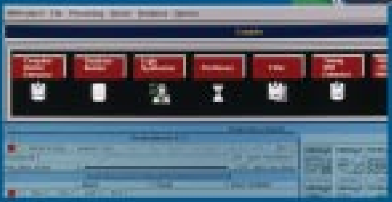
1997
Altera headquarters
(San Jose, California)

1993
Altera's 10th anniversary

1992
FLEX® 8000 device:
Altera's first FPGA

1991
MAX+PLUS® II software:
Industry's first Windows-based
development system



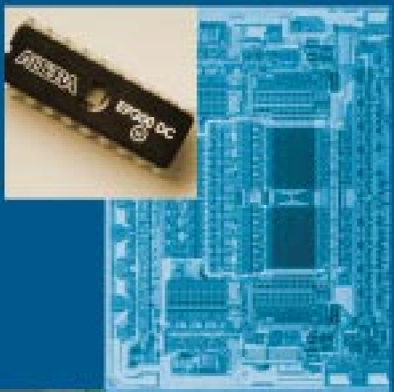
1988
MAX® 5000 devices: World's
first high-density CPLDs

1985
EP1200 device: Industry's
first high-density CMOS PLD

1984
A+PLUS software:
Industry's first PC-based
development system

20 YEARS of ALTERA INNOVATION

1984
EP300 device & die: World's
first re-programmable PLD



News & Views

JUNE 2003

20th Anniversary Commemorative Issue

1983
Altera's first demonstration
box, "T-Bird Tail Lights"

Building an Industry

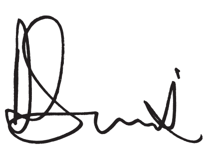
Witnessing the growth of Altera through the years has been quite a fulfilling experience for me. Looking back at our 20 years, we can be proud of having pioneered several important industry milestones. By combining memory cells to provide logic functions for the first time, we invented the reprogrammable logic device and a small startup company led to a multi-billion dollar industry. Our early choice of a fabless business strategy has redefined the model for today's semiconductor companies. This also spawned an important new wafer foundry industry. And we also were instrumental in evolving the way the distribution industry operates, helping them to become design win companies rather than just providing fulfillment. And, exhibiting a willingness to take risk to pursue our vision, we chose the IBM PC as a design and development platform, way back in 1983, before it became a household word.

The changes that have occurred in our own company have been driven by growth. From fewer than 20 people at our first offices in Hamilton Avenue, to our present home here at Innovation Drive, not only have we grown in size, but we have grown from a local Silicon Valley company to a global one, delivering high-value system-on-a-programmable-chip solutions to customers around the world. Through the years, Altera has been able to respond quickly and positively to the markets that we serve—changing our mindset, our attitudes, and our products. We have evolved as our customers have evolved. Several of our large customers, such as EMC, Cisco, Alcatel, and Fujitsu, have grown into global electronics powerhouses and built whole industries, facilitated by using programmable logic as their preferred methodology.

While many things have changed since 1983, some very important things have not. What have remained consistent are the founding principles of our company: to innovate, to motivate, and to serve. These principles are focused on our customers and their needs. These principles have survived our growth, the market ups and downs, and the changes in both our competitive landscape and the customers and markets we serve.

I look back with pride at what we as a company have achieved, but more importantly, I look forward with enormous gratification that this company will continue to remain steadfast in our commitment to our customers around the world.

To those customers who have grown with us through the years, I thank you for your loyalty. To those who have recently discovered the power of Altera's programmable logic offerings, our 20 years of accomplishments, our continued, consistent growth and dedication to innovation attest to the fact that you have made the right choice.



Rodney Smith
CEO 1983–2000
Chairman 1983–2003

All Roads Lead to Programmable Logic

Unprecedented growth and innovation have characterized the semiconductor industry over the past 20 years and driven it to the forefront of the high-tech business worldwide.

Despite this rapid growth, semiconductors are a cyclical business and have experienced periods of sharp decline as well. Programmable logic—estimated to be a $3 billion industry in 2003—has outperformed the industry throughout its ups and downs. PLDs have experienced this tremendous growth, bringing flexibility, time-to-market, integration and low risk to digital system designers across a wide range of markets. As a consequence of the steep semiconductor decline we have seen over the past two years, Altera is now presented with what is potentially the biggest opportunity ever for programmable logic.

Driven by the contraction in their business and an unclear growth path ahead, our customers are now taking a much closer look at both the materials and development costs of their end systems. Today, while the trend to push technology to its limits continues, cost has increasingly emerged as the driving factor for success. Strategically managing costs across an entire supply chain is now the focus of every chief executive, purchasing and engineering manager, system architect, and design engineer. It is no surprise that manufacturers today are on the hunt for alternatives to costly, high-risk ASICs. Meanwhile, ASIC companies, seeing their design starts dwindle, are struggling to reinvent themselves.

Faced with the enormous opportunity to greatly expand our total addressable market, Altera continues to build on its core competencies of PLD technology and operational excellence by focusing our attention on the needs of our customers to drive our product planning, engineering, sales, and marketing teams. It is with this approach that we developed and rolled out the company's most successful products to date—Stratix™ and Cyclone™ FPGAs. Directly addressing the cost issue, Cyclone devices were built from the ground up to balance our customers' need for features and lower cost. As a result, Cyclone market acceptance has been phenomenal. Customers wanting to take our new Stratix high-density FPGAs to high-volume production can now target HardCopy™ devices, a unique turnkey conversion product for cost reduction. And today, Quartus® II software leads the industry in PLD design tools with the best performance results and user interface features. You now have a full arsenal to meet both your technology and business needs.

With all these ingredients and the experience gained throughout the years, it is our objective to extend our value proposition beyond traditional boundaries and allow our customers to leverage programmable technology deeper and wider into their end systems. To do that, we will continue to evolve our company to adapt to both the business and technology needs of today's system manufacturers. In addition to giving you the lowest-cost development vehicle, we understand that your time is precious and ultimately, that is exactly what Altera delivers—TIME. Time-to-market and time-in-the market for your products.

Today, two decades after the inception of the company, Altera is proud to serve approximately 14,000 customers around the world. We would like to take this opportunity to thank those loyal to Altera and bid welcome to those who have just discovered the many advantages of programmability. You've come to the right place—as ours is a company that delivers on promises and measures our success by your success.

John Daane
CEO & Chairman, Altera Corporation

Stratix™	Most powerful FPGAs in the industry and winner of EDN's 2002 Innovation of the Year award
Cyclone™	Lowest-cost FPGAs ever
MAX®	Industry's best-selling CPLDs
Nios®	Most widely used soft core processor
Quartus® II	Easiest-to-use software
ardCopy™	Only low-cost migration path

20 YEARS *of*

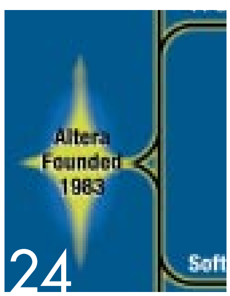
ALTERA®

INNOVATION

www.altera.com/innovation

The Story of Altera

Altera & the FPGA Evolution



Altera Timeline

PLDs & University Education

Features

Analyst Perspectives

Partner Viewpoints

Contents

20th Anniversary Issue Special Guest Editor:
Anna del Rosario

Editor:
Guy Spencer

Editorial:
John Panattoni
Doug Uptmor
Kati Wright

Contributors:
Stephen Brown
Suzanne Cope
Paul Ekas
Derek Minihane
Rachael Reddick
James Smith
Zvonko Vranesic
Cliff Tong
Martin Won

Special Contributors:
Don Faria
Bob Hartman
Paul Newhagen

Design & Illustration:
Jackie Moore
Maria Lee
Paula Cruz
Chandra Spence

101 Innovation Drive San Jose, CA 95134
Tel: (408) 544-7000
Fax: (408) 544-7809
n_v@altera.com

I.S. EN ISO 9001

The Road to Innovation Drive

The Book that Began it All

"The probabilities are high that someone will produce an electrically alterable logic array," predicted Bob Hartman, Paul Newhagen, and Michael Magranet in the closing pages of their 1982 book on the gate array industry. All Fairchild Semiconductor veterans, two years earlier the trio had founded Source III, Inc., a gate array design consulting firm. The group started writing the book, *Gate Arrays: Implementing LSI Technology,* a year or so later, while exploring various options to expand Source III's business. In the book's final chapter, they conclude that an electrically programmable gate array would be a highly competitive alternative to traditional metal-programmed gate arrays and cell libraries. Having conceived of what they originally called EAGAs, or electrically alterable gate arrays, Hartmann, Newhagen, and Magranet decided to develop their idea into a new technology—and thus the programmable logic device (PLD) industry was born.

To get their business off the ground, the team joined forces with an old friend from Fairchild Semiconductor, Dr. Jim Sansbury, then manager of production and R&D at one of Hewlett-Packard's fabrication facilities. Along with Dr. Sansbury's rich source of wafer technology knowledge and experience, they brought in financial expert Jim Hazle, former CFO of Fairchild. He reviewed the group's initial business plan and helped to provide access to attorneys and venture capitalists.

Disposing of Buffalo Chips

Of the many challenges that lay ahead, one of group's first decisions was choosing the right company name. In the days before Internet domains, back when Silicon Valley's Highway 101 was still lined with more orchards than buildings, the team began brainstorming for a good company name. However, they soon discovered that picking a company name had more to do with the choices available from the California Department of Corporations than with describing their business. After being repeatedly frustrated when their choices for straightforward names were unavailable, the team began considering humorous ones. Names like "Antelope Semiconductor" and "Buffalo Chips" were toyed with but discarded. Finally, focusing on their vision to create an "alterable" chip, the group con-

The book that started an industry.

Patent for the industry's first PLD: the EP300 device.

sidered two choices: "Altera" and "Terable." Fortunately for the future success of the company, not to mention employee morale, the latter choice was unanimously rejected. An updated business plan was sent to various venture capital firms with a request for financing. In May 1983, Alpha Partners of Menlo Park committed the first $500,000 in seed money. On Friday, June 3, 1983, the first round of financing was received and Altera Corporation was launched.

Pioneering the Fabless Business Model

Rodney Smith joined the company as CEO in November that same year. He strongly believed that the path to success lay in focusing on what the group knew best—designing and marketing a reprogrammable logic device. Pioneering a business model that later swept the industry, Altera decided to leave the product manufacturing to partners focused in that area of expertise. Back in those days, while a "fabless" semiconductor company was considered innovative, it was not thought to be the way to succeed in the chip industry. "Real men have fabs," sneered the CEO of one wafer process-oriented company at the time.

The EP300 device—Altera's first product.

Ricoh, Altera's first wafer foundry partner, delivered the company's initial product, the EP300, in March 1984. This first product, which provided the venture capitalists with a proof of concept, was manufactured using 3-micron CMOS erasable programmable read-only-memory (EPROM) technology and required ultraviolet light to erase the programming. The devices were programmed using "Alterans," the company's first place-and-route software tool. That first PLD had a blazing speed of 90 ns and was designed for use in an oil well instrumentation control board. The first order was for a PLDS system and 10 devices and brought in approximately $2,500 in revenue.

In January 1985, Altera introduced the EP1200, the first high-density PLD. That same year, the company contracted with Intel to serve as their foundry partner and second source. (Altera later bought the business, but not the fab, back from Intel in 1994.)

Over the years, the company expanded its foundry partnerships for various products to include agreements with Wafer Scale Integration (WSI), Cypress Semiconductor, and Texas Instruments. Toward the end of the 1980s, Altera also established a foundry partnership with Sharp that is still active today. Perhaps most importantly, in 1993, the company formed a close foundry relationship with Taiwan Semiconductor Manufacturing Company (TSMC) that continues to significantly contribute to Altera's product excellence.

On a Shoestring & an Ice Chest

For a company that has gained a reputation as a leader in programmable device innovation, Altera's early development lab could only be described as creative. Its first prober for wafer testing, for instance, was powered by compressed air from rented high-pressure cylinders. During delivery, the cylinders were rolled past the other offices in the complex, making loud ringing sounds that often brought employees out of their offices to watch them roll past. Worse, the chuck used to hold wafers in place during testing was powered by a fairly loud vacuum pump. The noise became so bothersome that the lab engineers put it in the bottom drawer of a wooden tech bench to reduce the racket. In another example of the primitive roots of high technology, cold testing in the early days was done using dry ice stored in a Styrofoam ice chest. Truly a state-of-the-art development lab!

Altera was one of the first companies in the semiconductor industry to realize the strategic advantages inherent in using an outsourcing model that allowed the company to focus on its areas of competency. In addition to outsourcing wafer manufacturing, the company used outside sales representatives and distribution partners to drive sales and deliver orders. This sales strategy worked particularly well for Altera because its PLDs were true "off the shelf" products, unlike custom ASICs, for instance. In addition, Altera was the first company to train and certify distributor field application engineers (FAEs) to offer design services, a revolutionary move that both significantly changed the face of the distribution industry and helped Altera to further grow its business.

The company was able to leverage this sales and distribution model to become one of the first U. S. semiconductor companies to earn significant revenue in Japan, then considered a "protected market" and notorious for discouraging American companies from penetrating its nation's high technology industry. Altera used in-country distributors and actively helped some local companies—such as Paltek—to expand their business. Through these localization strategies, Altera was able to generate nearly 20 percent of its business from Japan at an early stage in the company's development. This early penetration of the Japanese market helped fuel Altera's growth and positioned the company for further expansion in the Asian electronics markets.

Rent-a-PC

Probably the most visionary decision the company made was choosing the personal computer as a development and production platform. Until then, engineering development work was traditionally done using UNIX, VAX, Daisy, Mentor Graphics, or Apollo engineering workstations—all expensive machines that required large capital investments on the part of both Altera and its potential customers. Recognizing that the high cost of these development tools could be prohibitive for customers who might otherwise be willing to adopt PLD technology, Altera decided to bet on the potential of the relatively new PC technology that had been introduced only a couple of years earlier. Although the PC was nowhere near the powerful tool it is today, Altera's management had the vision to see that within a relatively short time, reductions in size and cost, coupled with increased performance, would turn the personal computer into a powerful and cost-effective design tool. At this time, of course, PCs were not the ubiquitous business appliances they are today.

Never a group to be held back by a challenge, the Altera sales force helped customers overcome any reluctance to purchase the new technology by referring them to United Rentals, a local San Jose company that rented both computers and lawn mowers, among other heavy equipment. The rental option allowed customers to minimize their investment in this new technology while they explored its potential benefits. Since PCs were considerably more expensive than they are today, even Altera's own sales force and FAEs were trained on PCs rented on a weekly basis.

From Bob's House to Innovation Drive

While Source III started in the back bedroom of Bob Hartmann's house and later moved to offices on Stevens Creek, Altera's first home was on Hamilton

The first demo box for the EP300 device was called "T-Bird Taillights." It simulated the brake lights and sequential turn signals of a classic Ford Thunderbird and successfully aided the company through four rounds of financing.

Avenue—a low-budget, low-profile office furnished with used steel desks. The site's impressive-sounding "computer-aided design center" initially consisted of two printing terminals without CRTs and a large wooden light table. Shortly after Rodney Smith joined the company as president and CEO in November 1983, the initial office grew, expanding first to three then to four adjoining office suites, accommodating the company's design, software test, and administrative departments. At the time Altera sold its first product in July 1984, total company headcount was approximately 20 employees, and its business occupied about 2,800 square feet of space.

Responding to current and anticipated growth, Altera moved to new facilities on Monroe Street in Santa Clara during the third quarter of 1984. Sales increased steadily over the next few years and Altera was courted by a number of large investment banking firms. The company went public in March 1988 (after one false start in the fall of 1987 when the market collapsed). Altera's IPO stock price was $5.50 per share. Revenues for the preceding year were $21 million and the company occupied approximately 50,000 square feet of space.

Altera's Don Faria demonstrates the latest in desktop programming for Personal Engineering News, *June 1987.*

By 1989, the company again outgrew its facilities and moved to its third location, on Orchard Parkway in San Jose. The company saw continued success and in 1991 its sales exceeded $100 million for the first time. That same year its employee headcount reached 450. 1991 was a significant year in terms of new products as well. Altera began to ship volume quantities of its MAX® 5000 family that had been introduced in 1988, as well as MAX+PLUS®II software, the industry's first Windows-based software development package. Initial samples of its MAX 7000 devices also began shipping that year. The next year, Altera introduced the FLEX® 8000 device, the company's first field programmable gate array (FPGA). By 1995, business had grown to such an extent that the company was shipping to over 12,000 customers around the world. In addition, regional sales offices were opened that year in London, Hong Kong, Penang, and Tokyo, with smaller local sales offices also being opened around the world to service the company's growing customer base. By 1995, employee headcount had grown to 900.

Remaining true to its Silicon Valley roots, Altera kept its headquarters in the Santa Clara/San Jose region, at the center of high-technology innovation and close to some of its major customers. Since 1997, the company has been headquartered in San Jose in a 500,000 square foot campus on Innovation Drive, off North First St., that houses 1,200 of the company's 1,900 employees.

Rodney Smith, the company's CEO for 17 years, retired in 2000, and John Daane took over the reins with the charter to expand and grow the company's technology and market leadership. After 20 years, the company remains as innovatively focused as it was at its inception. Last year alone, Altera introduced three new major products, the Stratix™, Cyclone™, and Stratix GX families, all groundbreaking technologies. In addition, the industry's first soft microprocessor for programmable logic, the Altera Nios® embedded processor, gained such strong market acceptance that companies are now buying corporate or site-wide licenses to give their designers access across company intranets as needed. Meanwhile, the Quartus® II software remains the most powerful unified design environment for FPGAs, CPLDs, and HardCopy™ devices. The dream of Altera's founders to create a "desktop silicon foundry" has become a reality.

What Lies Ahead

The semiconductor industry today is vastly different than it was 20 years ago. Advanced design rules have shrunk from 3 micron to 0.09 micron. Interconnects are made out of copper instead of aluminum and the area of a wafer has increased six-fold. As a result, today's electronic appliances don't sit on desktops, but are worn on belts or carried in pockets. Communications and computing devices are increasingly portable and wireless. Electronic control systems are embedded in everything from automobile engines to coffee makers.

Altera helped drive these developments, and while doing so has continued to grow and adapt to meet its customers' changing needs. PLD design flexibility—once a novelty—has become a critical tool enabling companies to deliver powerful new products, while reducing their development costs and time-to-market.

Once a niche product, programmable logic is now a market of its own within the overall semiconductor industry. PLDs have decreased in cost by an average of 30 percent per year since they were first developed, making them a highly cost-effective alternative to ASICs, but without the high development costs or risks of obsolescence. Altera's ambitious and revolutionary business model helped fuel the rise of today's highly

Continued on page 10


Future Electronics
Congratulates
Altera on 20 ears
of Innovation
Reach
for the sky.
Let Future Electronics give you a lift.
With around-the-clock customer service, high levels of available-to-sell inventory and reliable support, we'll help you soar past your competition, no strings attached!
Future Electronics is a worldwide leader in electronic components distribution, offering leading edge e-commerce supply chain solutions, state-of-the-art design centers and highly qualified engineering support in every corner of the globe.
FUTURE
ELECTRONICS
1-800-FUTURE-1
ext: 2255
The world's largest available-to-sell inventory

*The company's headquarters—
101 Innovation Drive, San Jose CA.*

...Continued from page 8

successful fabless semiconductor model—which has produced profit margins in excess of 50 percent for some companies—as well as the rise of the PC as a design platform. University students studying electrical engineering are taught programmable logic technology as part of their core curriculum. In fact, Altera has PLD programs in over 2,500 universities around the world.

Today, as ASIC development costs continue to escalate and the price of PLDs continues to fall, many industry analysts and other industry groups are focused on exploiting the advantages and the opportunities offered by programmable technology. In fact, other technologies are being replaced by PLDs simply because they can't compete in terms of development costs or time-to-market, critical factors in ensuring an acceptable return on investment. In the past 20 years of innovation, Altera has helped to reshape the semiconductor industry. The years ahead offer new, bigger, and more exciting opportunities for the company to do what it does best: deliver exactly what its customers want at precisely the right time.

The Altera Founders:

Bob Hartman

Bob, Altera employee #1, is known as the father of programmable logic—inventing and holding the patents for Altera's first PLDs. He established the design and layout engineering departments that developed Altera's Classic™, MAX®, SAM, and BUSTER PLD families. Bob retired in 1994 and currently has a golf handicap of 12.

Michael Magranet

Michael started Altera's marketing department and was the company's first director of marketing. He developed the customer and distribution marketing strategies that assisted Altera's direct and extended sales force. His efforts were instrumental in obtaining design wins and spreading the word about Altera. Michael was the first founder to retire from Altera, leaving the company in 1989 to pursue other personal interests.

Paul Newhagen

Paul established Altera's finance department. Well known for looking at every dollar Altera spent, Paul helped the company to reach profitability quickly. He was later crucial to the success of Altera's initial public offering in 1988. Paul celebrated the IPO, which raised $15 million, by having his 1977 Honda Civic painted. Paul retired as an employee in 1998 but continues to serve as a member of Altera's board of directors.

Jim Sansbury

Jim created Altera's initial technology, product, and test engineering teams. Through Jim's vision and technical expertise, Altera pioneered the fabless semiconductor model, now a standard for success in the industry. Jim ensured that the early EPLD devices were properly characterized and manufactured with industry-leading quality and reliability standards. Jim retired from Altera in 1999 and so far he has resisted the temptation to become involved again with technology.

Maximizing Design ROI: a TSMC-Altera Case Study

It is of course cliché to suggest that the semiconductor industry is at a crossroads. In fact, the semiconductor industry has seen an incredible number of crossroads in the 20 years that Altera has been around, let alone the 10 years of our business relationship. At every turn, our two companies have moved cautiously and methodically, to the benefit of the IC industry.

The ability to make sound judgments in such times is made easier by the synchronicity of our corporate goals, principally the goal of delivering leading-edge semiconductor technology to designers who need quick turnaround for highly innovative IC designs.

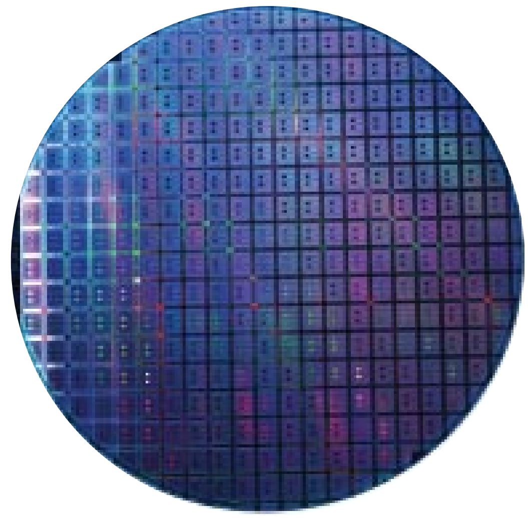
At the 0.13-micron generation, the semiconductor industry saw crossroads including a shift, at the technology level, from 200 mm to 300 mm wafer sizes and from aluminum to copper interconnects. At the macro-level, we collectively experienced a downturn across all semiconductor markets.

To weather this period, TSMC and Altera collaborated closely on the development of advanced technology, including some of the first production chips on 300 mm wafers and the first all-copper FPGAs. This collaboration ensured that Altera would have leading-edge silicon in high volumes when the upturn began. The proof of this strategy is already bearing itself out. To date, TSMC has delivered more than 20 product types across two FPGA families to Altera, representing some of the highest volumes anywhere on a 0.13-micron process.

At the 90-nm node, TSMC is poised to deliver the industry's leading semiconductor technology beginning with early design starts in the third quarter of 2003 and culminating in volume production in the first quarter of 2004. The timing alone is competitive with, if not ahead of, every IC maker in the industry. From a performance perspective, TSMC leads the industry with the only production-worthy low-k dielectrics, enabling both performance and power advantages over other processes.

We fully expect that once again TSMC and Altera will be there, when you need us, with the performance and power specifications you require.

Dr. Edward C. Ross
President, TSMC North America



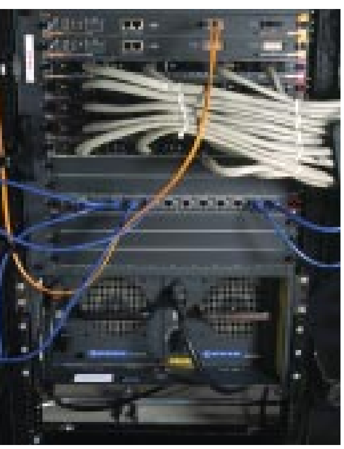
0.13-micron 300-mm EP1S25 wafer.

Why are all of these customers smiling?

Altera's Stars of Innovation are chosen for their groundbreaking use of programmable logic in leading-edge applications. The Stars of Innovation exemplify the excellence in engineering made possible by the power and flexibility of Altera's programmable solutions. For more information about the Stars of Innovation, go to www.altera.com/stars.

Cisco Systems

Cisco Systems, Inc. is the worldwide leader in networking for the Internet. Cisco's Internet protocol (IP)-based networking solutions are the foundation of the Internet and most corporate, education, and government networks around the world. Virtually all messages or transactions passing over the Internet are carried quickly and securely through Cisco equipment. In addition, Cisco solutions are the basis for most large, complex networks used by corporations, public institutions, and telecommunication companies, and are found in a growing number of medium-sized commercial enterprises.

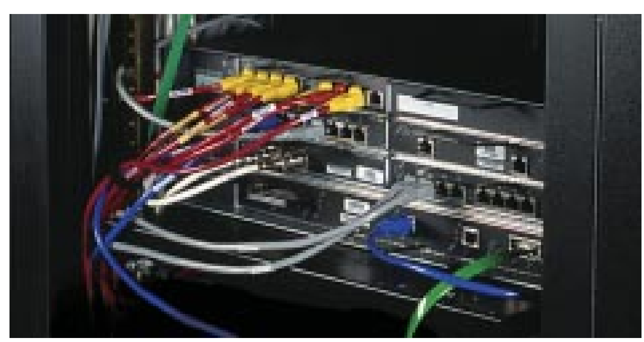


Altera's corporate network is almost entirely composed of Cisco routers, firewalls, and other products, like this Cisco Catalyst 5500 switch, which is used to support Altera's local area networks (LANs).

Altera has been supplying Cisco with advanced programmable logic solutions since 1993, when Cisco acquired Crescendo Communications, an Altera customer that developed the technology underlying the ground-breaking Cisco Catalyst 5000 series of Gigabit Ethernet and ATM-ready switches. The Cisco Catalyst 5000 series redefined enterprise-level networking, and enjoyed widespread success. The high density of Altera's products in the Cisco Catalyst 5000 series—up to 24 Altera devices on a single board—led Cisco to use Altera products in other switch families, including their premier intelligent multilayer modular switch, the Cisco 6500 Series.

Equipped with Altera's FPGAs and MAX® CPLDs, the Cisco 6500 Series switch sets a new standard for IP communications and application delivery in enterprise campus, service provider, and metro edge networks. The Cisco 6500 Series' ability to maximize user productivity and enhance operational control while providing unprecedented investment protection earned it Networld+Interop's Well-Connected award and Datamation's Network Infrastructure Product of the Year awards. While the Cisco Catalyst Series of switches enables the creation of leading-edge Ethernet-based networks, Cisco also offers a complete range of switching solutions that combine support for legacy circuit-switched functions, such as time-division multiplexed (TDM) voice streams, with support for the latest packet-based functions like voice-over-IP and video-over-IP. These multiservice switches enable customers to maintain and grow their existing data services, while integrating them into a lower-cost network infrastructure capable of supporting a broader range of more advanced functions and services.

Many of Cisco's multiservice switches contain Altera's products, including the Cisco MGX 8230 Advanced ATM Multiservice Edge Concentrator, which provides the most cost-effective gateway for narrowband services in space and power-limited situations; the MGX 8250 Edge Concentrator, which supports aggregation of a complete range of IP, voice, and narrowband services in an IP+ATM network; and the Cisco IGX 8400 series wide-area switches, which provide the backbone required to deliver today's enterprise data, voice, fax, and video applications by offering an end-to-end



This Cisco 7200 Series router acts as the core gateway to Altera's corporate wide area network (WAN) and the Internet.

Switches from the Cisco Catalyst 6500 family, like this one, are at the heart of Altera's LANs.

networking solution. These multiservice ATM solutions from Cisco Systems connect enterprise locations while integrating with existing routers and access devices to safely and cost-effectively support business-critical applications.

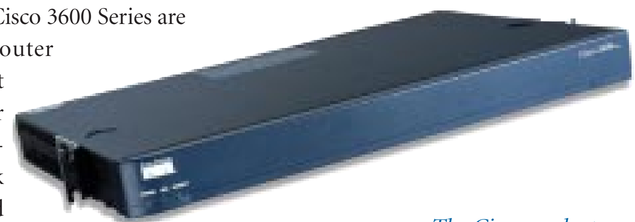
While ATM and LAN switching both have important roles to play, routing continues to be essential in building highly available and scalable networks. Routers provide the security, stability, and control needed for mission-critical enterprise networks. Moreover, an emerging set of applications and environments are expanding the boundaries of high-end routing. Likewise, Altera usage in Cisco products extends beyond their switches into their routers, a clear leadership area for Cisco.

Cisco's extensive line of routing hardware, which provides everything from high-end routing platforms for building IP-optimized backbones to Ethernet LANs to WANs for small businesses and small branch offices, relies on both Altera's FPGAs and MAX® CPLDs For example, in the Cisco 12000 Series routers, part of Cisco's family of multimillion packets-per-second (pps) IP and MPLS routing platforms, Altera APEX™ 20KE FPGAs provide high-speed digital processing, reinforcing the Cisco 12000 Series' position as the premier high-end routing solution for service provider backbone and edge applications.

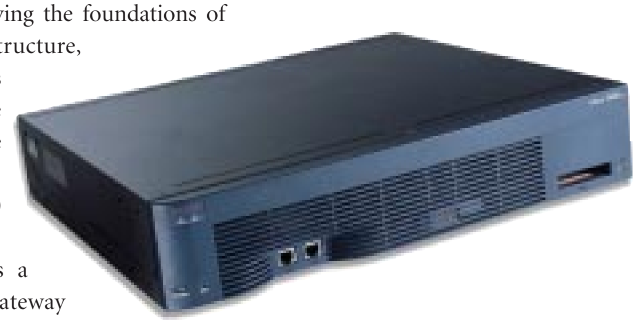
Altera programmable solutions serve in Cisco's other high-performance router families as well, including several members of the Cisco 7000 Series, which is the undisputed leader in their market space with over 76 percent market share. Within the Cisco 7000 Series, Altera devices are most prominent in the Cisco 7600 Series, which delivers high-performance WAN and MAN networking with line-rate IP services; the Cisco 7500 Series, which is designed for environments requiring high performance, high availability routing; the Cisco 7300 Series, which can be used for enterprise campus or Internet gateway applications or be deployed by service providers as a high-end CPE router for managed service offerings; and the Cisco 7200 Series, Cisco's fastest single-processor router, which can serve in applications such as enterprise WAN aggregation, point-of-presence leased line aggregation, and as customer premise equipment for outsourced WAN infrastructures.

Cisco's range of router solutions also extends to cover the needs of small to mid-sized businesses and branch offices. The Cisco 1600 Series router has become the proven choice for data access for small branch offices and small businesses because it provides flexible and secure data access, connecting Ethernet LANs to WANs via ISDN, asynchronous serial, and synchronous serial connections, as well as supporting frame relay, leased lines, switched 56, switched multimegabit data service (SMDS), and X.25. The Cisco 1700 modular access router series builds upon the success of the Cisco 1600 Series routers, delivering greater flexibility and investment protection. Cisco uses Altera devices in both the Cisco 1600 and Cisco 1700 Series routers.

For larger offices and small ISPs, Cisco offers the Cisco 2600 and Cisco 3600 Series routers. Both the Cisco 2600 Series and Cisco 3600 Series are multiservice router families that share modular interfaces, providing network managers and service providers a scalable, cost-effective solution to meet such needs as Internet/intranet access with firewall security, voice/data integration, analog and digital dial access services, and virtual private network (VPN) access. At the upper end of the Cisco 3600 Series is the Cisco 3660 multiservice access platform, which enables applications such as packetized voice aggregation and branch office ATM access ranging from T1/E1 IMA to OC-3 Altera MAX CPLDs are heavily used in both the Cisco 2600 and Cisco 3600 Series, and WAN interface cards for both families feature APEX 20KE devices and the Nios® soft embedded processor.

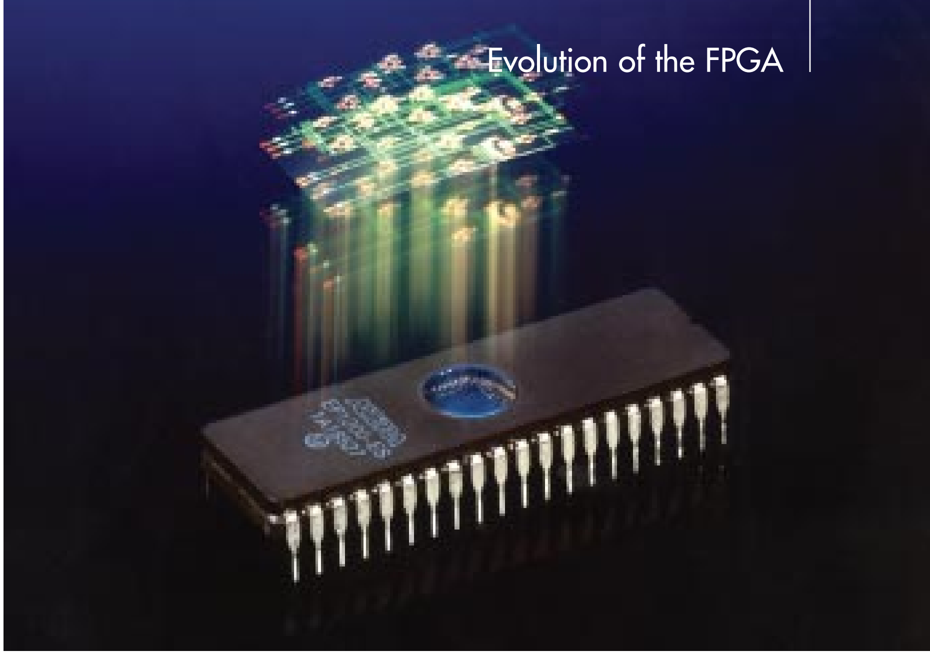


The Cisco product-based network at Altera is composed of over 400 individual devices or products, like this Cisco 2600 Series router (above) and Cisco 3600 Series router (below), and is the foundation for Altera's global computing infrastructure.



In addition to supplying the foundations of the Internet infrastructure, Cisco also offers products that enhance and improve the Internet experience. The Cisco 6400 carrier-class broadband aggregator is a high-performance gateway

Continued on page 20



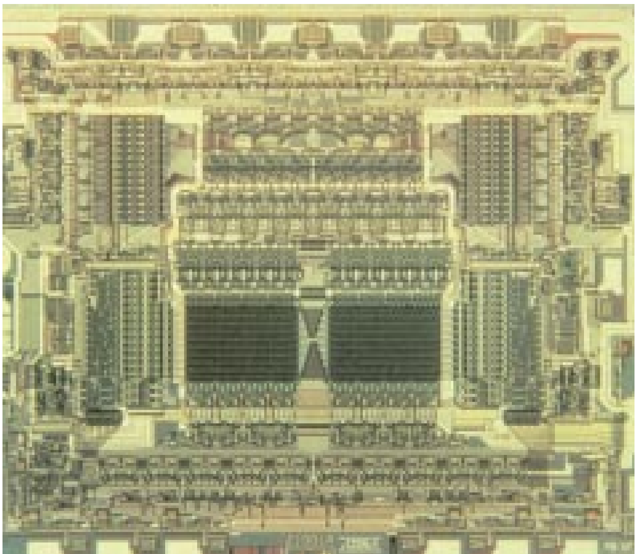
Altera & the Evolution of the FPGA

Since the introduction of the EP300 in 1984, programmable logic devices (PLDs) have evolved into one of the industry's most powerful semiconductor platforms—the FPGA. Today's FPGAs are able to handle more critical system processes than ever before. As FPGAs continue to evolve into true system-on-a-programmable-chip (SOPC) solutions, their presence will forever change the landscape of system design and implementation.

The First PLD

The idea behind the EP300 was to provide designers with a programmable array logic (PAL)-like devices that could scale to challenge the logic density of gate arrays and could be reprogrammed. Before the EP300, designers relied on programmable array logic (PAL) devices to program glue logic for interconnects between larger, ready-made circuits. While these devices could be programmed from a designer's workstation, the technology relied upon blowing apart fuses within the device to achieve the desired configuration. Since programming a fusible element is a destructive process, adequate testing of un-programmed devices is practically impossible. Also, the bipolar technology employed meant the devices were large and power-hungry. It was clear that this technology was not going to scale to be a viable alternative to gate arrays.

Altera's founders looked to employ CMOS technology along with a suitable reprogrammable element for allowing designers to alter the device's configuration. For this they used erasable programmable read-only memory (EPROM) in an entirely new way, applying the technology to logic applications.



The EP300 designers first had to consider the application layer with its logic elements, flip-flops, input-output ports, and a lot of interconnects to hook everything together. Secondly, they needed to look at the configuration layer containing the configuration memory in addition to the corresponding circuitry to allow configuration information to flow from the development system to the device. Each of these layers presented major challenges. At the application level, decisions had to be made on how to develop combinatorial logic, how many flip-flops to provide, how many inputs and outputs to use and how to "programmably" hook all of these elements together.

The configuration layer was also a major design challenge. Difficult design questions needed to be answered. How do you signal to the EP300 that you want to program it? How do you get access to each programmable element in order to actually program it? How do you steer the configuration information to the right location? To solve these problems, Altera employed a third logic level for signaling to the EP300 that certain pins were going to present programming information. Simultaneously, internal circuitry was turned on to steer programming information to the right place.

A year after the introduction of the EP300, Altera released the EP1200, the world's first high-density PLD with 1,200 gates and 28 macrocells. Along with the early devices, Altera also provided development tools which were fundamental to the broad adoption of programmable devices.

The Power of Today's FPGA

A lot has changed since 1984, when PLDs primarily served as glue logic, bridging core processes to basic

Continued on page 40

0.13-micron 300-mm EP1S25 wafer

Innovation by Altera—Empowered by TSMC.

When you need cutting-edge FPGA technology you can rely on, Altera and TSMC deliver. Offering the only 0.13-micron FPGAs shipping in volume—the Stratix™ and Cyclone™ device families—Altera and TSMC bring you the technology you need when you need it.

Our consistent record of on-time delivery means that you can take your products to market quickly and with the lowest possible risk.

The best process technology and the best FPGAs.
An unbeatable combination. Available now.

The Only 0.13-Micron FPGAs Shipping in Volume.

tsmc®

20 YEARS *of* ALTERA® INNOVATION

www.tsmc.com

www.altera.com

The stage is set. It's time to optimize your design chain.

Design chains create a whole new level of competition — one where development links between companies are critical. Cadence can help. We're the largest supplier to the electronics design chain. And we work with our partners to help companies optimize their design chains every day. Find out how we can help you. And enjoy the show.

WWW.CADENCE.COM/DESIGNCHAIN

...Continued from page 15

that enables service providers to deliver personalized broadband network services, and voice- and entertainment-driven traffic over the full suite of broadband access media. The service selection gateway (SSG) capability of the Cisco 6400 allows subscribers to dynamically select on-demand services such as video-conferencing, streaming video, personalized Internet, business-grade Internet, shopping, and gaming to create new revenue streams and help attract and retain subscribers. The SSG allows each family member to access multiple services simultaneously for the ultimate in service utility and flexibility. With the capability to reach more than 14,000 homes simultaneously with a cost-effective high-speed service delivery infrastructure, the 6400, equipped with Altera FPGAs, enables service providers to meet the needs of a rapidly growing subscriber base with a scalable solution.

The information age rapidly brought to fruition by the advent of the Internet has led to great advances in information storage and management. Cisco products equipped with Altera devices play an important role here, as well. For example, the Cisco MDS 9000 family of multilayer storage networking products allows customers to deploy high-performance storage-area networks (SANs), delivering intelligent network services such as multiprotocol/multitransport integration, virtual storage area networks (VSANs), comprehensive security, advanced traffic management, sophisticated diagnostics, and unified SAN management. In addition, the Cisco MDS 9000 family provides an open platform for embedding intelligent storage services such as network-based virtualization. With its multilayer approach to network and storage intelligence, the Cisco MDS 9000 family ushers in a new era in storage networking.

With over ten years of cooperation in developing the world's most advanced Internet networking products, Cisco and Altera have formed a close relationship highlighted by frequent technology sharing and individualized support at all levels. While gathering feedback from its customers on future product development, Altera received valuable input from Cisco and incorporated it into all of its recent products, including the Stratix™, Stratix GX, and Cyclone™ families. Accordingly, the first devices that Altera shipped from each of these families were delivered to Cisco to fulfill immediate needs in next-generation products. Altera maintains the highest level of commitment to its relationship with Cisco, which has led both of them to produce standards-setting solutions through technology leadership and enabled them to become the defining companies in their industries.

Creo Inc.

Right: Leaf Valeo Portable Power Digital Camera Backs.

As the world's largest supplier of prepress equipment, Creo is leading the transformation of the graphic arts industry. Named one of the 500 fastest growing North American companies of 2002 by Deloitte and Touche, Creo offers more than 300 products, including professional digital camera backs, scanning systems, halftone proofers, workflow systems and management software, computer-to-film and computer-to-plate devices, on-press imaging technology, components for digital presses, and color servers for high-speed, print-on-demand digital printers.

Creo's partership with Altera began in the mid 1990s, with the use of MAX® CPLDs and Altera's first FPGAs. Since then, they have adopted a strategy of following Altera's product development path to obtain the best value and performance for Creo products. Today, Altera programmable solutions play important roles in several Creo offerings encompassing the whole range

Continued on page 26

Dear Altera:

Congratulations on 20 years of successful business! While the electronics industry is experiencing its worst downturn ever, strong companies like Altera keep getting stronger. Few companies have formed a new design category, such as PLDs, that today have such tremendous potential.

The longstanding partnership between Altera and Synopsys has been very gratifying to me, because it has enabled us together to provide customers with the solutions they need to utilize advanced PLDs. Your PLDs have become so advanced, in fact, that in terms of logic and memory, high-speed I/Os, and embedded processors, they are approaching the performance and capabilities that ASICs reached just a few years ago. With such cutting-edge devices as yours available, designers gain the advantage of a greater set of viable choices.

The high-end FPGA market will continue to grow in importance. At the same time, though, PLDs are encountering the design challenges that ASICs did years ago. These challenges are not a surprise, but they must be resolved.

To that end, Synopsys is developing a platform of ASIC-class verification and implementation technologies to enable the high-end FPGA market. In this and many other ways, we are committed to continue working with Altera for the next 20 years to bring valuable solutions to our joint customer base.

Happy 20th Anniversary, Altera!

Aart de Geus
Chairman & CEO
Synopsys, Inc.

SYNOPSYS®

Nick Tredennick is the editor of the Gilder Technology Report. He was Altera's chief scientist in 1993.

Another Decade of Rapid Growth

In 1966, when programmable logic was proposed, there weren't enough transistors per chip to make practical devices. Moore's-law progress in semiconductors made programmable logic devices (PLDs) practical by 1983, when Altera was founded. However, Intel introduced the microprocessor in 1971 and microprocessor-based design grew to dominate the industry. This limited applications of programmable logic to prototyping and to displacing low-end ASICs. The PLD industry grew at a healthy rate, but microprocessor-based applications grew even faster. The microprocessor was popular then because it was cheap and its performance was adequate for a huge range of applications. The microprocessor's inefficiency was acceptable because most applications got their power from wall sockets.

Now, the world is splitting into tethered and untethered devices. Tethered devices plug into wall sockets and they connect by wires to the Internet. Untethered devices carry their own power and they connect to other devices and to the Internet by radio. These mobile (untethered) and basestation (tethered) radios process signals digitally. Fast-emerging applications for mobile devices make digital signal processors the fastest-growing segment of the microprocessor market.

But, as these radio-connected devices shift from voice to data, signal processing requirements exceed the capabilities of digital signal processors and microprocessors. Digital signal processors and microprocessors aren't efficient in performance or in power use. Direct hardware implementations, such as ASICs, have the efficiency and the performance, but design costs are escalating and production costs are rising rapidly. ASICs also lack the flexibility to adapt to the range of in-place legacy networks or to track evolving protocols. What are needed are components with the flexibility of programmed solutions and the performance of direct hardware implementation. These components need to be generic at manufacture to reduce cost and they need to be customized in the field to suit the application. For an increasing number of applications, that will be programmable logic. Programmable logic will begin displacing digital signal processors and microprocessors in a market that's ten times the size of the market PLDs dominate today. Another decade of rapid growth for Altera!

Programmable Logic Leads the Way to Increasing Innovation & Decreasing Customer Risk

Rich Wawrzyniak is currently a senior analyst responsible for the ASIC/SoC service at Semico Research Corporation.

In its 60+ years of existence, the semiconductor industry has always been able to rise to meet a challenge. There have been many instances where new technologies, new approaches, and new business models have emerged to solve problems and remove potential market growth bottlenecks or, more boldly, to create entirely new markets where none existed before. The programmable logic market is no exception, and it can be said to typify all the best attributes of innovative solutions and thinking "outside the box."

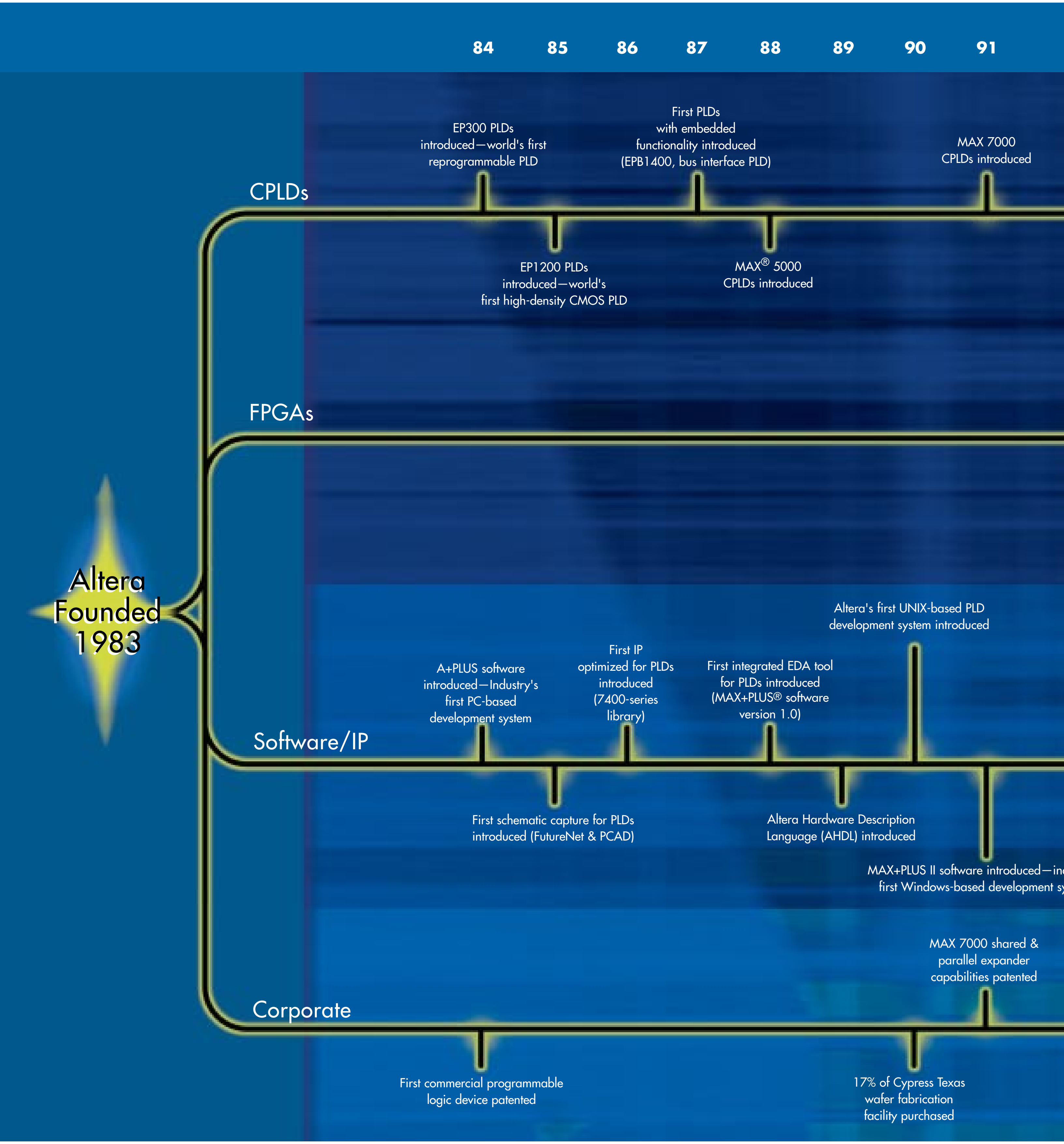
Today, the ASIC industry is again faced with a series of daunting challenges, not the least of which is the dramatically rising costs for mask sets. The ability of companies to create silicon solutions in low-volume applications is gated to a large degree by mask-set costs. As they rise, the volume needed to justify the design effort to regain the investment in time and resources also rises. Some applications will never grow past low volumes. Also, while is it undeniable that small companies can be more innovative and nimble than their larger cousins, curtailing this flow of new ideas because materials costs have priced alternative solutions and companies out of the market will not be a good situation for the semiconductor industry. An additional challenge is the high cost of non-recurring engineering (NRE) charges that relate to the costs to complete a complex SoC design.

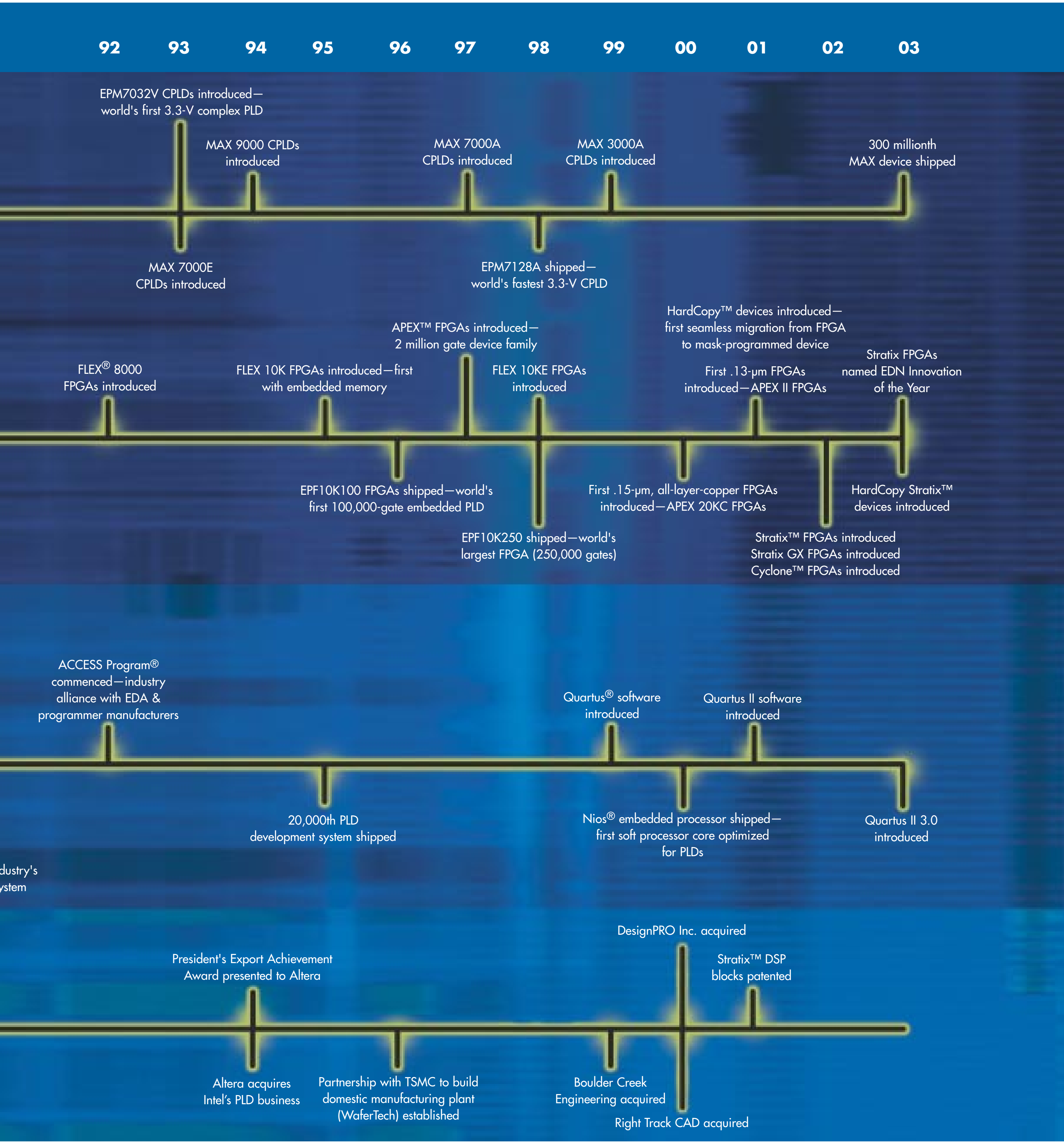
Enter the FPGA, with its zero NRE costs and its ability to allow the completion of a design very quickly to meet tight market constraints. Also, since customers can purchase exactly the number of parts they need to prove out a design, high mask-set costs can be largely offset. Further, the availability today of low-cost FPGAs presents a viable solution for applications that could potentially reach high-volume applications in the hundreds of thousands. This helps to keep the flow of new and innovative approaches that surface from small companies moving into production versus not being developed. The risk that small companies face is reduced through the introduction of high-performance, reprogrammable devices. This is beneficial for the semiconductor industry as a whole, since we all depend on that next big application to drive markets and device volumes.

The FPGA vendors themselves are not sitting back and waiting for markets and customers to find them, but are actively seeking new applications and markets to address, and developing new products accordingly. Some of this energy comes from the necessity to find new applications to keep revenue streams growing. But most of the process is due to the innovative spirit found in this industry as companies seek to push performance ever higher while lowering cost points at the same time. Additionally, the recent push to add high-speed, high-performance serial channels to FPGAs points out that innovation is alive and well in this industry.

Altera Corporation is a company that can stand as the archetype for innovative products that come to the aid of designers everywhere. If the first 20 years of their history are any guide to the future, the next 20 years are going to be really something to behold for customers and competitors alike.

Analyst Perspectives continued on page 31


84
85
86
87
88
89
90
91
CPLDs
EP300 PLDs introduced—world's first reprogrammable PLD
EP1200 PLDs introduced—world's first high-density CMOS PLD
First PLDs with embedded functionality introduced (EPB1400, bus interface PLD)
MAX® 5000 CPLDs introduced
MAX 7000 CPLDs introduced
FPGAs
Altera Founded 1983
Software/IP
A+PLUS software introduced—Industry's first PC-based development system
First schematic capture for PLDs introduced (FutureNet & PCAD)
First IP optimized for PLDs introduced (7400-series library)
First integrated EDA tool for PLDs introduced (MAX+PLUS® software version 1.0)
Altera Hardware Description Language (AHDL) introduced
Altera's first UNIX-based PLD development system introduced
MAX+PLUS II software introduced—in
first Windows-based development sy
Corporate
First commercial programmable logic device patented
17% of Cypress Texas wafer fabrication facility purchased
MAX 7000 shared & parallel expander capabilities patented


92
93
94
95
96
97
98
99
00
01
02
03
EPM7032V CPLDs introduced—world's first 3.3-V complex PLD
MAX 9000 CPLDs introduced
MAX 7000A CPLDs introduced
MAX 3000A CPLDs introduced
300 millionth MAX device shipped
MAX 7000E CPLDs introduced
EPM7128A shipped—world's fastest 3.3-V CPLD
HardCopy™ devices introduced—first seamless migration from FPGA to mask-programmed device
APEX™ FPGAs introduced—2 million gate device family
Stratix FPGAs named EDN Innovation of the Year
FLEX® 8000 FPGAs introduced
FLEX 10K FPGAs introduced—first with embedded memory
FLEX 10KE FPGAs introduced
First .13-µm FPGAs introduced—APEX II FPGAs
EPF10K100 FPGAs shipped—world's first 100,000-gate embedded PLD
First .15-µm, all-layer-copper FPGAs introduced—APEX 20KC FPGAs
HardCopy Stratix™ devices introduced
EPF10K250 shipped—world's largest FPGA (250,000 gates)
Stratix™ FPGAs introduced
Stratix GX FPGAs introduced
Cyclone™ FPGAs introduced
ACCESS Program® commenced—industry alliance with EDA & programmer manufacturers
Quartus® software introduced
Quartus II software introduced
20,000th PLD development system shipped
Nios® embedded processor shipped—first soft processor core optimized for PLDs
Quartus II 3.0 introduced
dustry's
ystem
DesignPRO Inc. acquired
President's Export Achievement Award presented to Altera
Stratix™ DSP blocks patented
Altera acquires Intel's PLD business
Partnership with TSMC to build domestic manufacturing plant (WaferTech) established
Boulder Creek Engineering acquired
Right Track CAD acquired

 ...Continued from page 20

of prepress activities from image capture and creation, to proofing and the production of print-ready output.

Creo's outstanding record of innovation is reflected in the Leaf™ family of digital camera back products. Creo introduced the world's first professional digital camera back in 1992, the Leaf DCB, and since then Creo has continuously led the professional digital market by developing novel, award-winning digital solutions. Leaf Valeo, the latest line of Leaf products, presents "Portable Power", providing the capability to shoot on-location and in the studio equivalently. Altera devices support all Leaf backs to provide various photographic working modes, with versatility and flexibility for the professional user. Customers can also get feature upgrades just by downloading new software versions from the Creo Leaf web site

Altera devices also figure prominently in Creo's Brisque® workflow family of solutions, a set of products that offer comprehensive prepress workflows to printers and prepress shops. Winner of *Prepress News*' Workflow System of the Year Bronze award, Brisque solutions support a wide variety of input and output formats, allow on-line communication for remote search and edit of files via standard web browsers, and provide automated content management for document versioning, personalization, and re-purposing.

Right: The Spire high-resolution color server for Xerox DocuColor printers. Above right: Lotem 800 II Quantum platesetter.

For the final stage of preparing media for the press, Creo offers a range of solutions, including the award-winning Lotem® platesetters and proofers family of commercial computer-to-plate (CTP) products, which utilize Altera devices. Professional printers rely on Lotem CTP equipment to convert computer-based digital information to print plates suitable for a wide variety of press formats with sharp resolution and the highest degree of accuracy.

Another of Creo's leadership areas is the realm of print-on-demand, one of the most exciting aspects of the graphic arts industry that facilitates high-volume, short print runs. Creo develops specialized workflow products to automate and manage the flow of digital information to high-speed digital printers for high-quality, full-color, personalized printing. Powered by Altera FPGAs and CPLDs, Creo's high-performance Spire™ color servers drive a range of Xerox DocuColor® printers, including the DocuColor 2000 digital color printer, the DocuColor 6060 Digital Color Press, and the DocuColor iGen Digital Product Press. With the ability to manage multiple print engines and perform raster image processing (RIPing) while printing, Spire servers eliminate downtime between successive ready-to-print jobs and improve workflow efficiency. Spire servers are unmatched in their support for variable information (VI) printing, one of the fastest-growing market segments in the printing industry, which allows efficient, high-volume printing of highly individualized documents.

Creo maintains its leading role in the digitization of the graphic arts industry by developing and offering the most compelling products in the prepress field. Currently, Creo has qualified Stratix2 FPGAs and intends to use Cyclone™ FPGAs to help them reduce costs for future products. Altera's role as their sole programmable logic supplier reflects Creo's commitment to continued innovation and leadership, built on the flexibility and performance that Altera programmable solutions provide.

Extreme Networks

Extreme Networks is committed to solving the single, defining business problem for the early 21st century: implementing the most effective applications and services infrastructure. This way, companies can keep up with the increasing demand for mission-critical applications and services, in order to better meet business objectives and gain a competitive advantage. This single-minded focus has led Extreme to build some of the largest networks in the world—Air Products and Chemicals, Arrowhead AB, China Telecom, Compaq, Deutsche Bank, Korea Telecom, Lockheed Martin Aeronautics Company, Microsoft, Siemens, and YIPES.

Extreme Networks began using Altera FPGAs in the late 1990s during the development of their award-winning SummitPx1 Application Switch. The SummitPx1 is the world's first and only content-aware application switch to deliver an unprecedented level of Layer 4-7 intelligence and consistent line-rate Gigabit Ethernet performance. Equally impressive is that SummitPx1 Application Switch maintains wire-speed no matter how many content-aware forwarding rules are enabled. These capabilities allow the SummitPx1 to accelerate network traffic to an extraordinarily high degree, eliminating communications bottlenecks and improving the overall experience for network end users.

Combining a TCP/IP stack, a real-time content analysis engine, and a resource tracking and allocation engine, the SummitPx1 performs wire-speed TCP session analysis, termination, origination—and even modification. These tasks are accomplished by using Altera FPGAs, which cuts complex software, general purpose CPUs, and network processors out of the loop. This guarantees wire-speed Gigabit Ethernet operations from TCP/IP Layer 4, deep into application Layer 7.

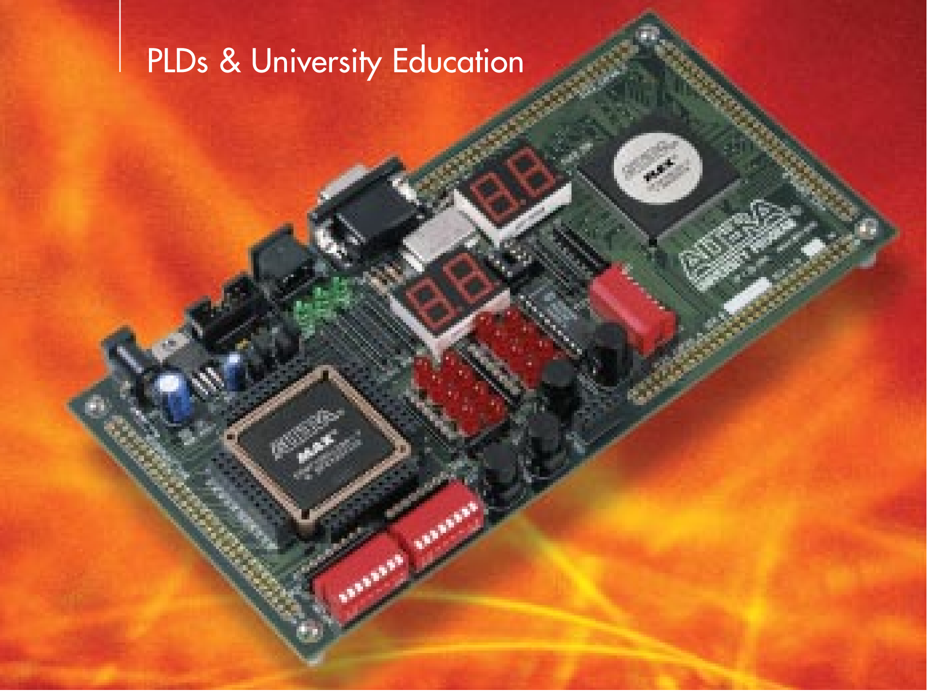
The SummitPx1 Application Switch has something else going for it: its horsepower and high-end intelligence makes it an enormously effective weapon against denial-of-service (DoS) attacks, web-borne worms, and viruses. DoS attacks, for instance, attempt to overwhelm servers, gaining control of network resources that are normally off-limits. Given the SummitPx1's connection capacity, it can simply terminate malicious sessions while continuing to make more than enough connections available to legitimate traffic. Also, since the SummitPx1 Application Switch actually inspects every packet it processes, it instantly recognizes requests for specific URLs that are part of the signature of every worm and virus. It then blocks them before they ever get close to a server or an application. Real requests, meanwhile, are shunted to their destination at wire speed.

The SummitPx1 Application Switch.

While the SummitPx1 relies on the re-programmability of Altera FPGAs to ensure compliance for evolving application protocols, Extreme has also realized that cost savings can be achieved by migrating support for more mature functions, such as transmission control protocol (TCP) and Internet protocol (IP), to a fixed, non-programmable component. To that end, Extreme and Altera worked together to develop a HardCopy™ solution, which is a non-programmable version of Extreme's Altera FPGA design. The HardCopy device exactly matches the functionality and performance of Extreme's original design, providing Extreme with a low-cost, drop-in replacement to the Altera FPGA.

Extreme's forward-looking vision for the SummitPx1 earned it the Editor's Choice award from *Communications News* as well as the Best of Show award from Networld+Interop, where it was named the best new product in the performance enhancement category. The Summit Px1 won the award due to its ability to process 1,000,000 URL pattern rules at gigabit wire speed, plus many other proven network performance improvement capabilities. With several projects underway that rely on Altera FPGAs, including Stratix™ devices, Extreme is well-poised to continue this tradition of innovation.

Stars of Innovation continued on page 32



How PLDs Revolutionized the Teaching of Digital Systems

PLDs in today's classroom are giving students invaluable hardware design experience.

It wasn't easy being an electrical engineering student if you wanted actual experience with integrated circuits back in the 1970s. University laboratory equipment consisted of small-scale integration (SSI) and medium-scale integration (MSI) chips placed on breadboards, and students plugged wires into the breadboard to build a circuit. This approach was awkward to use, error prone, and did not provide much real-world system development training. While students worked with building-block circuits, they did not gain experience with the contents of these blocks. Hardware-oriented courses are most meaningful if they involve a laboratory component that features technology used in current engineering practice.

In the late 1980s, university labs began employing small programmable logic devices (PLDs), such as PALs and PLAs, for teaching purposes. These devices did not accommodate large circuits, but they reduced the need to connect many SSI chips together with wires, and they allowed students to begin to create circuits by using simple design tools. From this stage onward, the student lab experience has become steadily more interesting and exciting, driven by the availability of new generations of PLDs and design tools.

Altera's PLDs and other products have played a key role in enabling enhancements to university curricula. As a part of its University Program, in 1997, Altera produced the UP-1 laboratory development board, featuring a FLEX 10K® EPF10K20 FPGA and a MAX® 7000 CPLD. The board contained expansion I/O ports, so that it could be used either alone or incorporated into a larger system. A version of the MAX+PLUS® II design software was made available to all students. This state-of-the-art system allowed students to perform design entry, timing analysis, and simulation at home—they could prepare the assigned designs at home and then implement and test them during laboratory sessions. Altera continued to enhance its university support with the later introduction of the UP-2 board, and today by offering a variety of useful development kits suitable for implementation of entire system-on-a-programmable-chip (SOPC) solutions. The MAX+PLUS II software is now superseded by the Quartus® II design software. With its powerful VHDL and Verilog compilers and the ability to target industry-leading CPLDs and FPGAs, the Quartus II software allows students to explore designs of almost any level of complexity. Using the Nios® soft processor and the SOPC Builder software, the students can implement complex designs in a rather short time. Altera plans to expand the Quartus II opportunities for students in many new, powerful ways in the near future.

Within today's classroom, PLDs have revolutionized the teaching of digital systems in the university environment. A typical program in computer and electrical engineering includes several courses involving intensive laboratory exercises that introduce the students to key concepts of computer hardware and software. Having learned a programming language, such as C, C++, or Java in an introductory course, it is useful to expose students to the fundamentals of hardware in a sophomore course

The Nios Development Kit, Stratix Edition featuring the EP1S25 device.

on logic circuits. This is naturally followed by courses in computer organization (architecture), operating system software, and compilers. Eventually, a design project course may be used to solidify the knowledge gained in other courses.

Using Altera's support and products, even the first course on logic circuits can be made very interesting and useful. The course must focus on the discussion of basic concepts of combinational and sequential circuits, commonly used structures such as adders, multiplexers, flip-flops, registers, and counters, as well as the notions of optimization, stability, and performance. But students should also be introduced to a modern hardware-description language (HDL), which typically means either Verilog or VHDL, as well as to a modern design system such as the Quartus II software. This makes it possible to have productive laboratory exercises, without placing unreasonable time demands on the student. Compiling HDL code allows students to learn how high-level descriptions of circuits relate to the final implementation of those circuits in a PLD. HDL code also introduces a key design concept: the statements in the code are concurrent in nature because each one represents a part of a circuit. This is in contrast to the semantics of a normal programming language, in which the statements are executed sequentially on a processor.

A follow-on course on computer organization can make excellent use of the technology learned in the previous course. Input/output subsystems, DMA controllers, and simple arithmetic and logic units provide interesting and challenging subjects for implementation in FPGA devices in the laboratory. The generic nature of PLDs allows students to easily control board-level units such as LEDs, 7-segment displays, oscillators, SRAM chips, and VGA displays. By the end of this second course, students can undertake more complex assignments, such as the design of a simple processor unit.

PLD technology provides an ideal medium for a senior course that features a large design project or a thesis project. It is possible to undertake complex projects, yet expect the students to produce a working implementation of the designed system. Prior to the emergence of PLDs and powerful design tools, such projects could be attempted only in the software domain. Since students can design and build nontrivial circuits by using design tools and PLDs, they can develop better analytic and debugging skills. Because these are critical abilities for engineers to possess, most universities rank the teaching of analysis and debugging skills as the most important part of an undergraduate engineering education.

PLDs also provide tremendous opportunities for graduate-level students. They can prototype large pieces of hardware quickly and inexpensively, embarking on projects that would not be possible without using PLDs. Graduate students often work on innovative research topics in the areas of design tools, such as algorithms for synthesis, placement, routing, and physical synthesis, and on PLD architectures. They can also work on novel applications of PLDs, such as the reconfigurable computing paradigm in which a PLD is employed as a co-processor in combination with a microprocessor. These research topics are strongly influenced by the industry directions being pursued by PLD companies and their customers.

Early exposure and continuing emphasis on PLD technology and design tools gives students an edge in entering the industrial job market. They find it easier to obtain summer jobs and their chances of landing a challenging position upon graduation are greatly enhanced. The continued support of companies like Altera will help to further strengthen electrical and computer engineering programs, producing better graduates, and ultimately leading to a more competitive and exciting global marketplace.

Congratulations on 20 years!

Congratulations to Altera Corporation for 20 years of excellence in their field. Being at the top of your game for so long is no small achievement, and everyone in the industry recognizes Altera as pioneers and innovators in the programmable logic arena. As of May, Altera has engaged with Future Electronics to act as its second distributor in North America. Chosen for its strength in demand creation in a broad array of markets, Future complements Altera's corporate strategy to widen the reach of programmable logic technology beyond traditional markets and applications. "The addition of the world's best programmable solutions to our product line gives our customers in North America access to a competitive edge that will drive future success," said Stephen Segal, Office of the CEO at Future Electronics. "We are looking forward to joining forces with the Altera team to expand the reach of programmable logic and make immediately available all the advantages and benefits of this technology."

George Papa, senior vice president of global sales at Altera, had this to say about the partnership: "Future's strength and access to both traditional and non-traditional FPGA and CPLD markets, combined with Altera's new, powerful product portfolio, is the one-two punch that will propel the design win momentum we are currently enjoying."

It is with unbridled enthusiasm that Future Electronics anticipates to contribute to the continued success and growth of Altera over the next 20 years.

FUTURE ELECTRONICS

Programmable Logic for DSP

Will Strauss is president of Forward Concepts Co. He is considered the leading authority on markets based on DSP technology.

I have been tracking the market for digital signal processing (DSP) silicon since the first useful single-chip digital signal processor hit the street in 1980. Over those years, I've tracked the trend from 3-µm NMOS to 0.13-µm CMOS, and from two-cycle multiply-accumulators (MACs) that could barely handle speech filtering to multiple MACs per cycle for video on those processors. And the market has been good, growing at a compound annual rate of 35% over the last 20 years (even including the 2001 market downturn). But, over the past several years, DSP technology has expanded beyond the traditional bounds of a "DSP chip."

First, every RISC and MPU chip on the planet has added at least a minimal MAC capability so they can get a shot at the speech, communications, and multimedia applications requiring DSP functionality. But, the majority of those RISC and MPU chips were looking to do less DSP work than a traditional DSP chip could do. At the other end of the spectrum, engineers and algorithmists discovered that they could implement a multitude of MACs on an FPGA. And with literally hundreds of MACs at their disposal, they could handle DSP tasks that are impossible on traditional DSP chips, from extreme bandwidths for satellite communications to multiple-channel spread-spectrum operations in cellular base stations.

At first, the use of the FPGA approach bordered on serendipity, since there were none specifically tailored for DSP functionality, and development tools for DSP were either primitive or non-existent. Since then, products like Altera's Nios® embedded RISC processor, partnered with traditional FPGA capability, offered a more complete platform for DSP functionality, and DSP-specific development tools also became available. Expanding further on DSP capabilities, Altera has introduced the Stratix™ FPGA family with a powerful DSP-specific foundation and sophisticated development tools, making life much easier for the algorithmists and engineers who need the utmost in signal processing capability.

Forward Concepts predicts a healthy growth in a reconfigurable logic, which will continue to expand beyond traditional FPGAs for DSP. From $255M in 2002 to an even wider selection of reconfigurable DSP logic in 2007, the selection of DSP logic will grow to the $800M level for a compound annual growth rate of 26%, a rate significantly higher than for the semiconductor market as a whole. As a significant player in the DSP market space, I congratulate Altera on its progress through the 20 years since the PLD was introduced. It's clear that Altera has built a foundation for continued growth through the next 20 and DSP technology will be a significant part of that growth.

Analyst Perspectives continued on page 34

Alcatel

Alcatel is the world's leading supplier of telecommunications infrastructure, with a portfolio that includes a full line of the products needed to build any type of communication network. Its customers include Internet service providers, telecommunications operators and carriers, as well as businesses and consumers. The global networks that Alcatel builds enable a number of information services and products, including streaming multimedia, e-commerce, virtual private networks (VPNs), video conferencing, as well as voice and data communications. Alcatel has been an Altera customer since 1992, and today, Altera products play critical roles in all of Alcatel's leadership areas, including broadband access, optical transmission, as well as networking and mobile communications.

With over 20 million asymmetric digital subscriber line (ADSL) lines shipped, Alcatel is the number one supplier in DSL technology and the market leader in high-speed Internet access. Alcatel maintains its DSL market dominance with compelling products like the 7300 Advanced Services Access Manager, which is powered by several Altera FPGAs and CPLDs, and offers the lowest cost per ADSL line. The LiteSpan Multiservice access platform, which also uses Altera FPGAs, adds another important component to Alcatel's DSL success by offering full DSL access multiplexer (DSLAM) functionality, enabling service providers to offer DSL access via remote locations rather than being limited to the central office.

The Litespan platform also provides fully integrated ATM-based ADSL and higher-performance symmetric high-bit rate DSL (G.SHDSL), making DSL provisioning more cost effective for service providers, and addressing the growing demand for DSL services. For fiber optic networks, Alcatel's 7340 Fiber to the User platform, which utilizes Altera FPGAs and embedded processor solutions, extends optical access across the "last mile" of the communications network, providing high-speed Internet connectivity to end users at over 3,000 times the speed of traditional dial-up modems.

Alcatel's leadership in optical networks is exemplified by its installation of over 30,000 new-generation synchronous digital hierarchy (SDH) systems in 2001 and ownership of 20% of the world market in long-distance dense wave-division multiplexed (DWDM) systems. Communicating at the speed of light requires data routing and handling at multi-gigabit rates, which is why Alcatel relies on Altera devices in several of its transmission products. For example, Alcatel's 1680 Optical Gateway Cross-Connect uses Altera FPGAs supporting high-speed I/O standards. Also, Alcatel's aggressive pursuit of advanced technologies to give them a competitive edge led them to early adoption of Altera's embedded processor solutions. These embedded processor solutions are being incorporated into several Alcatel products and currently serve in two of its major building blocks for metropolitan and regional networks: the 1660 SM STM-16 Multiservice Metro Node and the 1670 SM STM-16/64 Multiservice Core Node. The 1660 and 1670, which also use several Altera FPGAs, are ideal for large metropolitan rings, regional or national backbones, cross-border applications, and international gateways.

Telecommuncations operators and service providers invested heavily to meet increased demand for new products, while at the same time maintaining and growing traditional data and voice services. In the area of data networks, the growing demand is for Internet protocol (IP) traffic. To accommodate the buildout of IP infrastructure while preserving and expanding existing services, Alcatel offers the 7770 Optical Broadband Exchange platform. The 7770, which incorpo-

Alcatel's 7300 Advanced Services Access Manager offers the lowest cost per DSL line.

rates both Altera FPGAs and CPLDs, is a reliable, highly scalable platform that allows service providers to offer guaranteed amounts of bandwidth and differentiated levels of support, enabling them to manage increased traffic and broaden their product offering.

In the area of mobile communications, service providers need solutions that can manage subscriber migration from second-generation (2G) to third-generation (3G) networks and products. Alcatel's 3G Core Network enables delivery of 3G services such as text, digitized voice, video, and multimedia by supporting the Universal Mobile Telecommunications Service (UMTS) standard. Altera FPGAs and CPLDs, play a vital role in Alcatel's Evolium UMTS platform, which minimizes capital expenditures by seamlessly integrating into a carrier's existing heterogeneous network environment, while offering a strategic evolution path towards all IP-based multimedia services.

Currently, Alcatel is engaged in projects using all of Altera's major programmable logic families, including Stratix™, Stratix GX, Cyclone™, APEX™ 20K, and MAX®. Alcatel is also an Altera Megafunction Partner Program (AMPP℠) member, offering Ethernet media access controller (MAC) intellectual property optimized for use with Altera FPGAs. In Alcatel, Altera has an aggressive partner that demands excellence from its suppliers in order to lead the telecommunications field. Altera's commitment to providing Alcatel the best programmable solutions is reflected in their strong, decade-spanning relationship, which has seen both of them rise to become the foremost innovators in their industries.

Stars of Innovation continued on page 39

Dr. Handel H. Jones is the founder and CEO of IBS. Dr. Jones has over 35 years of experience in the electronics industry.

Strategic Issues in Programmable Logic

The initial programmable logic products were intended to replace standard logic and ASIC products. Programmable logic provided time-to-market advantages and lower-cost prototypes, as well as flexibility for design engineers to optimize system functionality.

The initial programmable logic capabilities also provided a significant market opportunity and, through the technology expertise of programmable logic vendors, the ability to generate high profits.

The migration to 130 nm and 90 nm technologies has resulted in major new growth opportunities for programmable logic, i.e., the application solution phase; however, the following end-market issues must be addressed:

- The need to bring new systems to the market within short time windows.
- The need to minimize time-to-revenue for new systems.
- The need to minimize time-to-profit for new systems.
- The need for low-cost development of new systems (increasingly important with the growing costs of ASIC prototypes).
- The need to embed intellectual property (IP), which includes processor engines, high-speed interfaces, and specialty memory. This is a major growth area for programmable logic.
- Access to platforms that allow for the development of software while hardware functionality is being finalized.
- The need to provide system design engineers with flexibility to modify designs as new inputs are obtained.
- The need for an easy-to-use design environment so design engineers in multiple locations can be involved. Within the programmable logic arena, tens of thousands of engineers in many geographic regions are involved in designs.

Although the requirements for system design support are extensive, the functionality enhancements and cost reductions of programmable solutions are expanding the depth and breadth of the applications that can be cost-effectively addressed.

The migration to 90 nm will result in programmable logic with 20M total available system gates. It will be possible to embed multiple processor cores (ARM®, DSP, media processors, etc.) as well as multi-gigabit interface functions and large blocks of embedded memory with a few million gates of programmable logic. These systems in silicon concepts will soon be available, resulting in a high-growth phase within the programmable logic market.

The ability to reduce cost per function increases the volume crossover level between the hardwired custom approach and the programmable logic approach. With the migration to the application solution phase of programmable logic, new architectural concepts will emerge, which can expand market growth opportunities. There will likely be increased software content in the programmable logic application solutions, which increases revenue and profit margin potential.

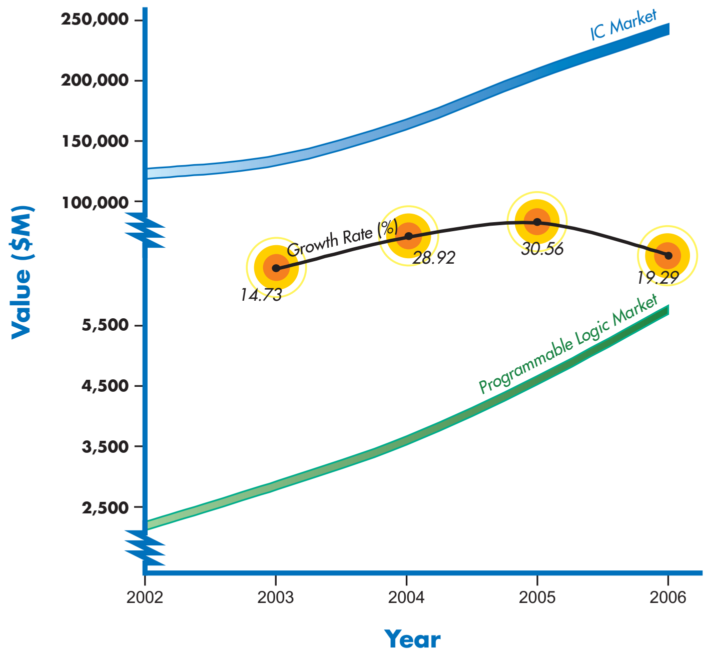


Figure 1— The Programmable Logic Market

The growth of the programmable logic market is expected to be higher than that of the IC market over the next few years. (See Figure 1). The growth of the programmable logic market is expected to be high through 2005 but will decline somewhat as the IC market begins a down cycle.

After 2006, growth is projected to be very positive for programmable logic as application solution and platform-level concepts gain momentum. Key requirements in the programmable logic market will be to build up IP portfolios and improve application expertise within strategic end-market segments. Design tool capabilities will also need to be strengthened so that a large base of engineers can take advantage of the performance functionality and cost-of-ownership benefits of programmable logic.

Altera is well-positioned to experience strong revenue growth within the programmable logic market because of its extensive IP capabilities, including the Nios® and ARM-based Excalibur™ embedded processors, DSP engines, high-speed interfaces, etc. The Quartus® II design environment is powerful, with well-established Internet access capabilities. Altera's supply partnership with TSMC should allow the company to remain at the leading edge of feature dimension capabilities.

The migration toward application solutions within the programmable logic market increases the technology base that has been established over the past 20 years but represents a major change in the competitive positioning of programmable logic in terms of system functionality. The incorporation of systems in silicon establishes new business opportunities for programmable logic, which can potentially increase longer-term growth opportunities.

Programmable logic will experience significant revenue growth opportunities from the migration to 90-nm and smaller feature dimensions, where a range of IP functionality is embedded. The use of new architectural concepts, which will involve the embedding of programmable logic functionality with key system building block functions, will dramatically expand the market growth opportunities for programmable logic.

New Generation FPGAs: ASIC Complexity on an FPGA Schedule

Simon Bloch, General Manager, Design Creation and Synthesis Division, Mentor Graphics

As FPGAs rise in prominence and popularity, it is interesting to note that FPGA designers now face many of the design-complexity issues so familiar to ASIC designers.

As designs get larger and larger, more than just gate count increases. Today's complex FPGAs—which we should think of as programmable system-on-chip devices—include system-building features such as high-speed I/O, arithmetic modules, embedded processors, and copious amounts of memory tailored for a variety of applications. Design teams working on these massive FPGA designs have to deal with some of the largest packages and highest pin-counts ever.

We're also seeing greater performance and timing challenges in FPGA designs. Today's designs operate at higher frequencies and their delays are increasingly dominated by layout effects. As well, an FPGA can have dozens of clocks with complex timing paths that cross clock domains. These challenging timing problems demand both sophisticated analysis tools and powerful optimization techniques.

The sheer complexity of these systems means that tools must raise their level of abstraction and accuracy. Abstraction leverage can be gained from techniques such as C-based design, synthesis, and verification. Accuracy requires industrial-strength timing analysis tools backed up by physical synthesis and optimization technologies.

I find that design teams are ready to adopt these new technologies and methodologies immediately, perhaps because ASIC design has already blazed the trail. Furthermore, I think this transition will proceed much faster than any of us expect.

In short, we need new tools and methodologies. Not only must these tools produce good results but also preserve the well-known attractions of FPGAs: productivity and a fast time-to-market.

At Mentor Graphics, we've created a comprehensive suite of FPGA design solutions that manage this complexity. Our vendor-independent environment facilitates concurrent, team based design in multiple technologies with cross-tool debugging, FPGA-on-PCB integration, powerful FPGA timing analysis, and physical synthesis and optimization technologies that rapidly achieve timing closure on large, high-performance circuits.

Congratulations on 20 Years of Innovation

It gives me great pleasure to extend best wishes to Altera on the occasion of the company's 20th anniversary. We've grown up together and experienced many challenges along the road from pioneering start-up to veteran industry leader.

Altera has done a stellar job of developing products capable of handling next-generation architectures. Programmable logic technology has taken only a third of the time it took ASICs to approach a complete design solution. The move to increasing FPGA design, already apparent before the downturn, has accelerated as a result of increasing cost pressures in a tight market. High-end field-programmable design starts are outstripping new ASIC and COT designs. As FPGAs have increased in complexity, programmable logic is now a key vehicle to drive state-of-the-art design and a new electronic system methodology, frequently platform-based.

As FPGA designers increasingly apply ASIC flows and design methodologies to design with these complex FPGAs, they will expect the same tool functionality that they currently have for designing complex SoCs. Complete design solutions will require tools for design capture, simulation, hardware-software co-verification, embedded software, physical synthesis, board-level signal integrity, and C-based high-level design, as well as embedded intellectual property cores. The high levels of complexity make accurate verification increasingly crucial.

At increased levels of FPGA complexity, placing large FPGA devices on a printed circuit board creates huge challenges of synchronization and integration to address connectivity and timing closure problems. With increased pin counts and clock speeds, manual integration board and FPGA processes will no longer cut the mustard. A better, automated bi-directional link is essential.

Mentor and Altera continue to work together on these issues to solve the problems of today and tomorrow. As one industry veteran to another, we both know that surviving and thriving for twenty years in a fast-changing industry is the result of innovative engineering, hard work and going the extra mile to meet customer needs.

Once again, happy birthday and congratulations to an outstanding company!

Wally.

Walden C. Rhines
Chairman and CEO
Mentor Graphics Corporation

BlueArc

BlueArc Corporation, a leader in highly scalable network attached storage (NAS) and creator of the SiliconServer architecture, provides the fastest, most reliable NAS system for sharing, managing, and protecting data in enterprise environments.

Above: BlueArc Silicon Server NAS products mounted in a rack. Right: BlueArc's Si8900 SiliconServer.

Unlike traditional NAS systems that use network operating systems and microprocessor-based architectures to handle data processing, BlueArc's SiliconServer Architecture leverages Altera programmable logic to perform the same tasks and achieve hardware-accelerated performance while retaining the flexibility of software for upgrades and maintenance. With its unique architecture, BlueArc delivers unprecedented speed, scalability and reliability and is the only NAS vendor capable of scaling toward tomorrow's 10 Gbps networks. By serving storage at the speed of silicon, BlueArc is able to provide an extremely high performance storage solution that meets both current and future customer needs, as well as a simplified storage infrastructure that lowers the total cost of ownership and achieves long-term return on investment (ROI).

BlueArc began using Altera FPGAs in 1999 while developing the first member of its SiliconServer family, the Si7500. After shipping the first SiliconServer products in July of 2001, BlueArc expanded its product line in 2002 with the Si8000 SiliconServer family, including: the Si8300 for departmental enterprise applications; the Si8700 for enterprise applications requiring scalable storage and throughput; and the Si8900, featuring a 2 Gbps Fibre Channel back-end to deliver the fastest, most scalable NAS solution to meet the challenges of sharing, managing, and protecting data in any high-growth enterprise environment.

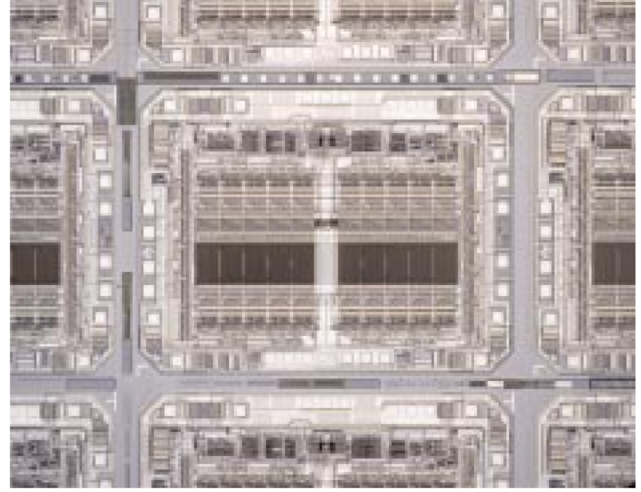
In April of 2003, BlueArc made available a multi-tiered storage (MTS) solution that delivers the right application storage at the right price point making available both Fibre Channel and ATA disks. With a full range of highly scalable, high-performance products for a broad range of storage needs, the BlueArc SiliconServer gives customers the flexibility to manage their storage resources with the optimal mix of price and performance.

Altera's FPGAs are critical to the wire-speed performance of BlueArc's products now and in the future. By moving data in hardware, BlueArc is able to backup data to multiple tiers of storage or other SiliconServers without impacting users, unlike traditional solutions that use general-purpose processors. Moreover, the reconfigurability of Altera FPGAs allows BlueArc to release new features and functionality in the field. These updates can be downloaded and installed over the network at any time, adding value to and extending the lifespan of all BlueArc products based on the SiliconServer architecture.

While BlueArc has benefited substantially from Altera's products, the reverse is also true. In 2001, Altera became a BlueArc customer after beta testing its product and realizing its great potential to benefit Altera's IT infrastructure. Altera has since purchased three SiliconServer products, enabling the company to consolidate data from several existing servers behind a single solution, which has decreased backup times and reduced storage support costs. More recently, Altera and BlueArc have entered into a strategic agreement, which promotes technology sharing between the two companies and guarantees BlueArc access to the most advanced programmable logic devices for the development of its groundbreaking products.

Stars of Innovation continued on page 42

 ...Continued from page 17



Right: Early MAX 5000 device die.
Below: Altera's first 3.3-V complex PLD.

peripheral systems. While they still serve that function in current electronic systems, they now support the most advanced communications interfaces—those requiring ultra-high-performance transceiver design and bridging functions dependent on high performance logic, digital signal processing (DSP), and memory architectures.

Unlike other semiconductor products, FPGAs enable system designers to develop custom components that exactly fit the needs of a particular application. Present-day FPGAs can serve as host platforms to complex electronics systems composed of multiple processors, dense memory cells, custom co-processors, and high-performance peripherals. These functions all take place in a single device that can be reprogrammed as necessary to support evolving product requirements.

The ASIC Alternative

In today's FPGAs, logic shares a proportion of the die area with a variety of new functions—such as transceivers, specialized memory, embedded processors, embedded DSP accelerators, and clock data recovery circuitry. These functions can be built into an FPGA just as cost-effectively and achieve the same high performance as many ASICs.

FPGAs are now an enabling technology that allows system designers to minimize the time and risk involved in developing a new product. Most importantly, FPGAs, with their in-field programmability, extend the time a product is in the market, thereby decreasing its threat of obsolescence by new generations of the same product.

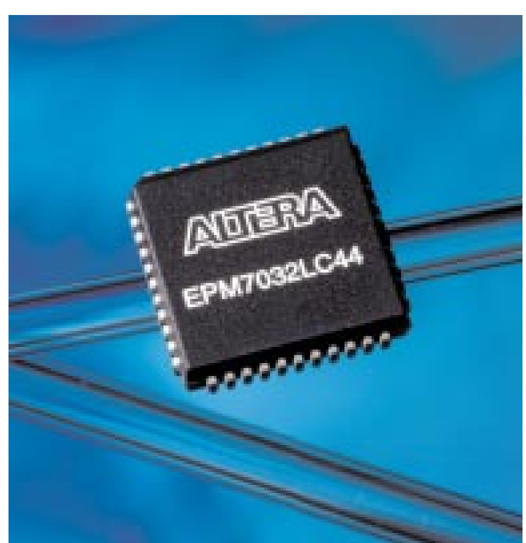
The economic and technological complexities of semiconductor manufacturing are increasingly becoming a threat to the dominant position held by ASICs and ASSPs, presenting enormous opportunities for programmable logic. The industry's shift to the 90-nm process node is only accelerating this trend as development costs skyrocket in step with the sophisticated and complex manufacturing requirements of the next generation of devices. Contrary to the increasing costs and risks of designing ASICs, FPGAs, with their growing densities and on-board system functionality, are rapidly proving to be a cost-effective, flexible, and lower-risk alternative.

The High Risks & Development Costs of ASICs

Development costs to first silicon have been rising with each new process node, with current expenses reaching $20 million. At the 90-nm node, development to first silicon can cost $30 million or more. If first silicon doesn't perform to specification—a likely possibility given today's highly complex designs incorporating hundreds of millions of transistors—development costs can rise significantly before the product goes into volume production. The impact on time-to-market and time-in-market—that period when a product's pricing, profitability, and market dominance can be maximized—could be severe in terms of lost market share and revenue.

Typical ASIC development time to first silicon takes approximately 16 to 18 months. Even a relatively small design fix to bring the device up to desired performance specifications can result in delaying its time-to-market by as much as six to nine months. Not only does each such delay erode a manufacturer's credibility in the market, it provides an opportunity for the competition to seize dominant market share for a product generation, or more, all the while reaping the benefits associated with greater time-in-market.

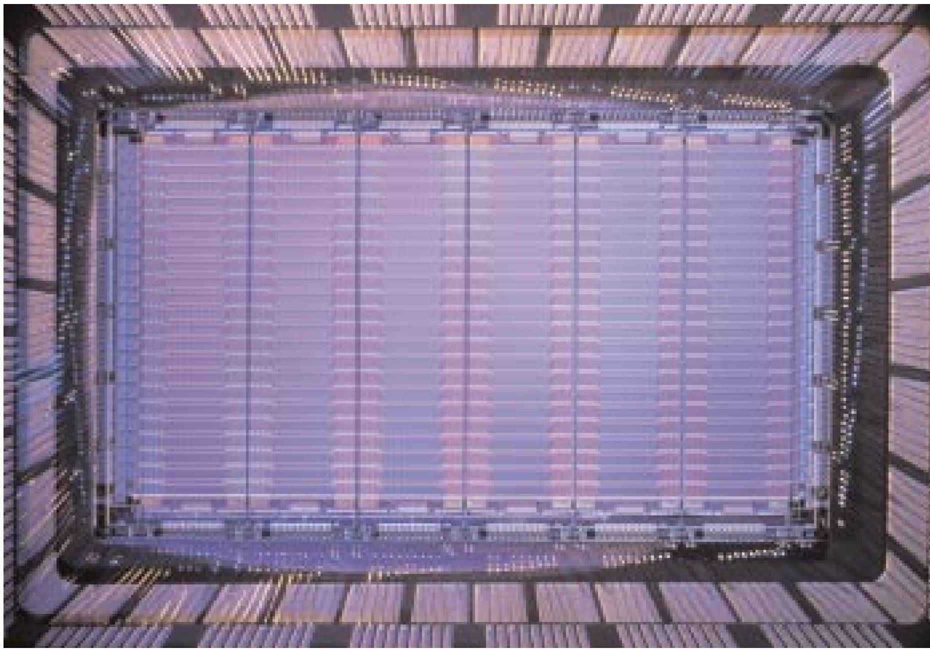
An increasing number of designers are flocking to FPGAs for volume applications because of their increased flexibility, reduced risk, better time-in- and time-to-market, and lower overall costs. Low-cost



FPGA families are within a hairsbreadth of ASIC prices and are increasingly being used for cost-sensitive, volume applications—especially for consumer electronics products such as digital video players and set-top boxes—where overall system cost and time-to-market are major considerations.

Flexibility remains one of the major advantages provided by FPGAs because of their re-programmability. Systems using programmable devices can be easily upgraded or have bugs repaired in the field. In addition, system manufacturers can use the same FPGA to differentiate system performance and cost with minimal redesign since most changes in performance functionality can be programmed and hardware redesign, a supply chain headache, becomes a thing of the past.

An FPGA solution also provides significant cost savings in terms of design and support tools. A suite of the tools required to design a new FPGA costs approximately 85 percent less than those required for new ASIC development. That can amount to a savings of nearly $400,000 in development costs.



FLEX 8000 device die—Altera's first FPGA.

The FPGA Advantage

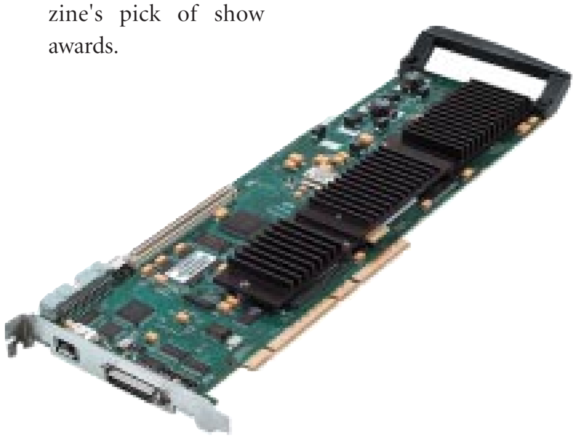
The electronics industry—whether at the system or device level—is highly competitive and unforgiving. The history of the industry is littered with the names of companies who had great products, but either failed to get them to market on time or could not build them cost-effectively enough to ensure profitability. With less venture capital funding and more small companies with great ideas, the field is quickly narrowing. While there are still high-volume, high-performance markets where ASIC unit cost and performance clearly outweigh high development costs and risks, the number of those markets is steadily shrinking, thanks to advances in FPGA technology. Lower development costs, reduced risk, better time-to- and time-in-market, superior flexibility, and the option to migrate to a high-volume hard mask-programmed solution have made FPGAs a cost-effective and highly compelling alternative.

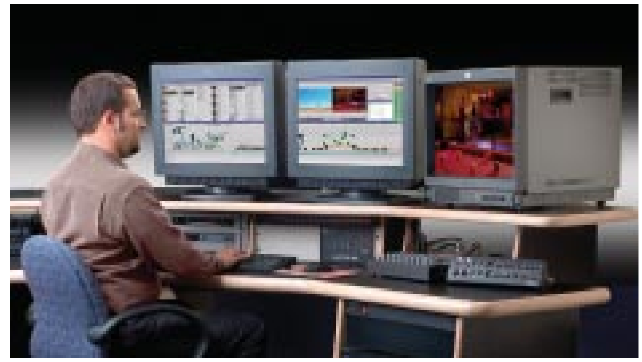
Pinnacle Systems

Pinnacle Systems is the leading supplier of video editing solutions, delivering high quality, real-time video content creation and distribution tools to customers worldwide. Pinnacle Systems provides broadcasters and consumers with cutting-edge digital media solutions for use at home, in the studio, and on the air. Recognized worldwide as an industry leader by audio and video professionals, Pinnacle Systems has received eight Emmy Awards for their technical achievements in media creation and management.

Above: Pinnacle System's Thunder XL chip and still server platform. Right: The TARGA 3000 for desktop video production. Below: TARGA 3000 board for real-time editing and compositing of uncompressed video.

Pinnacle Systems began using Altera programmable logic in 1994 and has since designed both Altera FPGAs and MAX® CPLDs into several of its leading products. In the area of image management, Pinnacle Systems' Lightning 1000 system, known in the video industry as the standard for still image storage, is powered by Altera devices. Their flagship clip and still server platform, Thunder XL, also relies on Altera FPGAs. Thunder XL was employed by NBC during its coverage of the 2002 Winter Olympics, and is the winner of both *AV Video* and *Multimedia Producer* magazine's Achievement award and *Television Broadcast* magazine's pick of show awards.





In the increasingly popular area of desktop video production, Pinnacle Systems offers the TARGA 3000 for real-time editing and compositing of uncompressed video in multiple formats. TARGA 3000, which uses both Altera FPGAs and MAX CPLDs, has received several awards, including the Platinum award from *AV Video* magazine, the editor's pick of show award from *Television Broadcast* magazine and the Pick Hit of the show award from *Broadcast Engineering* magazine.

Pinnacle Systems complements its strong portfolio of media production offerings with a full range of content-delivery solutions. The rapidly expanding field of web-based media is well served by Pinnacle Systems' StreamFactory X2™, the broadband industry's most trusted turnkey web media encoder. StreamFactory X2, which utilizes Altera APEX 20KE FPGAs, is used by RealNetworks, AT&T Digital Cable, NTT-E Japan, BBC-Tech, and Akamai, and has received *PC Magazine's* Editor's Choice Award.

Design for Success with Mega-gate FPGAs

Penny Herscher, Executive Vice President and Chief Marketing Officer,
Cadence Design Systems, Inc.

Electronics companies are relying more heavily on FPGAs in such industries as networking, wireless, and high-end consumer electronics. And for good reason: FPGAs are capable of handling multi-gigabit data rates, embedded intellectual property (IP), microprocessors, and memories. In fact, mega-gate FPGAs now have more in common with traditional SoC design than with traditional FPGA design. That's why volume production with mega-gate FPGAs demands many of the tools and methodologies commonly associated with traditional SoC design.

Cadence has a world of experience in completing SoC designs successfully—both through our Design Foundry and as a result of collaborating with our market-leading customers. Using transaction-level modeling, engineering teams can rapidly integrate verification IP and design IP to wring out bugs before committing to a lengthy RTL coding cycle. With confidence in their functional design, engineering teams can apply assertions at the RTL level to ensure design intent is maintained throughout implementation. This critical groundwork provides the ideal verification environment for replaying and resolving bugs discovered running the FPGA at speed, in circuit.

To maintain speed and efficiency, board design must overlay the verification process. Printed circuit board (PCB) designers need an integrated high-speed design flow that allows high-level board design—ideally one that enables design and analysis of the entire system interconnect, from silicon to package to board. Additionally, IC manufacturers need to transfer their electrical design intent in a more intelligent way so systems designers can spend more time designing their products and less time figuring out how to plug the device into their PCB.

The deep experience Cadence has in methodology and technology offers the best path to a first-time working design. With Cadence as a partner, customers can achieve their FPGA quality and performance goals quickly and reliably.

Here's to Another 20 Outstanding Years!

Arrow Electronics, Inc. would like to extend congratulations to Altera for 20 exceptional years of business. Arrow and Altera have been long-time partners, and through the dedicated efforts of people from both companies, we have watched our business grow steadily. Our mutual success has been the result of our perfect fit together—a unique relationship within the industry.

Together, Altera and Arrow have experienced tremendous growth over the years. One key reason is that both organizations have demonstrated an unwavering commitment to getting products to market faster for customers. The flexibility provided by Altera's programmable logic devices provides customers with the building blocks needed to get from concept to production in as little time as possible. Over time, customers have migrated from simply consolidating logic functions onto a single chip to embedding large blocks of pre-defined intellectual property. Altera's flexible approach is a perfect match for the diverse needs of Arrow's broad customer base.

Recognizing that a comprehensive technical skill set is vital, Altera has taken a leadership role in enhancing the technical competency of Arrow's field application engineers (FAEs). Toward that end, the company contributed to the development of technical training modules for customers trained by Arrow's FAEs.

This kind of cooperation has led customers to say that, together, Altera and Arrow deliver the industry's best logistics support. Seamless support for our customers' demanding supply chain requirements does not happen by accident. Our partnership has allowed us to leverage the unique competencies of both companies and provide optimal solutions to our customers' needs. "Our long-term relationship with Altera has been the result of a business model that really works," said Skip Streber, Senior Vice President of the Semiconductor Supplier Services Group of Arrow's North American Components Division. "Together, both companies have succeeded in focusing and delivering on a common set of goals."

There are many reasons behind our successful relationship—but none greater than Altera's ability to see the true value of partnership. It's this kind of commitment to partnership that shines through in every business decision.

Thank you, Altera, and congratulations.

ARROW ELECTRONICS, INC.

Get a leader on board.

When you need a leader to run your board, MAX® devices step up to the challenge. In applications from complex control logic to high-speed decoders and memory interfaces, MAX devices allow systems to operate at peak performance.

Now Supported by QUARTUS® II

Visit www.altera.com/board to jump on board with the leader.

20 YEARS *of* ALTERA® INNOVATION

www.altera.com/board

To our friends at Altera and the Altera user community:

On behalf of Synplicity, I wish to commend Altera for its pioneering work in FPGA technology and continued technological leadership in the field. Your commitment to delivering the complexity, features, time-to-market, and performance required by advanced system developers has led to the emergence of programmable logic as a leading IC implementation choice.

Indeed, FPGAs are selected today as the solution for a growing number of applications that formerly would have been realized in ASIC technology. This can largely be attributed to declining FPGA prices and increasing complexity and features that bring FPGA costs and capabilities on par with their ASIC counterparts. This, combined with FPGAs' inherently low development time, low risk, and field-programmability, make programmable devices increasingly attractive for today's system developers.

Going forward, programmable technology has the potential to command even more ASIC market share, not only because of an increasing convergence with ASIC capabilities, but also due to its unique software-like design, debug, and support advantages. With the increasing complexity and decreasing market windows of today's advanced systems, rapid and flexible development cycles become increasingly important. Like software, FPGA development provides a quick and easy means to experiment and evaluate design approaches, making it possible to rapidly and cheaply iterate and tune a design, as well as reach timing and functional closure. Further, field programmability, like software code, enables after-the-fact design modification, an increasingly vital capability with today's rapidly evolving standards and changing user needs.

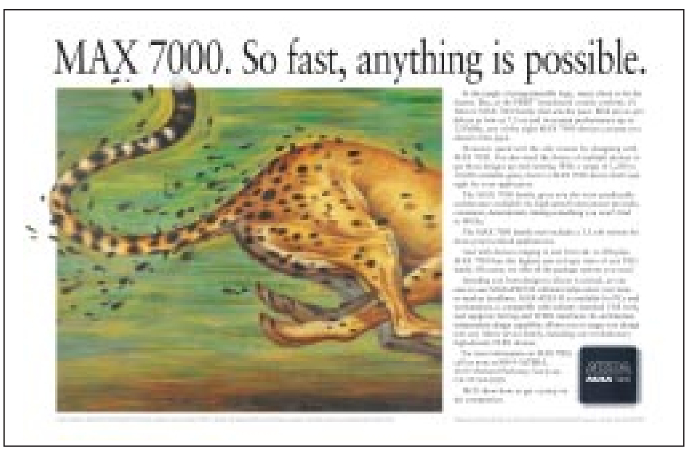
To meet the challenges facing the FPGA market in coming years, it is more critical than ever that suppliers and design tool developers work very closely together. With tools and architectures closely aligned, even from the point of architectural development, we can further close the ASIC density and speed gap and extract more value from the field-programmability of FPGAs. Synplicity looks forward to continuing our long, close relationship with Altera for the success of our mutual and future customers.

Ken McElvain
Founder & CEO
Synplicity Corporation

Synplicity®

1985

1992



1993

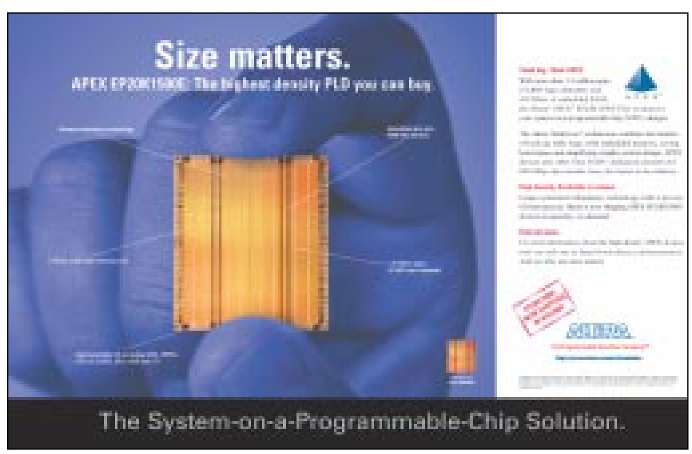
1996

1996

1996

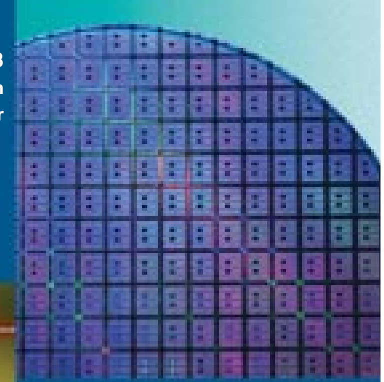
1998

1999

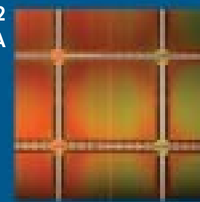


2000

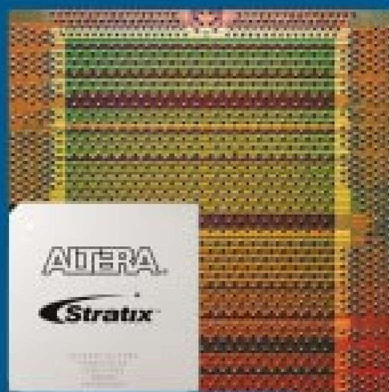
2003
0.13-micron 300-mm
Stratix™ FPGA wafer



2002
Cyclone™ wafer:World's lowest-cost FPGA

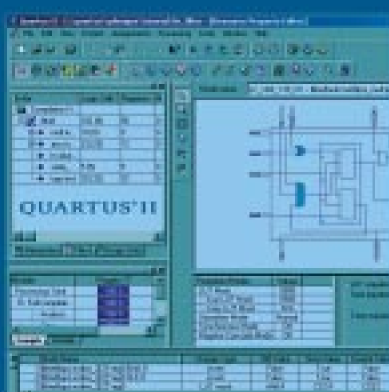


2002
Stratix device & die:
World's first FPGA with
embedded DSP blocks

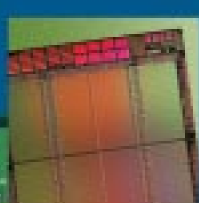


2001
Mercury™ device: World's first FPGA
with embedded transceivers

2001
Quartus® II design software



2000
Development board for Nios® processor:
World's first soft-core processor optimized
for programmable logic



2000
ARM®-based Excalibur™ device
die: World's first FPGA withembedded processor

1999
Ad for Altera® intellectual property
(IP) MegaStore® website

1999
Ad for APEX™ EP20K1500E
device: Industry's first PLD with
more than 1.5 million gates