicon 60: Hot Startups to Watch. The company is also supporting the Little Box Challenge, presented by Google and the IEEE Power Electronics Society, where Google has created a $1m prize for radical size reduction in power electronics. For the first time, those participating in the Little Box Challenge can register with GaN Systems to access previously undisclosed product and technology information, and fully leverage the firm's data sheets, PSPICE models, and packaging information.

With GaN Systems breakthrough device design, power transistors now stand to enable previously unseen switching efficiencies that could lead to more sustainable energy use and increased power efficiency, while reducing the costs and environmental impacts of some of the world's fastest-growing industries. On a global level, the impact could be a reduction in energy demand that is greater than the current adoption of solar power. In GaN Systems, Chrysalix sees the next great company capable of leading this enormous $15bn industry through its largest innovation cycle in many decades. ■

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