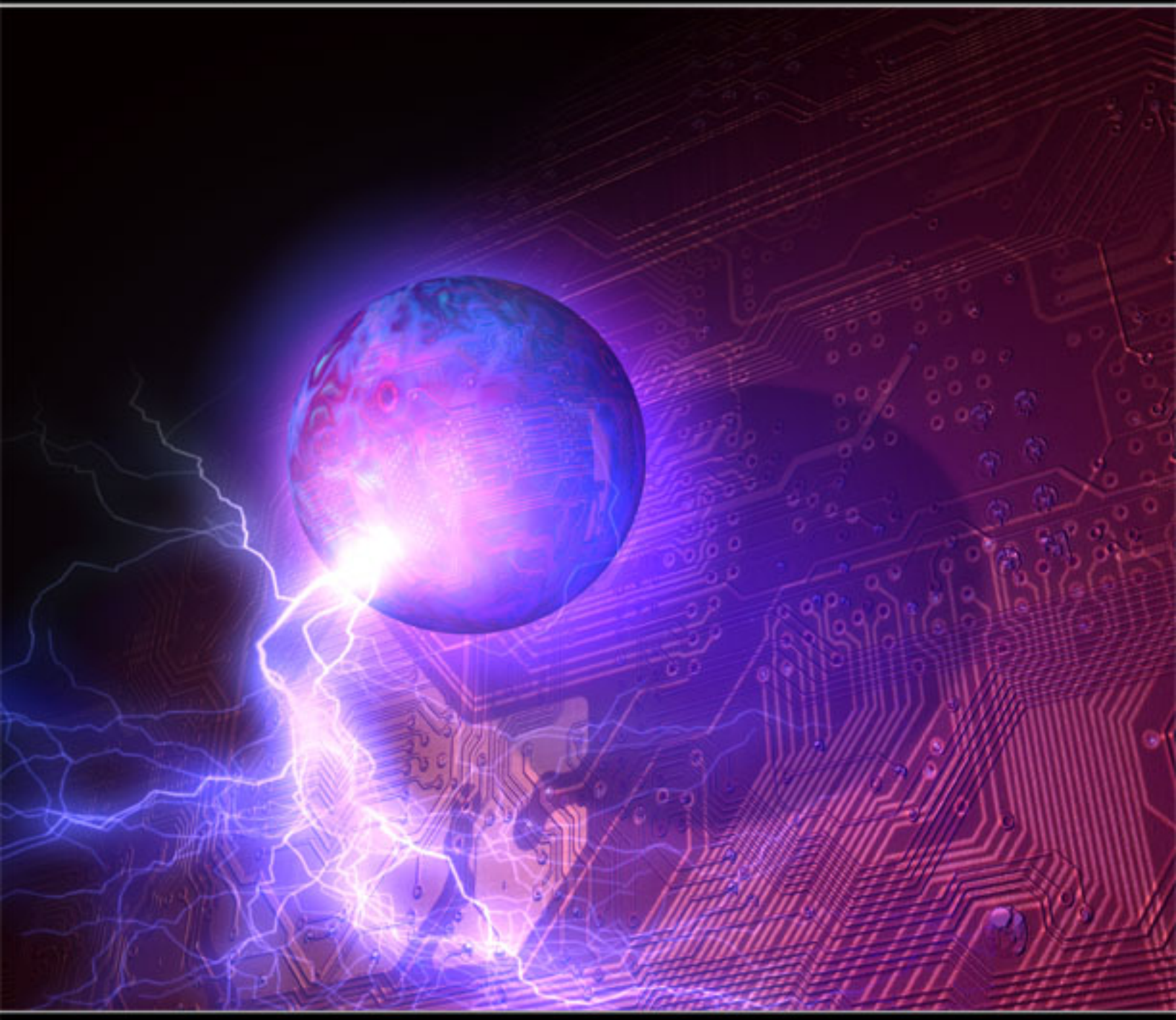
INSIDERS' GUIDE:

FPGAs, Tools, and Boards



Prepared by:
eg3.com
Jason McDonald, Senior Editor

eg3.com
tel : 510.713.2150
email : info@eg3.com
web : http//www.eg3.com

FPGAs, Tools, and Boards:
Contents – October 1, 2007

Contents

FPGAs, or "Field Programmable Gate Arrays" show enormous promise for embedded systems - from ASIC prototyping to medical to military to telecommunications. FPGAs are exciting and powerful! But they have their downside as well. This Insiders' Guide outlines the FPGA ecosystem, provides an in-depth survey analysis, offers vendor interviews, and details the FPGA vendor community.

Executive Summary

FPGAs, or "Field Programmable Gate Arrays," show enormous promise for embedded systems - from ASIC prototyping to medical to military to telecommunications applications. A savvy engineer might consider FPGAs because of their processing power, their flexilibity and reprogrammability, their ability to combine and implement "intellectual property" (IP), or a litany of many reasons. FPGAs are exciting and powerful! But they have their downside as well: they are notoriously difficult to program, have a relatively steep learning curve, and the "ecosystem" of providers, tools companies, media outlets, IP, and services around FPGAs is weakly developed.

This *Insider's Guide* is here to help. First, it outlines the key issues in using FPGAs, identifying the top Internet resources and categorizing FPGA vendors by product offering. Second, a survey of FPGA "experts" and evaluators provides insights into what real engineers are doing (or trying to do) with FPGAs, alongside interviews with vendors of FPGA hardware, software, and/or services. Finally, appendices identify the most important Internet resources and classify companies by product offering.

FPGAs, Boards, and Tools: The FPGA Ecosystem

The FPGA Ecosystem

If the Internet were a city - a city of FPGA technology - what sites would you want to see? How would you know the lay of the land? What sites are the "most important?" What issues, tensions, and competitions organize the "FPGA ecosystem?" .

- Internet Tour & Overview: Why FPGAs?
- FPGA Learning Sites on the Internet
- The FPGA Ecosystem
- FPGA Vendors
- FPGA Tools
- FPGA Intellectual Property ("IP")
- FPGA Boards

EG3.COM INSIDERS' GUIDE: PHILOSOPHY

Who are the "insiders" in FPGA? Who really knows the technology in and out? If FPGAs were a city - who would be the best "guides?" Despite what the journalists at *EE Times*, *FPGA Journal*, or *Embedded Systems Design* might say, the smartest people on FPGAs are the people who are *already* working with FPGAs. Or perhaps the vendors of FPGA hardware, tools, IP, or services. With all due respect to our fellow journalists, the real FPGA experts are not media reporters! As Woody Allen said, "Those who can't do, teach. Those who can't teach, teach gym." (h t t p : // w w w .humorsphere.com/movie_quotes/woody-allen.htm, 17 July 2007). Those who understand FPGAs, do FPGAs. Those of us who don't, consolidate information and write guides.

- Our goal, therefore, is not to write the *definitive* guide to FPGAs but rather to help you (the engineer, FPGA designer, or programmer) to understand the high level issues surrounding FPGAs and to identify the best jumping off places in the FPGA community for you to obtain useful information.

As for FPGA "insiders," there are two basic expert groups:

- **Insider Group #1**: the *engineer users* of FPGAs, i.e. your peers. Those who have gone before you and already used an FPGA in their design, a design tool, or a board. Included are also those currently considering FPGAs, i.e. at the first steps in their design cycles wrestlings with many of the issues common to FPGA newcomers. We shall call the first group "experts" and the second group, "newbies."
- **Insider Group #2**: the *vendors* of FPGA technologies. Companies like **Xilinx, Altera, Lattice;** software vendors like **Celoxica, Altium**, or **Mentor Graphics;** board makers like **National Instruments, Bittware, Dini Group,** or **Pentek.**

We use surveys to tap the knowledge of the first group, and interviews to tap the knowledge of the second. In addition, we provide a brief introductory sketch of the FPGA ecosystem with lots of links to more information and cool sites on the Web. We hope you find this guide a useful "starting point" on your personal FPGA educational journey. Comments? Questions? Please contact us at info@eg3.com or Tel. 510-713-2150.

WHO THIS GUIDE IS FOR

This guide is first and foremost a guide for electronic design engineers considering FPGAs, FPGA tools, Intellectual Property ("IP"), and/or boards. It is for designers at the early phase of a design when they must try to understand all the hardware, software, and services available in the "FPGA ecosystem" and attempt to research the "best" choice of possible outside vendors. It is therefore for:

- **Engineers** - anyone involved in FPGA design, tools, IP, or boards.
- **Managers** - managers or engineering team managers whose design(s) involve FPGA technology

We are sure that the FPGA vendor community will rush to download the guide, especially the survey, and use it to bolster (or challenge) their preconceived notions of how the FPGA ecosystem operates. They may find it interesting, but ultimately the guide is for practical engineers who want a single-stop to getting started with FPGAs.

Internet Tour & Overview: Why FPGAs?

If the Internet were a city - a city of FPGA technology - what sites would you want to see? How would you know the lay of the land? What sites are the "most important?" What issues, tensions, and competitions organize the "FPGA ecosystem?" Engineers are fond of **Google**, and rightly so, but a simple **Google** search for *FPGA* (h t t p : // w w w .google.com/search?hl=en&q=FPGA) returns over 11,000,000 results. The #3 result is an outdated site at the University of Idaho, and the #4 result is *fpga4fun.com*, a useful but basic hobbyist site (14 July 2007).

If you were in Rome, or at the Prado museum in Madrid, Spain, you might hire a guide. Find a resident who could quickly show you the highlights to which you could backtrack at the end of your tour for more detailed viewing. Here, then, are the highlights of the FPGA ecosystem.

Why FPGAs?

Before we even begin our tour of the FPGA ecosystem, however, we should stop for a moment and clarify **why** many engineers are considering FPGAs today for their embedded designs. Why are you considering FPGAs? What factors in your design are encouraging you to take the leap to FPGA technologies?

Heretofore, most embedded designs were based on standard microcontrollers or microprocessors, some as simple as 8-bit architectures like the 8051 or others like 32-bit ARMs. Why then migrate to an FPGA? From the high end down, many high volume designs are based on ASICs. Why would an ASIC designer migrate "down" to an FPGA?

- What advantages do FPGAs bring to either the embedded group or the ASIC group?

At the highest level, FPGAs can bring these important factors to bear:

- **Programming power.** Compared with standard microprocessors, FPGAs provide much greater raw processing power, especially because they give the designer the choice to run applications in hardware vs. software.
- **Reprogrammability / Reconfigurability.** Compared with ASICs and with standard microprocessors, FPGAs can be reprogrammed or reconfigured. Because of the growing market in "intellectual property" (IP), FPGAs are a good choice for purchasing and configuring intellectual property to create highly customized and efficient designs.
- **Intellectual Property (re)Use.** Few designs are completed by just one person these days, especially in more complex applications. Buying or obtaining third party IP is increasingly important, and FPGAs allow you to mix and match third party IP to create a solution customized for your application but drawing on the knowledge of the design community.
- **Low Cost vs. ASICs**. ASIC designs are very expensive (especially the up-front *Non-recurring Engineering Costs (NRE))*, and FPGAs allow ASIC designers to prototype quickly and efficiently, and in more and more cases to avoid doing an ASIC altogether (deploying in an FPGA instead).

Altera (h t t p : // w w w .altera.com/), the number two FPGA vendor by market share, outlines the advantages of FPGAs in this fashion:

- **Increase productivity—**Whether you are a hardware designer or software developer, [Altera] ha[s] tools to provide you with unprecedented time and cost savings.
- **Protect your software investment from processor obsolescence—**Altera's embedded solutions protect the most expensive and time consuming part of your embedded design—the software.
- **Scale system performance—**Increase your performance at any phase of the design cycle by adding processors, custom instructions, hardware accelerators, and leverage the inherent parallelism of FPGAs.
- **Reduce cost—**Reduce your system costs through system-level integration, design productivity, and a migration path to high-volume structured ASICs.
- **Establish a competitive advantage with flexible hardware—**Choose the exact processor and peripherals for your application. Deploy your products quickly and feature-fill over time to accelerate your time-to-market and establish a competitive advantage.

(h t t p : // w w w .altera.com/technology/embedded/fpgas/emb-why-use.html, 14 June 1007).

Competitor **Xilinx** has a nice summary of the "target markets" that are ideal for FPGA designs:

- Aerospace / Defense
- Automotive
- Broadcast
- Consumer
- Data Processing and Storage
- Industrial / Scientific / Medical
- Wired Communications
- Wireless Communications

(h t t p : // w w w .xilinx.com/esp/, 14 June 2007).

Our survey (see below) confirms that these are the common verticals for FPGAs. FPGAs are also used more and more in signal processing (DSP) applications, low power consumer devices, and even parallel processing applications in network computing or “server farms.”

Indeed, the FPGA vendor community has its sites set on ASICs and low power consumer applications - areas that were not once FPGA strongholds. **Actel**, for example, argues that FPGAs are now ready for *low power* applications:

> The Actel IGLOO family of reprogrammable, full-featured Flash FPGAs is designed to meet the demanding power and area requirements of today's portable electronics. Based on the Actel nonvolatile Flash technology and single-chip ProASIC3 FPGA architecture, the 1.2 V / 1.5 V operating voltage family offers the industry's lowest power consumption—as low as 5 µW. The IGLOO family supports up to 3 million system gates with up to 504 kbits of true dual-port SRAM, up to 6 embedded PLLs, and up to 616 user I/Os. (h t t p : // w w w .actel.com/products/igloo/, 24 August 2007).

In conclusion, FPGAs should interest you if -

- Your application requires a lot of **processing power** (as in military or medical imaging);
- You might be considering an **ASIC**, but want to prototype or perhaps even deploy the first generation in an FPGA to avoid the high costs and high risks of ASICs.
- Your application benefits from the **flexibility** and reprogrammability of FPGAs.
- You are interested in obtaining and implementing third party **"Intellectual Property" (IP)** in a non-ASIC design.

FPGA Learning Sites on the Internet

In the age of the Internet, the good news is that one can quickly surf from site to site to gain education on a topic (whether it be *FPGAs* or *Lung Cancer*). That said, it is often difficult to identify the best or top sites for a given topic. Between **eg3.com**'s mission as the leading indexing service on the Internet and our FPGA survey, we can identify these as the best sites to begin learning about FPGAs.

FPGA Portals and Websites

Beyond the vendors themselves, there are a few "must see" sites on the Internet for learning about FPGA design. The top sites are:

1. **Techonline** (h t t p : // w w w .techonline.com/) - numerous webinars on FPGAs, VHDL, Verilog and other technical topics. If you enter "FPGA" in the top search bar, and check the box for "webinar" you get a nice listing of all available webinars on the topic. Here is the exact URL - h t t p : // w w w .techonline.com/TechSearch/Search.jhtml?c7=NetSeminars&queryText=FPGA&site_id=TechOnline&Site+ID=TechOnline&sortSpec=score+desc&Search.x=6&Search.y=14.
2. **DSP-FPGA.com** (h t t p : // w w w .dsp-fpga.com/) - online magazine from **Open Systems Publishing**, focusing most on FPGA boards and DSP issues.
3. **FPGA Developer** (h t t p : // w w w .chipdesignmag.com/fpgadeveloper/) - the latest FPGA and Structured ASIC news, opinions from industry experts, and timely technology articles.
4. **FPGA Journal** (h t t p : // w w w .fpgajournal.com/) - in-depth original articles, the latest industry news, and rich technical resources for programmable logic designers, as

well as new product, promotion and event announcements from industry-leading companies

5. **Programmable Logic DesignLine** (h t t p : // w w w .pldesignline.com/)- This site provides the practical how-to information needed to program, develop, and implement field programmable gate arrays (FPGAs) and programmable logic devices (PLDs) in wireless, networking, industrial, automotive, and other design applications
6. **FPGA World** (h t t p : // w w w .fpgaworld.com/) - portal and conference on FPGAs.

eg3.com, of course, tracks **all** FPGA-related sites including portals, media, news releases and new product announcements, white papers, seminars/webinars, etc. at h t t p : // w w w .eg3.com/fpga.htm. You can also sign up for e-clips, our news alert service, at that link and be alerted when we find news and/or new items each week.

As for real-world trade shows and print publications, as well as more general sites, check out Appendix A for a complete list.

Basic Overviews

What if you are very (very) new to FPGAs? Fortunately, there are a few very basic overviews to FPGAs on the Internet. At the most basic, visit Wikipedia's FPGA entry at http://en.wikipedia.org/wiki/FPGA. While simplistic, this site overviews FPGAs with a brief history, applications, main vendors, and other discussion. If you are new to FPGAs it is a useful primer; if you are already experienced, it is not worth a visit. A popular tutorial is at h t t p : // w w w .tutorial-reports.com/computer-science/fpga/ with useful sections on:

FPGA Overview
Logic Block
FPGA Routing Techniques
FPGA Structural Classification
Programming Methodology
FPGA Design Flow

Vendor Education Sites: Hidden Gems

Google and the free sites of the Internet are great. However, for those in business environments that are truly serious about deploying FPGAs, vendor sites actually have some of the best educational materials on the Internet. Our survey results confirm this as Xilinx is the number one FPGA information site on the Internet, and Altera is the number four. So don't miss the **Xilinx** and **Altera** websites, followed closely by **Actel**. The caveat is that the FPGA vendors are (of course) trying to convince you to use their own FPGA technologies, so their "learning sites" are often biased in their favor. That said, these vendors offer excellent **webinars**, **white papers**, **online tutorials**, and **demos** - most of which are free of charge, and all of which are good introductions to FPGAs and FPGA technology. In addition, each company partners with third party training companies or distributors to offer real-world seminars and training courses on FPGAs. These are excellent, inexpensive ways to learn about FPGAs.

Xilinx

Start with **Xilinx** at h t t p : // w w w .xilinx.com/support/education-home.htm. Here you will find training courses, training providers, curriculum providers, "quickstart packages," events, webcasts, and real-world events. For example, you can click on the link for "curriculum path" --> "embedded" and end up at the course, "Fundamentals of FPGA Design" (h t t p : // w w w .xilinx.com/support/training/abstracts/fundamentals.htm). Clicking on the registration

link for your region will bring you to an "authorized training center" such as **Technically Speaking** (h t t p : // w w w .technically-speaking.com/).

Altera

Altera's "technology center" is at h t t p : // w w w .altera.com/technology/tc-index.html. Here you will find overviews to *Digital Signal Processing*, *Embedded Processors*, *Parallel I/O*, *System Integration*, *Memory*, *High-speed Serial I/O*, and *Signal Integrity*. **Altera**'s education and events section at h t t p : // w w w .altera.com/education/edu-index.html has links to training courses, webinars, events, university programs, and product demos. As with competitor **Xilinx** courses range from the broad "Introduction to FPGAs" to "Introduction to VHDL" to very specific courses on technology issues and product-specific questions. Delivery choices range from **Altera**-based instructors, to online presentations, to interactive webinars. If you become an **Altera** customer, there are forum sites such as h t t p : // w w w .alteraforum.com/ where you can exchange ideas and questions with other users and **Altera** staff.

Actel

Actel also has online learning at h t t p : // w w w .actel.com/support/training/descriptions.aspx. Courses topics include VHDL, introduction to (Actel) FPGAs, designing for low power, introduction to PCI, and general overviews to **Actel** design tools.

The bottom line is that many - if not all - of the various companies in the FPGA ecosystem often have white papers, demos, free tools, or webinars - so keep your eye out for them. Many of the bigger players have real-world seminars and educational events - so check their "events calendar" or "seminars" sections for those. Most are free or conducted at a very nominal charge, and they offer a great opportunity to learn about FPGA technology from real "Insiders."

Distributors: Another Hidden Gem

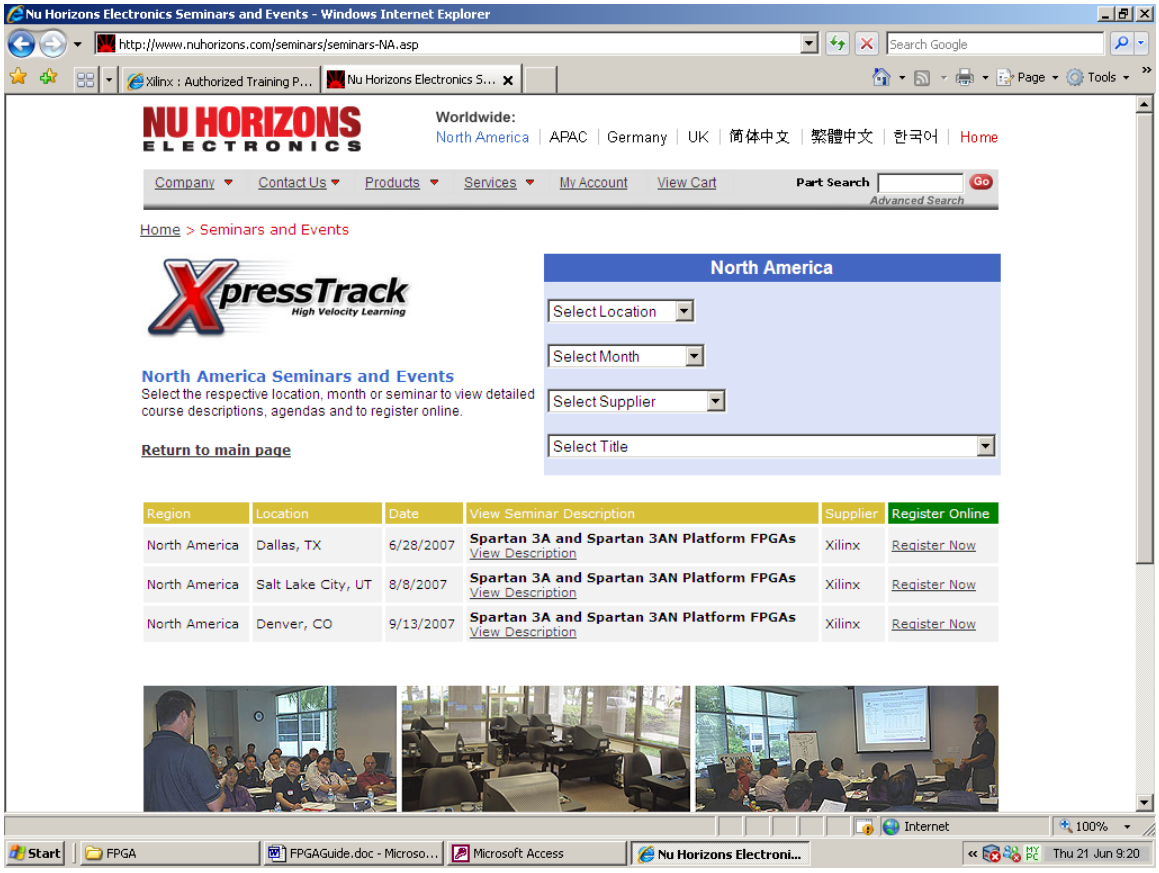
The large FPGA vendors provide much of their product through distributors, and they work with these distributors to educate the community on FPGA technology. Therefore, another excellent source of education on FPGA is the distributor sites such as **Avnet** (h t t p : // w w w .avnet.com/) , **Arrow Electronics** (h t t p : // w w w .arrownac.com/), or **Nu Horizons** (h t t p : // w w w .nuhorizons.com/). Watch each for both online and real-world evaluation boards and webinars/seminars - all great opportunities to learn about FPGAs.

In summer, 2007, for example, **Avnet** and **Xilinx** kicked off *X-Fest* - a series of free technical seminars offering practical, how-to training for FPGA, DSP, and embedded systems designers:

> The series kicks off its 90-city global tour in Beijing April 3, 2007 and continues through July 13 in locations throughout Europe, Asia, Japan and North America. The one-day seminars will offer several 90-minute training courses for attendees to choose from, designed to provide specialized training on design solutions for FPGA circuitry and the components surrounding FPGAs. At many locations attendees will have access to partner demonstration exhibits (varying by region), which offer a unique opportunity to explore some of the latest design solutions.
>
> (h t t p : // w w w .em.avnet.com/evs/home/0,1707,RID%253D%2526CID%253D35679%2526CCD%253DUSA%2526SID%253D32214%2526DID%253DDF2%2526LID%253D32233%2526PRT%

253D0%2526EFL%253D%2526PVW%253D%2526ASM%253Dl%2526BID%253DDF2%2526CTP%253DEVS,00.html 21 June 2007)

Nu Horizons also conducted a series of **Xilinx** seminars called *XpresssTrack*, many of which focus on FPGA technologies. Information about this and future seminars is at h t t p : // w w w .nuhorizons.com/seminars/seminars.asp.



The bottom line is that in addition to **Xilinx**, **Altera**, and **Actel**, the major distributors are also a good sense of education and learning about FPGAs. Check them out and watch out for their frequent real-world seminars or online webinars.

FPGA Tool Vendors: A Third Source of FPGA Education

A few of the major FPGA tool vendors also have "learning" or "educational" sites. First and foremost, **Mentor Graphics** has a wealth of white papers, webinars, and real-world seminars on their FPGA design flow. Check it out at h t t p : // w w w .mentor.com/products/fpga_pld/index.cfm. As of this writing, they were promoting a seminar series entitled, "7 Habits of Successful FPGA Design" at various locations worldwide:

This workshop will teach you 7 habits that will make it possible for you to design FPGAs to meet all of your FPGA design goals while using Mentor Graphics' Precision® Synthesis. Precision is optimized for all complex FPGA architectures and utilizes sophisticated RTL and physical optimization algorithms to minimize the number of design spins needed to obtain your final complete design.

(h t t p : // w w w .mentor.com/products/fpga_pld/events/seven_habits_workshop.cfm?int=1&id=32425&listid=0830 21 June 2007).

Check the vendors in the Appendices on the Web, and keep your eye out for learning opportunities. Ask or look for:

- Demos / evaluation boards and/or free FPGA tools
- Webinars or other "online tutorials"
- Real-world Seminars (often with "free" lunch), as opportunities to learn about FPGA technology
- White papers

Unfortunately, many hi-tech websites are poorly organized or overwhelming in their complexity - but if you know that demo software, inexpensive evaluation kits, or webinars/ seminars exist - you know to ask for (and/or look for) them. Start looking!

THE FPGA ECOSYSTEM

Once you have decided to consider FPGAs, you have a few basic alternatives. These might be considered the "sections" of the FPGA city. These are:

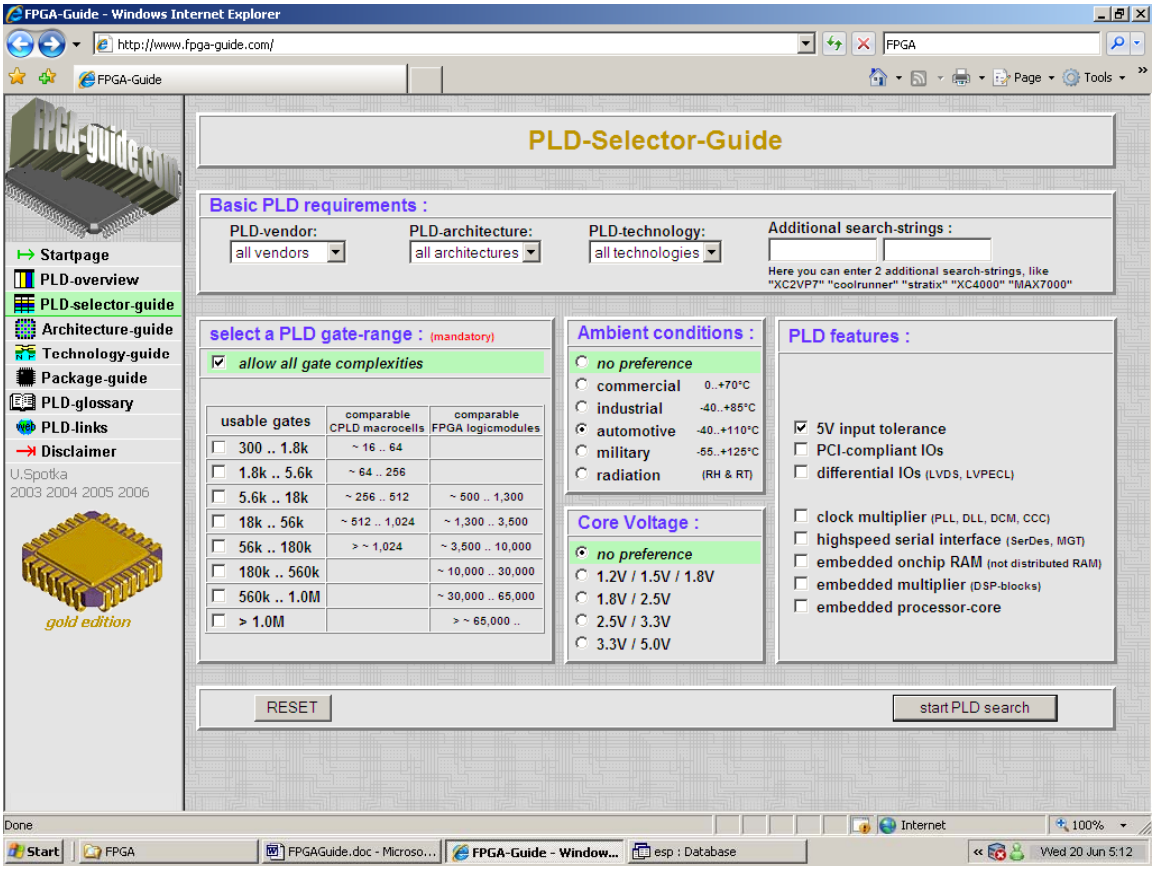
1. **The FPGA vendors - Altera, Xilinx**, and the like. These are the producers of FPGAs each with a competing offering and a competing ecosystem of tools and boards to encourage you to "design in" their FPGA.
2. **FPGA tool vendors** - vendors like **Mentor Graphics**, **Synplicity**, **Celoxica**, or **Altium** who provide FPGA and FPGA/PCB tools to help you design FPGAs and FPGA boards. These tools are somewhat competitive with the "free" tools of the FPGA vendors and somewhat complementary to those tool flows.
3. **FPGA IP ("Intellectual Property")** - companies like **CAST** or **PLDA** that specialize in selling IP as well as "free" IP from the FPGA makers or tool producers like **Mentor Graphics** or **Synopsys.**
4. **FPGA Board Vendors** - these participants range from **Acromag** to **Pentek** to **National Instruments**, these are vendors who have already "designed in" an FPGA / or FPGAs into a board and thus have done much of the hard FPGA design work and FPGA / PCB design integration for you. A very special subset is those that concentrate on DSP, and they run from FPGA prototyping boards (for ASIC development) to deployable FPGA boards to all-in-one platforms like **National Instruments'** *CompactRIO*.

Is there a "best" FPGA vendor? Of course there is. Despite the desires of each vendor to be identified as the "best" or "leading," however, the reality is that the choice that is best for one design is not necessarily the choice that is best for another.

- **Take away.** The "best" FPGA vendor will vary based on your own business and technical design needs.

The point of this *Insiders' Guide*, therefore, is not to solve your design challenges nor to identify the "best" FPGA, tool, or board for your design. The point of this guide is to identify the "must see" stops on the Internet, FPGA vendors, tools vendors, or board suppliers. Turning first to FPGA vendors, a "must see" destination is *EDN* magazines 2004 "Programmable Logic Directory" at h t t p : // w w w .edn.com/index.asp?layout=article&articleid=CA421504. Sadly, this useful directory has not been updated since. But it does provide a useful starting point to all the FPGA vendors and product information.

A second useful - if somewhat outdated - guide to FPGAs can be found at h t t p : // w w w .fpga-guide.com/. This guide offers a vendor-independent PLD search engine to find the best fitting FPGA or CPLD device for your requirements. The devices are preselected by gate-complexity and year of introduction. It has a useful selector for identifying potential FPGA/PLD choices, but there is no guarantee of its accuracy.



Finally, the easiest way is to simply surf to each FPGA vendor one-by-one and browse their website looking for technical information and product specifications. Here are the major FPGA vendors (in alphabetical order) with descriptions and keywords taken from their websites:

- **Actel Corporation** (h t t p : // w w w .actel.com/) - As the leader in single-chip FPGAs, Actel Corporation offers Flash- and antifuse-based solutions that are live at power-up, low power, and highly secure. Actel also provides IP cores, including CoreMP7, its soft ARM7 core; design suites; programming tools; and design services. [Cores: 8051, ARM, CORTEX-M1, SPARC]
- **Altera** (h t t p : // w w w .altera.com/) - Altera is the world's pioneer in system-on-a-programmable-chip (SOPC) solutions. As a leading supplier of FPGAs, CPLDs, structured ASICs and embedded processors, Altera combines programmable logic technology with design software, IP, and design services to offer designers high-value programmable solutions. Central to Altera's embedded solutions is the Nios II processor, a user-configurable, general-purpose RISC embedded processor, and...
- **Lattice Semiconductor Corp.** (h t t p : // w w w .latticesemi.com/) - Lattice Semiconductor Corporation provides the industry's broadest range of Field Programmable Gate Arrays (FPGA) and Programmable Logic Devices (PLD), including Field Programmable System Chips (FPSC), Complex Programmable Logic Devices (CPLD), Programmable Mixed-Signal Products (ispPAC) and Programmable Digital Interconnect Devices (ispGDX). Lattice also offers industry leading SERDES products. Lattice is 'Bringing the Best Together'...
- **Xilinx** (h t t p : // w w w .xilinx.com/) - Supplier of complete programmable logic solutions, including advanced integrated circuits, software design tools, predefined system functions delivered as cores, and unparalleled field engineering support. [FPGA, PLD, Programmable Logic]

Mathstar (h t t p : // w w w .mathstar.com/) is a fabless semiconductor company that claims to have an alternative to FPGAs - Field Programmable Object Arrays. According to the company, FPOAs are “a reprogrammable device that offers up to four times the performance of an FPGA. The FPOA is a two dimensional array of Silicon Objects. Silicon Objects are 16 bit configurable machines, such as an Arithmetic Logic Unit, Multiply-Accumulator or Register File. Both the Silicon Object behavior and the interconnection among Silicon Objects are field-programmable” (h t t p : // w w w .mathstar.com/overview.html, 26 June 2007).

Another vendor targeting the FPGA market with a “non-FPGA” out-of-the-box product is **Cypress Semiconductor** (h t t p : // w w w .cypress.com). Their PSoC Mixed-Signal Controllers are programmable systems-on-chips (SOCs) that integrate a microcontroller and the analog and digital components that typically surround it in an embedded system. A single PSoC device can integrate as many as 100 peripheral functions (h t t p : // w w w .cypress.com/portal/server.pt?space=CommunityPage&control=SetCommunity&CommunityID=209&PageID=215&gid=13&fid=24&category=All 26 June 2007).

We have vendor interviews with most of the key players. (The ones that are absent are absent because they failed to respond to repeated requests. Viva bureaucracy!)

FPGA Tools

FPGAs have a bad reputation as difficult to program and design for. The good news is that most of the FPGA makers provide free or low cost tools or development environments to work with their FPGAs. (They also provide Intellectual Property (“IP”) blocks, *see below*). In general, the

advantages to using the FPGA makers' tools are that the tools are customized to their particular FPGAs (who would know better their own FPGA than the vendors themselves?) and that they are generally free or low-cost. The disadvantage is that the FPGA vendors attempt to "lock you in" because their tools only work with their own FPGAs as generally do their Intellectual Property (IP) blocks (such as PCI, or PCI Express).

Here is a chart with direct links to the tools sections of each FPGA vendors' website:

Tools from FPGA Vendors	
Vendor	**Tools URL:**
Actel	h t t p : // w w w .actel.com/products/software/.
Altera	h t t p : // w w w .altera.com/products/software/sfw-index.jsp
Lattice	h t t p : // w w w .latticesemi.com/products/designsoftware/index.cfm
Xilinx	h t t p : // w w w .xilinx.com/products/design_resources/design_tool/index.htm

In addition to tools, most also provide "design services" or link to registered partner companies that will provide **design services** to get your design up and running quickly. One of the most visible is that provided by **Avnet** (h t t p : // w w w .em.avnet.com/). According to their website:

> Avnet helps specify, develop and design FPGAs by serving as an extension of the design team. Avnet provides the additional resources and knowledge base during the critical implementation phase, so customers can meet aggressive time-to-market milestones.
>
> Services include:
> - **Core Integration -** Avnet has developed high-level building blocks that can be easily adapted to new designs.
> - **Design Optimization** - Avnet can take existing designs and optimize them for FPGAs, improving performance, density, power consumption and reliability.
> - **Technology Migration** - Avnet can take designs in older technologies and target them to newer devices, saving money and improving product availability.
> - **Complete System Design** - Avnet can do complete system designs, adding the support and interface devices necessary to implement an entire application.
> - **C Code Conversion** - Utilizing Celoxica's DK1 Design Suite, Avnet can convert C code to an EDIF netlist or RTL VHDL. (h t t p : // w w w .em.avnet.com/sta/home/0,4610,RID%253D0%2526CID%253D31825%2526SCR%253DN%2526CCD%253DUSA%2526SID%253D32215%2526DID%253DDF2%2526LID%253D0%2526BID%253DDF2%2526CTP%253DSTA,00.html 26 June 2007)

Finally, most provide **development or evaluation boards** either directly or via distribution so that you can test and debug your FPGA designs prior to full commitment. **Altera**'s development kits and evaluation boards are well organized at h t t p : // w w w .altera.com/products/devkits/kit-index.html where you can find kits sold directly by **Altera** as well as links to kits provided by third parties (some of which also provide design services). Check the website of each FPGA vendor to look for free or low cost tools, IP, design services, and evaluation or development boards.

FPGA Tools: Third Party Offerings

The great advantage to FPGA vendor tools - that they are closely coupled with their own hardware - becomes the great *disadvantage* as well. If you are FPGA agnostic, i.e. not sure at this point which FPGA best fits your design tools, there are third party vendors that provide software tools that are *hardware agnostic***,** meaning that they do not lock you into a particular hardware vendor. In fact, one argument is that you should prefer independent third party tools because the FPGA that might work best for your design #1 might not be the FPGA that works best for design #2, etc., and you do not wish to be "locked in" to a particular **Xilinx** or **Altera** design flow. Nothing in life is free, and this goes for "free" FPGA design tools as well!

Broad FPGA Tools

There are many vendors of FPGA- or ASIC-related tools, but two in particular really target broad FPGA design in competition (cooperation?) with the "free" tools of the FPGA vendors themselves. They are:

- **Altium** (h t t p : // w w w .altium.com/) - Altium Designer provides electronic designers and engineers with a single, unified application that incorporates all the technologies and capabilities necessary for a complete electronic product development. Altium Designer integrates board- and FPGA-level system design, embedded software development, and PCB layout, editing and manufacturing within a single design environment.
- **Mentor Graphics Corporation** (h t t p : // w w w .mentor.com/) - Mentor Graphics is a technology leader in electronic design automation (EDA), providing software and hardware design solutions that enable companies to develop better electronic products faster and more cost-effectively. The company offers innovative products and solutions that help engineers overcome the design challenges they face in the increasingly complex worlds of board and chip design.

Altium targets the PCB/FPGA integration issues, whereas **Mentor** has a somewhat broader focus on FPGA/ASIC tool flow including but not limited to FPGA/PCB integration. According to the **Mentor** product literature, only **Mentor** has a unified flow that lets you design for

> **Any Silicon:**
> PLD, FPGA, Platform FPGA, Structured ASIC, ASIC Prototypes, ASICs and SOCs
>
> **Any Vendor:**
> Actel, Altera, Atmel, ChipExpress, Lattice, Xilinx, plus any ASIC foundry
>
> **Any Language:**
> VHDL, Verilog, SystemVerilog, C/C++, PSL, SVA
>
> (h t t p : // w w w .mentor.com/products/fpga_pld/fpga_advantage/index.cfm 26 June 2007)

Specialized FPGA Tools

Beyond these two companies that have made a broad commitment to FPGA tools, there are a number of vendors that offer software tools for *FPGA* development, usually in line with products or offerings that are also applicable to *ASICs*. These fall into a number of broad categories, and here are some highlights of notable vendors in each. (Note: consult *Appendix D* for a full list of FPGA tool vendors). Here are some representative examples:

Verification.

Aldec Inc. (h t t p : // w w w .aldec.com/) - Aldec is currently delivering high performance, mixed HDL-based design entry and verification software to support the development and verification of IC designs. The products also support Co-Simulation of C/C++ and Matlab/Simulink for verification of both software algorithms and HDL based descriptions from one environment. [FPGA, ASIC, SystemVerilog, SystemC, VHDL, Verilog, FPGA/CPLD]

GateRocket, Inc. (h t t p : // w w w .gaterocket.com/) - GateRocket offers the industry's first Device Native verification solution for Field Programmable Gate Arrays (FPGAs). This product can cut in half the time it takes to develop the electronic products that enrich our lives every day. As FPGAs become larger and ever more complex, electronic design engineers face a crisis in their inability to adequately verify and test these advanced designs. GateRocket provides a new, Device Native...

Temento Systems S.A. (h t t p : // w w w .temento.com/) - Temento Systems S.A.is an innovative provider of Test, Debug and Verify Solutions for FPGA, System On Chip (SoC), Boards and Hardware Platforms. Temento Systems products are used by different functional teams (Development, Industrialization, Manufacturing, Maintenance) and in major companies from various industrial sectors worldwide : Semi-conductor, Telecommunications, Consumer Electronics, Computer, Automotive, Aerospace.

TransEDA (h t t p : // w w w .transeda.com/) - TransEDA is a leading provider of integrated verification solutions for SoC, ASIC and FPGA designs. TransEDA Solution is an integrated design verification and verification measurement environment with tools that perform code & assertion coverage analysis, coverability analysis, static property checking, test suite optimisation and configurable HDL checking. In addition TransEDA provide verification IP and transistor abstraction tools.

Synthesis

Celoxica Inc. (h t t p : // w w w .celoxica.com/) - Celoxica is the technology leader for Software-Compiled System Design, a process that accelerates design productivity by using high-level languages to directly drive design verification and implementation. Celoxica provides tools and services that support the co-design, verification and implementation of hardware and software through a platform-based design methodology. [Keywords: C synthesis, FPGA, Handel-C, SystemC, ESL]

Synplicity (h t t p : // w w w .synplicity.com/) - Innovative synthesis, verification, and physical implementation software solutions for designers of programmable logic, ASICs, Structured / Platform ASICs, and SoCs. The industry's most widely used FPGA synthesis solution, Synplify Pro uses a true timing-driven approach to synthesis. All products support industry-standard design languages (VHDL and Verilog) and run on most popular computing platforms.

Other

Mirabilis Design (h t t p : // w w w .mirabilisdesign.com/) - The product, VisualSim, is used for performance, functionality and power exploration of IC, SoC, FPGA, boards and real-time software. Models are constructed in a graphical block diagram editor using parameterized modeling blocks provided in VisualSim, Third-Party IP in SystemC or C, and custom Java/C/C++/Script and SystemC. Multi-levels of abstraction including traffic, queuing, performance (untimed and timed), transaction-level and...

FPGA Intellectual Property ("IP")

One of the attractive features of FPGAs is their promise to allow the designer to "mix and match" IP that is both internal and external - to allow each design to be fully customized for the design needs, and to give wings to the promise of "design reuse." While IP is also heavily employed in the ASIC market, it has developing roots in the FPGA community. What resources, therefore, exist to help you figure out whether, and how, to employ IP in your next FPGA design?

Internet Resources

First and foremost, here are some of the best Internet sites for identifying IP:

- **SOCcentral** (h t t p : // w w w .soccentral.com/) - System on a Chip (SoC) and ASIC design information, EDA tools and design methodologies, intellectual property (core IP), design reuse, or programmable logic (including FPGA, PLD and CPLD design).
- **Design and Reuse** (h t t p : // w w w .design-reuse.com/) - The world's largest directory of Virtual Components, Software and Services for designing systems on chip IP exchange on Internet works; test it by getting a free IP and look at the new format of IP Exchanger. Part of the massive Techweb database.
- **OpenCores** (h t t p : // w w w .opencores.org/) - OpenCores is a loose collection of people who are interested in developing hardware, with a similar ethos to the free software movement. Currently the emphasis is on digital modules called 'cores', since FPGAs have reduced the incremental cost of a core to approximately zero.
- **ChipEstimate.com** (h t t p : // w w w .ChipEstimate.com/) - ChipEstimate.Com is an intuitive new tool for IC designers that generates fast and accurate chip estimates. The tool makes it easy for designers to visualize tradeoffs between key design metrics, and across technology nodes and process variants. InCyte lets users generate accurate and optimized chip estimates at the architectural stage of the design process, resulting in significantly shorter design times and lower design costs.

eg3.com tracks the keyword "IP" at h t t p : // w w w .eg3.com/intellectual-property.htm.

IP from the FPGA Vendors

Xilinx, **Altera**, and other FPGA vendors are keen to have you design (and deploy) lots of devices with their FPGAs, and so they attempt to make it easy by providing free or low cost tools as well as free or low cost IP. As is the case with tools, the upside to IP from these vendors is that it is closely matched to the hardware. The downside is that it is usually not broadly portable to other hardware options. That said, you can check out the IP subsections of each major vendor.

IP from FPGA Vendors	
Vendor	**IP URL:**
Actel	h t t p : // w w w .actel.com/products/ip/default.aspx
Altera	h t t p : // w w w .altera.com/products/ip/ipm-index.html
Lattice Semiconductor	h t t p : // w w w .latticesemi.com/products/intellectualproperty/index.cfm
Xilinx	h t t p : // w w w .xilinx.com/ipcenter/

Each vendor attempts to catalog available IP and provide a quasi-"store front" at which the developer can identify useful IP. **Altera**, for example, has one of the most developed and easiest-to-use IP sections on their website, called appropriately their "Altera Intellectual Property Megastore" (h t t p : // w w w .altera.com/products/ip/ipm-index.html). While not exactly the **Walmart** of IP for FPGAs, the subsite is one of the best at identifying appropriate IP and the procedures by which you can incorporate it into your design. **Xilinx** has a less glamorous front page, but has an easy-to-use search engine for identifying possible IP at h t t p : // w w w .xilinx.com/ipcenter/index.htm.

Both **Xilinx** and **Altera** have invested heavily in their own IP cores: *Microblaze* for the former, and *Nios/Nios II* for the latter. **Actel** has formed a partnership with **ARM** to provide the 32-bit ARM Cortex-M1 "free" with **Actel**-based designs. Details are at h t t p : // w w w .actel.com/products/mpu/CortexM1/. In addition to their own (or licensed) processor cores, the vendors provide much of the "plumbing" involved in many designs - ethernet, PCI Express, Video Codecs, etc. - i.e., IP that is commonly used and does not constitute the real value add of a design. All of this is aimed at getting your design up quickly and effectively.

Aldec has a new partnership with ARM, providing an ARM core with selected FPGAs (h t t p : // w w w .actel.com/products/mpu/CortexM1/).

IP From the Third Party Vendors

As is the case with FPGA tools, a market has emerged for "independent" IP. The advantage here is that this IP is not tied to specific hardware, giving you design freedom. The disadvantage is that it isn't generally free and, in the case of tools vendors, is affiliated with a particular design flow.

Among the EDA tools vendors, most now offer IP. **Synopsys**, for example, has an important microsite on IP at h t t p : // w w w .synopsys.com/products/designware/designware.html. It is focused largely on protocol IP such as USB, Wireless USB, PCI Express, PCI, Xaui, etc. Similarly, **Mentor Graphics** has its own IP microsite at h t t p : // w w w .mentor.com/products/ip/index.cfm. That company signaled its increasing commitment to IP with a May, 2007, announcement of a USB subsystem solution. "This past year, many of our large customers have experienced integration issues –primarily with digital controllers and embedded software IP – delaying their consumer product introductions. To help remove these integration challenges, we are responding to customer requirements with our Subsystem IP solution," stated Bill Martin, Mentor Graphics IP Division general manager. (h t t p : // w w w .mentor.com/products/ip/news/subsystemip_usbsubsystem.cfm, 18 July 2007)

Beyond the FPGA vendors and the EDA vendors lie a group of smaller companies that specialize in delivering IP for FPGA and/or ASIC designs. One of the more interesting is **CAST**, inc., a small New Jersey company that has specialized in "IP that works." They provide over 100 different popular and standards-based IP cores, including 8051s, H.264, PCI Express, AES, and

even complete platforms for ARM-based SoCs. Similar to the advantage of third party tools, one of the major advantages of using **CAST** (third party) IP is that it is "hardware neutral" and thus will not lock you into a particular FPGA vendor. They are at h t t p : // w w w .cast-inc.com/. (See their interview in the Interview section).

Other specialized IP vendors are:

- **Eureka Technology Inc.** (h t t p : // w w w .eurekatech.com/) - Eureka Technology is a leading intellectual property (IP) provider for ASIC and FPGA designs. The company offers a wide range of fully synthesizable, silicon-proven system core logic functions and peripheral functions to support different bus standards and CPU interfaces, including PCI, PCI-X, PCI Express, Cardbus, PowerPC, ARM, MIPS, ARC, SH2/3/4, SDRAM, DDR/DDR2 SDRAM, NAND Flash, Flash/SRAM/EEPROM, SD memory, SDIO, CompactFlash and PCMCIA.
- **nSys** (h t t p : // w w w .nsysinc.com/) - nSys Verification Suite (nVS) family is the largest collection of Verification IPs in native Verilog that is available from a single source. Hundreds of ASIC/FPGA/IP developers are currently using the nVS family to benefit from widely accepted and proven Bus Function Models, Monitor, Assertions based Checkers and Test Suites. [Intellectual Property]
- **PLDA** (h t t p : // w w w .plda.com/) - PLDA, the largest provider of IP cores for the logical and transport layers of PCI, PCI-X and PCI Express (The Linley Group, Apr 2006), designs and sells a wide range of ASIC, structured ASIC and FPGA interfacing solutions for the PCI Express, PCI, PCI-X, and derivative protocols. The company offers complete solutions, including IP cores, hardware, software, and comprehensive technical support provided directly by the IP designers.

FPGA Boards

If designing FPGAs weren't difficult enough, once an FPGA is designed it has to be integrated onto a printed circuit board. ASIC design companies have whole teams devoted to ASIC / board integration as they would if there were an FPGA / board integration issue. And **Altium** and **Mentor Graphics**, as we have seen above, have complete design solutions for this problem, but what do you do if you are in a hurry? The FPGA boards market has four basic groups of board solutions.

1. **FPGA development or evaluation boards** - these are boards provided by **Xilinx**, **Altera**, or another FPGA maker to "seed the market" by making their FPGAs easy to design with. These are not generally meant as production boards, and are sometimes available through distributors like **Avnet** or **Arrow.**
2. **FPGA boards for ASIC Prototyping** - these are boards, often from Third Parties, that are not meant for deployment but rather for quick and effective prototyping of what will ultimately become an ASIC.
3. **FPGA deployment boards** - these are FPGA-based single board computers or blades that are meant for actual deployment. Vendors compete to provide boards that are both easy to prototype on and/or easy to deploy. **DSP** is an especially important subset of this group.
4. **FPGA modules** - this is a new type of FPGA-based board that is meant as both a development and deployment platform, not particularly for FPGA experts. The best example of this is the *CompactRIO* product from **National Instruments**.

We shall consider each of these in turn.

FPGA Development or Evaluation Boards

The FPGA manufacturers are very eager for you to develop using their products, and so it is usually a simple matter to get your hands on a development board. Simply check their websites and stay alert for special offers or promotions (usually tied to their latest and greatest FPGA). **Altera**, for example, has a specific web section on development boards at h t t p : // w w w .altera.com/products/devkits/kit-dev_platforms.jsp as well as a special online store (h t t p : // w w w .buyaltera.com/) from which to order kits. And in some cases the development kits are sold in association with third parties that also offer services. One such company is **Dallas Logic** which specializes in digital electronic design, circuit board design, and the delivery of board assemblies for prototype and small production runs (h t t p : // w w w .dallaslogic.com/).

Xilinx development boards information is at h t t p : // w w w .xilinx.com/products/devboards/. Similarly to **Altera**, you can search by application, vendor, or desired FPGA. **Lattice** development board information is at h t t p : // w w w .latticesemi.com/products/developmenthardware/fpgafspcboards/index.cfm?source=topnav. Don't forget to check out the major distributors. They often have special offers on new development boards, as well as affiliated design services and educational seminars/webinars.

As of July, 2007, for example, **Avnet** had an offer in partnership with **Actel**, which just introduced an ARM® processor designed for use in Flash-based M1 ProASIC3 and M1 Fusion devices. Together with **Avnet Memec**, **Actel** is offering qualified registrants the chance to win an M1 ProASIC3 Development Kit. Offer ends December 31, 2007. The marketing plug is:

> **Actel** recently announced the availability of its implementation of the ARM® Cortex™-M1 processor, a small, high-performance 32-bit soft core co-developed by the companies for optimal use in field-programmable gate arrays (FPGAs). With the addition of the FPGA-optimized ARM Cortex-M1 processor, free of license and royalty fees, system designers can select the solution that best meets their design requirements regardless of application or volume.
>
> (h t t p : // w w w .em.avnet.com/spc/home/0,1727,RID%253D0%2526CID%253D40126%2526CCD%253DUSA%2526SID%253D32214%2526DID%253DDF2%2526LID%253D32234%2526BID%253DDF2%2526CTP%253DSPC,00.html 19 July 2007)

Arrow in comparison announced a US seminar series promoting **Altera** latest Cyclone® III FPGA family and Linear Technology's newest power management devices on an Arrow developed Low Power Reference Platform (LPRP). For $450, you get a development board as well as a one-day training seminar. In most cases, in conclusion, development boards are supplied at low costs in order to "seed" the market by encouraging designs on the newer FPGAs. Stay alert at the vendor and distributor sites for these opportunities.

FPGA Boards for ASIC Prototyping

One of the larger uses of FPGAs is for ASIC prototyping, an application that requires not just advanced FPGAs but good board and tool support. In this case, there are many third parties that specialize in FPGA boards that are for prototyping.

An example board vendor that specializes in this niche is **Gidel** (h t t p : // w w w .gidel.com/). The company provides development tools and universal FPGA platforms for systems, ASIC prototyping and algorithm development. GiDEL's high productivity software tools complement high-performance PCI boards and stand-alone boards that offer outstanding cost/performance

advantages. GiDEL PROC FPGA boards are used as critical part of vision, imaging, DSP, pattern matching machines and systems. It's most recent product is *PROC9M*™, an SoC Prototyping System. The PROC9M is designed to debug and verify SoC designs of diverse styles up to 9 million ASIC gates in size. The PROC9M system sets a new standard for prototyping performance; interconnect flexibility, and ease-of-use (h t t p : // w w w .eridon.com/products_boards.htm 26 June 2007).

If you are not certain whether you will end up with an ASIC or an FPGA, or you want to outsource some of the design services as well as purchase a development board, there are companies that hybridize the board and design services purchase. **AMIRIX** (h t t p : // w w w .amirix.com/), for example, provides PCI and PCI/e Platform FPGA Development Boards, as well as standard and custom deriviative reference designs, for researchers and OEMs looking to develop embedded FPGA System-on-a-Chip (SoC) solutions using Xilinx FPGAs. **Trenz Electronic** of Germany (h t t p : // w w w .trenz-electronic.de/) has a similar profile, also focused on **Xilinx** FPGAs. There is also **The Dini Group** (h t t p : // w w w .dinigroup.com/). In most cases, these are really service companies and you are paying for their design expertise as much as for the boards. Consequently the business relationship and negotiations are essentially a service negotiation and not a product purchase.

FPGA Deployment Boards

Because of the attractiveness of FPGAs, there are more and more companies and products that offer deployable boards based on FPGA technology. Application areas include medical, military, and high-end telecommunications and the efforts are to offer "standardized" products that get you started with a board for which you do hardware and software customization. The great thing here is that much of the initial IP for the FPGA as well as the FPGA/board lay out is already taken care of.

A representative example here is **Vmetro** (h t t p : // w w w .vmetro.com/). According to their literature:

> VMETRO's products have been developed to allow FPGAs to be used alongside DSPs and PowerPC CPUs. This means that the FPGAs can focus on the most demanding aspects of the application (e.g. digital filtering of a high bandwidth signals, tracking or FFTs) while the processor can handle the more complex, but less processor intensive, parts of the application, such as system control. Single board computers (SBCs) mounted with PMC-FPGA03 PMC modules is one such supported combination.
>
> (h t t p : // w w w .vmetro.com/category556.html).

Acromag, another vendor specializing in FPGA-based boards, has a useful on-demand PowerPoint presentation on FPGA boards at h t t p : // w w w .acromag.com/software/downloads/Custom_Board_Level_FPGA_Solutions.wmv Finally, one company that has done an excellent job of providing information on FPGA boards technology is **Nallatech**. Check out their FPGA education center at h t t p : // w w w .nallatech.com/?node_id=1.5 for white papers, articles, and other technical media explaining the various logic application areas for FPGAs.

FPGA Deployment Boards: DSP

Another very common use is for DSP-related applications that can really profit from the processing power and reconfigurability of FPGAs. Indeed, **Xilinx** even has a special section of its website on DSPs at h t t p : // w w w .xilinx.com/products/design_resources/dsp_central/grouping/index.htm. The FPGA / DSP connecdtion is also the subject of an in-depth report by **Berkeley Design Technologies,** *FPGAs for DSP, Second Edition* (h t t p : // w w w .bdti.com/products/reports_fpga2006.html):

> BDTI examines recent DSP developments in FPGAs and explains why FPGAs are, increasingly, an attractive solution for implementing DSP. The report compares key offerings from FPGA vendors and discusses important differentiators. BDTI also compares FPGAs to mainstream DSPs to help answer the question of when to use an FPGA and when to use a DSP.
>
> (h t t p : // w w w .bdti.com/products/reports_fpga2006.html 26 June 2007)

The price is hefty at $2,495 and one hopes that a 2007 edition will be forthcoming.

Among board vendors, many concentrate on FPGA boards for DSP-intensive applications. **BittWare, Inc.** (h t t p : // w w w .bittware.com/), for example, is a DSP board vendor in Concord, New Hampshire, that has concentrated on DSP boards and has recently launched a series of **Altera**-based FPGA boards for great processing power. On April 3, 2007, the company launched *GX-AMC (GXAM),* its inaugural FPGA-only board based on **Altera**'s line of high-density, high-end FPGAs. This Advanced Mezzanine Card (AdvancedMC™) uses the Altera Stratix II GX FPGA to provide unparalleled flexibility, ideal for the development and deployment of a variety of systems, including wireless infrastructure. (h t t p : // w w w .bittware.com/media/press/pr.cfm?id=34 26 June 2007).

Pentek (h t t p : // w w w .pentek.com/) is another vendor that has added FPGA boards to its DSP board line up. That company has an excellent white paper on the *XMC* standard or *VITA 42*. The paper explains the rationale for FPGAs in formerly pure DSP applications well:

> In recent years, FPGAs (field programmable gate arrays) have permeated mezzanine card architectures for reasons entirely incidental to XMC, and yet today FPGAs represent the single most significant catalyst for XMC adoption.
>
> FPGAs offer a collection of resources ideally suited for peripheral I/O functions. FPGAs may be configured to implement numerous electrical interface standards as well as a variety of protocol engines. By reconfiguring its FPGA, not only can a single I/O product replace several legacy products, it can also adapt to future standards and protocols as well. This forestalls product obsolescence, both at the board level and at the deployed system level.
>
> Another reason FPGAs find their way onto mezzanine cards is their unmatched ability to implement real-time signal processing and high-level local control. FPGAs deal effectively with the very high frontend data rates for A/D and D/A converters, network interfaces, sensor arrays and highspeed data channels by mustering a troop of high-performance hardware resources, configured to match the specific task at hand. For more sophisticated front-end processing, most FPGAs now feature DSP engines with built-in hardware multipliers to tackle the toughest algorithms with ease. Arrays of these engines can be deployed in parallel, completely surpassing the capabilities of general-purpose programmable RISC or DSP processors that must execute serial instructions.

> By performing these types of intensive protocol, formatting, decoding and DSP functions on the mezzanine, the workload for the processor on the carrier board can be significantly reduced. This may lead to fewer processors or fewer processor boards in the system, for considerable savings in system cost and size.
>
> (h t t p : // w w w .pentek.com/tutorials/16_1/XMC.cfm 26 June 2007)

Other vendors active in the FPGA/DSP space include **Lyrtech Inc.** (h t t p : // w w w .lyrtech.com/), **Vmetro** (h t t p : // w w w .vmetro.com), **Hunt Engineering** (h t t p : // w w w .hunt-dsp.com/) and **Mango DSP, Ltd.** (h t t p : // w w w .mangodsp.com/) among others.

FPGA Modules

Finally, one vendor that has tried a very new approach to FPGAs is **National Instruments** (h t t p : // w w w .ni.com/). The company has made a major commitment to FPGAs and has a special version of their LabVIEW software just for FPGAs, appropriately called *NI LabVIEW FPGA*. The idea is to allow "domain experts" to capitzalize on FPGAs without having to really understand how to program them:

> The National Instruments LabVIEW FPGA Module extends LabVIEW graphical development to reconfigurable FPGAs on NI reconfigurable I/O (RIO) hardware. With the NI LabVIEW FPGA Module, you can create custom I/O measurement and control hardware without low-level hardware description languages or hardware board-level design. You can use this custom hardware for unique timing and triggering routines, ultrahigh-speed control, and interfacing to digital protocols.
>
> (h t t p : // w w w .ni.com/fpga/ 26 June 2007).

The companion hardware product is called *CompactRIO* (h t t p : // w w w .ni.com/compactrio/). For those new to FPGAs, eager to get their product to market, and not extremely cost sensitive, **National Instruments** can be an excellent first foray into the world of FPGAs. **NI** is attempting to bring FPGA power to non-FPGA experts across a range of "domains" or application areas. We wish them the best of luck, and if your application is not high volume and/or not exceedingly price sensitive it is very much worth a look. (See their interview in the interview section).

FPGAs, Tools, and Boards: Survey Results

FPGA Survey Results

What do real users of FPGAs think? Are there hidden "gotchas" amongst FPGAs, tools, and/or boards? How do expert users differ from novices or "newbies?" We polled our e-clips audience, and present herein our survey results.

- FPGA Users Survey
- Survey Demographics and FPGA Expertise
- Vertical Industries Applicable to FPGAs
- Reasons Encouraging Designers to Use FPGAs
- FPGA Vendors: Familiarity and Opinions
- FPGA Tools: Familiarity and Opinions
- FPGA IP: Familiarity and Opinions
- FPGA Boards: Familiarity and Opinions
- FPGA Design Information
- FPGA Anecdotes

FPGAs: User Survey

What do real users of FPGAs think about FPGAs? Are they a good design choice? Are there hidden "gotchas" in the design process? Do you need to be an "expert" to program them, or are the commercially available design tools sufficient? And what about newbies - people selecting FPGAs for the first time? How do their preconceptions of FPGAs compare and contrast with the "experts" who have at least one FPGA design under their belt?

eg3.com operates one of the largest news services in the embedded systems industry, *e-clips* (http://www.eg3.com/eclips/). With 36,000 subscribers, e-clips is a useful community that eg3.com can poll about their pre- and post-design experiences. To that end, we sent out a request in August, 2007, and had 359 willing volunteers take an extensive survey on FPGAs, tools, and boards.

Here are our analysis and results:

- Survey Demographics and FPGA Expertise
- Vertical Industries Applicable to FPGAs
- Reasons Encouraging Designers to Use FPGAs
- FPGA Vendors: Familiarity and Opinions
- FPGA Tools: Familiarity and Opinions
- FPGA Intellectual Property ("IP"): Familiarity and Opinions
- FPGA Boards: Familiarity and Opinions
- FPGA Design Information
- FPGA Anecdotes

Survey Demographics and FPGA Expertise

359 persons responded to our survey on their hopes, frustrations, fears, and design experience with FPGAs. 137 of these were students, so in almost all answers we have excluded this group from our analysis. For the questions and graphs below, we indicate how many actual respondents there are for each question, which is a smaller subset as well.

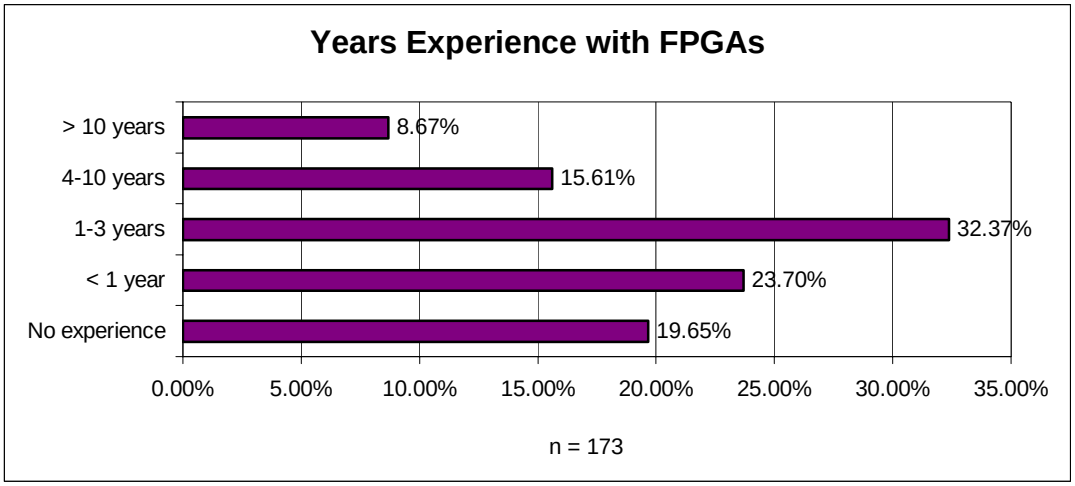
Job Title

What sorts of persons are interested in FPGAs? As is true for most embedded systems, the days of "software" guys vs. "hardware" guys no longer apply. Of the 172 people who provided a job title, 38.95% - a plurality - indicated that they both do hardware and software, followed by 33.14% doing software only, 33.14% doing hardware only, and 6.98% managing an engineering team. With FPGAs providing a choice between running an application in hardware vs. in software, design trade-offs are facilitated by people with expertise in both, as well as design teams that have both software and hardware guys.

Experience with FPGAs

How experienced is this community with FPGAs? Are there a lot of FPGA "experts" out there, or

a lot of people coming in to FPGAs for the first time? We were very curious about FPGA experience, and can provide this graph of the total community:



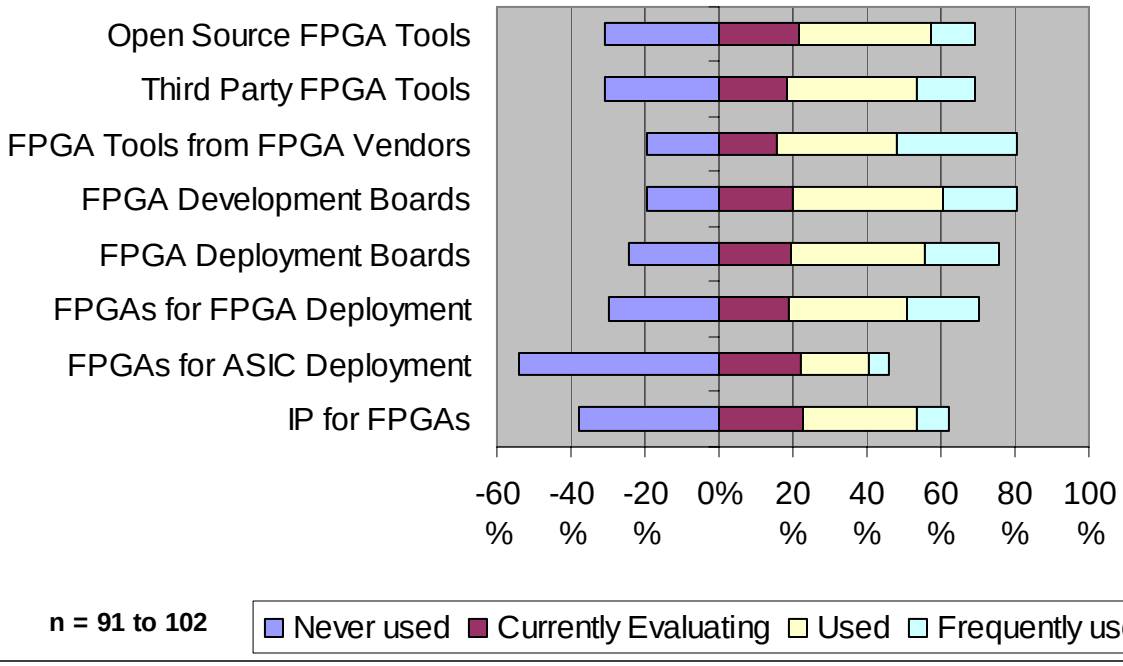
Most people have just 1-3 years with FPGAs, but there are good minorities with over ten years and from 4-10 years. In addition, there are 19.65% with no experience, investigating FPGAs for what would be their first design. For further analysis, we designated those with more than one year experience as our "expert" group, and those with less than one year or no experience our "newby" group. Comparisons between the two groups can illuminate the differences between design preconceptions and actual experiences with FPGAs.

Involvement with FPGAs

How involved are the total group, the expert group, and the newby group with FPGAs and the various components of the FPGA ecosystem?

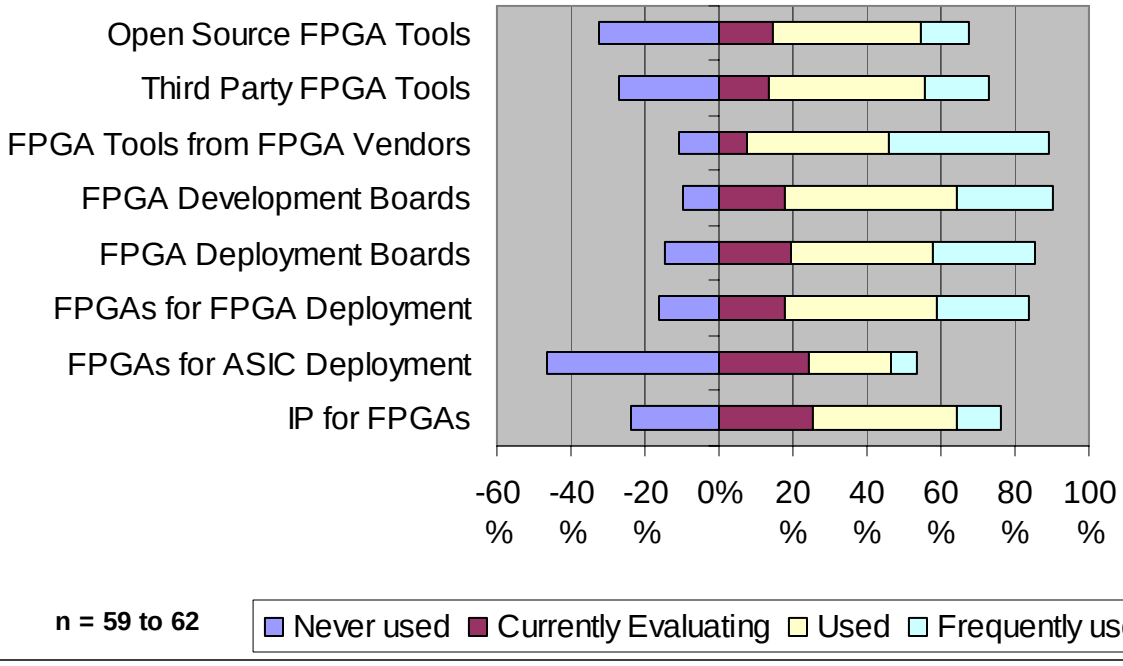
Here are graphs comparing each:

Involvement with FPGAs / Total Group

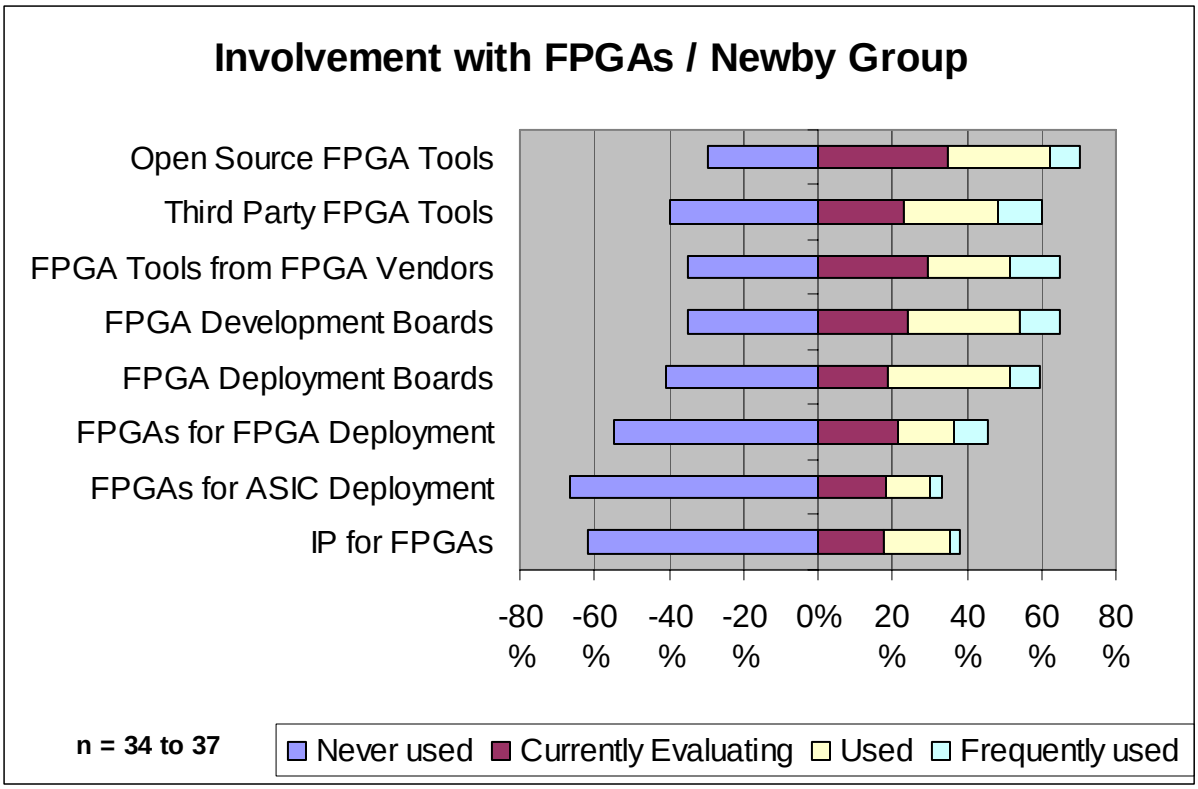


n = 91 to 102

Involvement with FPGAs / Expert Group



n = 59 to 62



The highest involvement is with FPGA tools from the FPGA vendors themselves. This dynamic shows up elsewhere in the survey. It is both important and not surprising: the FPGA manufacturers know their own technology best, have huge incentives to provide basic software, and thus most FPGA designers end up interacting with the vendor-supplied FPGA software.

- **Take away**: for your own project, be sure to familiarize yourself with the vendor-supplied FPGA software. You should like it, as you will live with it during your design. (The same is true for software provided by the FPGA board makers.)

As we shall see later, it is usually not a choice of either software from the FPGA vendors **or** third party software, but rather **both**.

"Open source" FPGA software and IP is vastly more popular among newbies than among experts, a trend we observed in our *Selecting an Embedded OS* report as well. This may reflect the fact the Open Source enjoys great branding - everyone is for "free" - but experienced users have a more balanced view of its utility.

Another big divergence is in "Intellectual Property." Most FPGA designs end up involving IP from the FPGA vendors, IP from third parties, and home-grown IP. As a result, the overwhelming majority of the FPGA expert group have experience with IP, but the newby group does not. IP is clearly an area where people new to FPGAs should concentrate: it is both unknown and essential to the FPGA development process. Indeed, 25.42% of the expert group is "currently evaluating" IP, which reflects that fact that much of FPGA design involves purchasing third party IP and/or developing one's own IP, and then integrating (and verifying) the IP blocks. And the need for effective IP tools, whether from the FPGA vendor or third parties, is paramount.

- **Take away**: don't forget to consider available IP (from both the FPGA vendors as well as third parties) in making your FPGA choice. A healthy *IP* ecosystem might be as important as a healthy *tools* ecosystem.

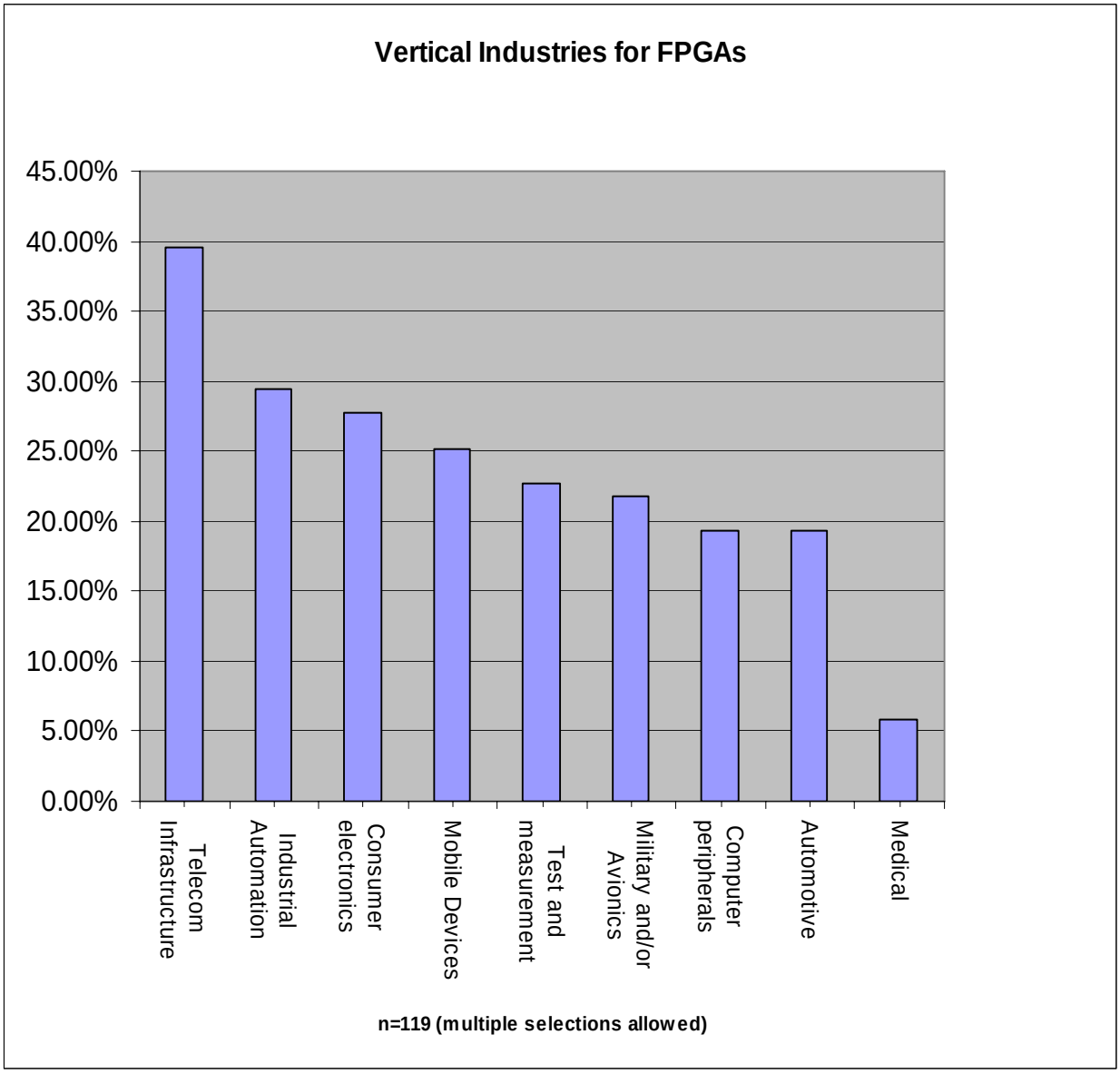
"FPGAs for ASIC prototyping" is a bit misleading in terms of raw numbers. ASIC prototyping - by the very fact that ASIC design starts are relatively few - is something that is done by a relative minority of engineers. But to those who are doing ASICs and are involved in ASIC prototyping, FPGAs can be an excellent vehicle. FPGA development boards, in contrast to FPGAs for ASIC prototyping, are used by a wide group because they have wide applicability to many, many designs.

- **Take away**: if you are considering FPGAs as an ASIC prototyping tool, don't be discouraged by the smaller numbers of survey respondents. This important facet of FPGAs is, by its very nature, a smaller community. On the other hand, the FPGA vendors are keen for these high volume applications, so you can expect "gold" service from Xilinx, Altera, Lattice, Actel or others.

Vertical Industries Applicable to FPGAs

If you ask a person with a hammer, so the saying goes, everything will appear to be a nail. So it is with hardware and software vendors. If you ask the marketing or sales rep at an FPGA vendor, what applications are especially good for FPGAs, you will often be told, "everything." More realistically, FPGAs are often seen as applicable for signal processing and data applications, and these days for more and more consumer applications.

So we asked our audience, "Which vertical industries have you primarily or often used FPGAs for?" The answers did not differ substantially among the three groups.

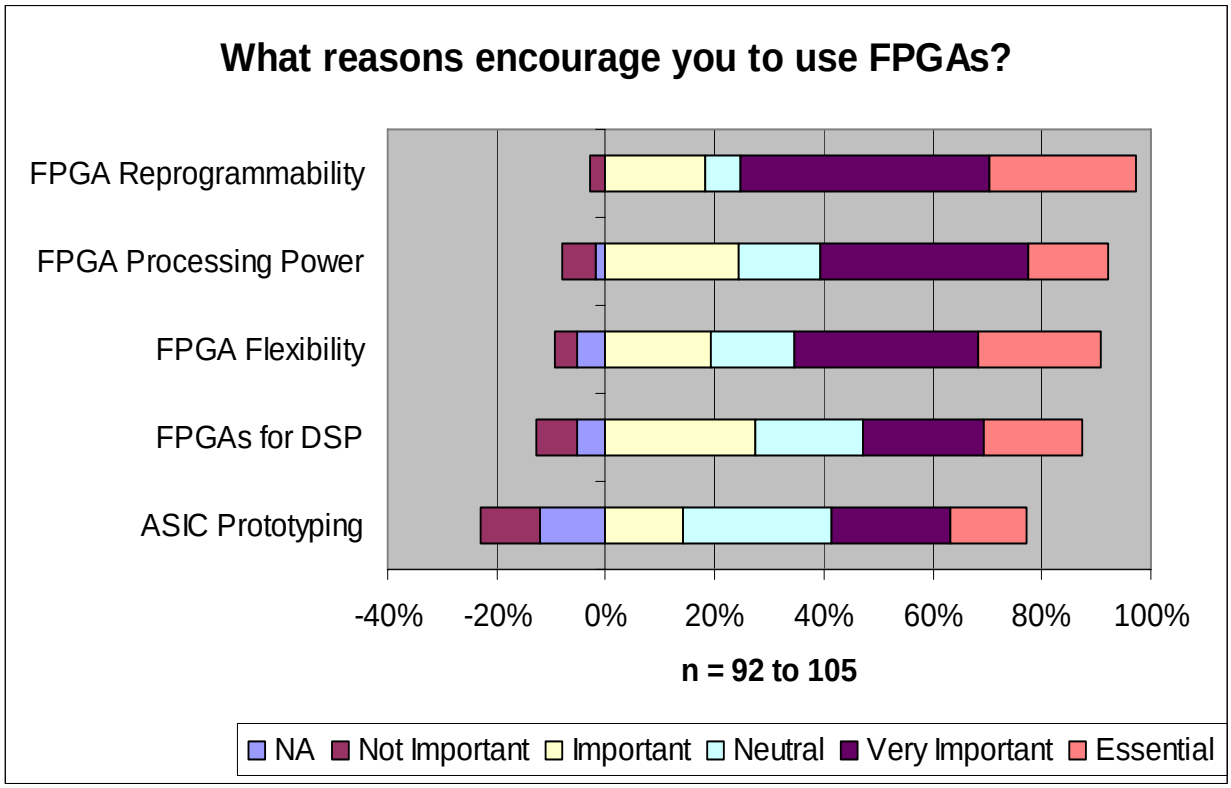


Telecommunications infrastructure is number one at 39.50%, followed by industrial automation 29.41%, and consumer electronics at 27.73%. Mobile devices is in 4th place. The good news here for the FPGA vendors is that FPGAs are being considered (and ultimately deploying) in two target markets - consumer and mobile, areas that historically have not been FPGA strong suits.

One caveat is in order. Asking a group of engineers the vertical industries that they are designing for may not be indicative of the total dollar volume, or FPGAs shipped, for any given industry. One design win in consumer electronics, for example, may mean many millions of units shipped vs. one design win in telecom infrastructure which might be just a thousand units. This is a quantitative graph, but it indicates that FPGAs are applicable to a wide variety of vertical markets.

Reasons Encouraging Designers to Use FPGAs

FPGAs are known for their high performance and reprogrammability, and have been widely used for ASIC prototyping as well as in DSP (signal processing) applications. What reasons did the survey group use for looking at FPGAs? Again there were no significant differences among the groups.



Reprogrammability is number one at 26.67% "essential" and 45.71% "very important." But all the answers are close enough to not be significantly different - FPGAs are chosen for the reprogrammability, their processing power, and their flexibility. Two common applications are DSP and for ASIC prototyping. No real news is here.

Throughout the survey, we asked users for anecdotal comments. One comment here summed up a common thought:

> "We can use a single FPGA for multiple applications alternately with less cost and less area occupation."

Engineers are not the best writers, but the thought is that the reprogrammability of FPGAs allows them to be a jack-of-all-trades and allows for "design reuse" in terms of board layout and lower level software.

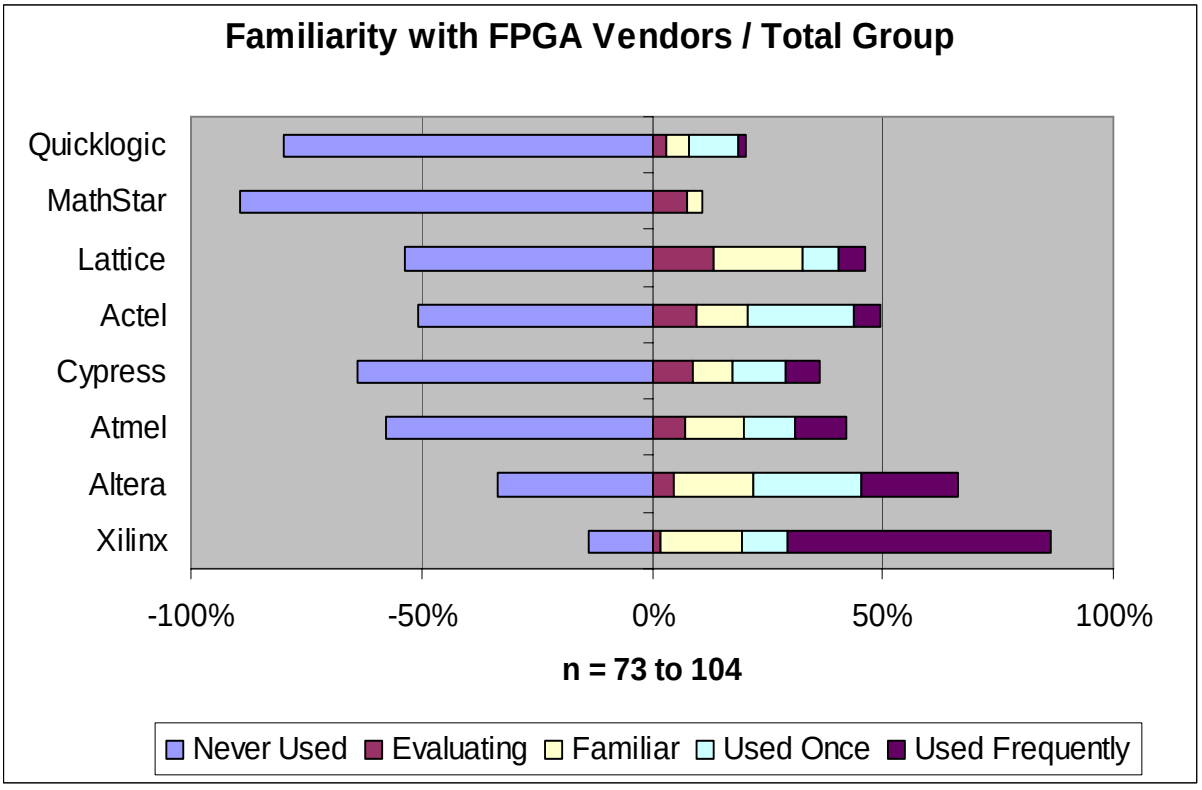
FPGA Vendors: Familiarity and Opinions

When making the major commitments of life - whom to marry, what car to buy, what neighborhood to live in, what FPGA to include in a design - everyone would like the benefit of hindsight, from that early moment of choice all the way through to project completion. This is, unfortunately, not possible and it is even less possible when two factors are at work:

1. **Small sample size** - our sample size, given the vagaries of engineering and the Internet, is small enough that all results herein should be taken skeptically. Statistical extrapolations should not be made - the answers from this survey are more like asking people at a cocktail party their opinions, than asking thousands of people an opinion and statistically correlating it with answers.
2. **One-to-one relationships** - each FPGA-based design is unique, addressing a unique set of design needs, cost parameters, and designer preferences. Just because the crowd thinks that such-and-such is fantastic, or hasn't heard of such-and-such does not mean that your own FPGA choice should follow the crowd logic. Read and research everything, but ultimately make an in-depth choice of the "best" FPGA, tool, and/or board for your own personal design project, and the crowd be damned.

That said, we asked engineers a range of questions on their familiarity and opinions of different vendors and design choices. It is a useful look at the "before" and "after" FPGA experience, of interest, to any engineer currently selecting an FPGA, tool, and/or board.

Familiarity with FPGA Vendors



For the total group, not surprisingly, the overwhelming majority were familiar with Xilinx at 84.31%, followed by Altera at 61.54%. These two vendors have the largest market share and the most robust marketing. They enjoy the best market penetration. Does that mean you should "choose" Xilinx or Altera? It may only mean that those vendors work best for the crowd, but they may not work best for your focused application. Vendors such as MathStar or Actel, in contrast, tend to specialize on niche applications (e.g., high end signal processing or lower power) and may be a "better" fit.

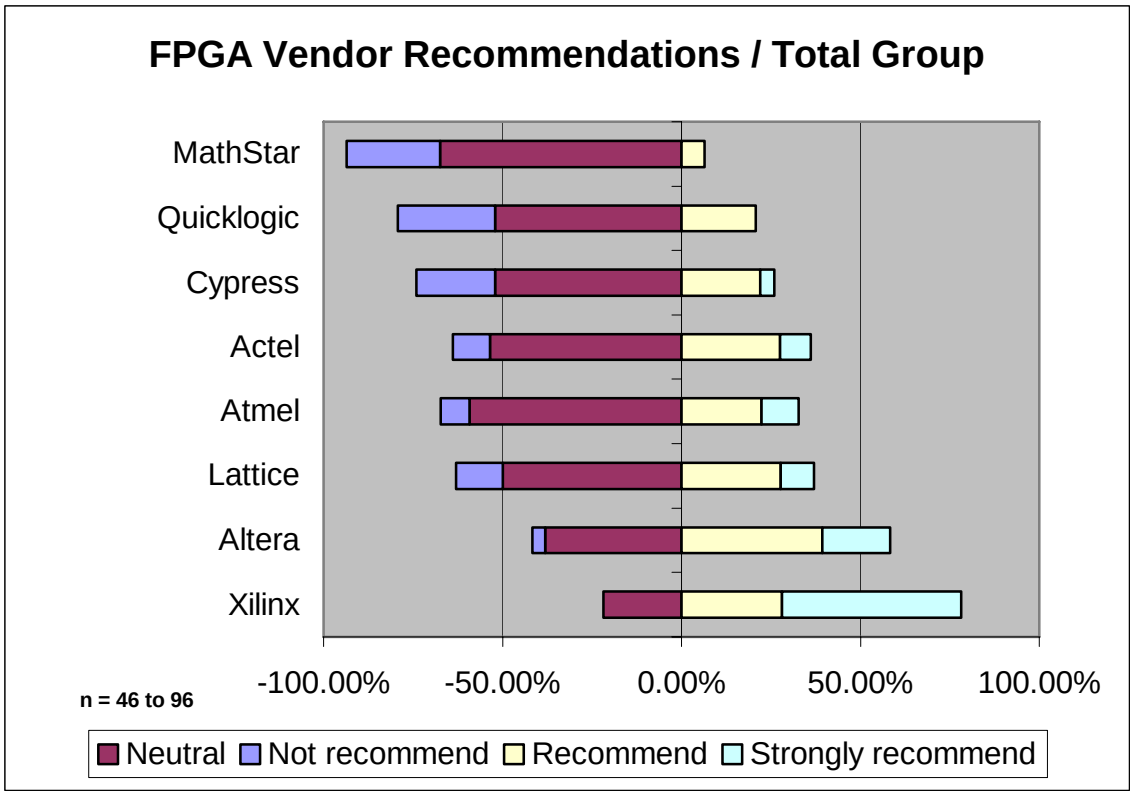
- **Take away.** Because each design project is "unique," be aware that what might work for *most* engineers might *not* work for you because your design is unique, and your requirements might be better fit on a technical level by a smaller more "niche" FPGA vendor.

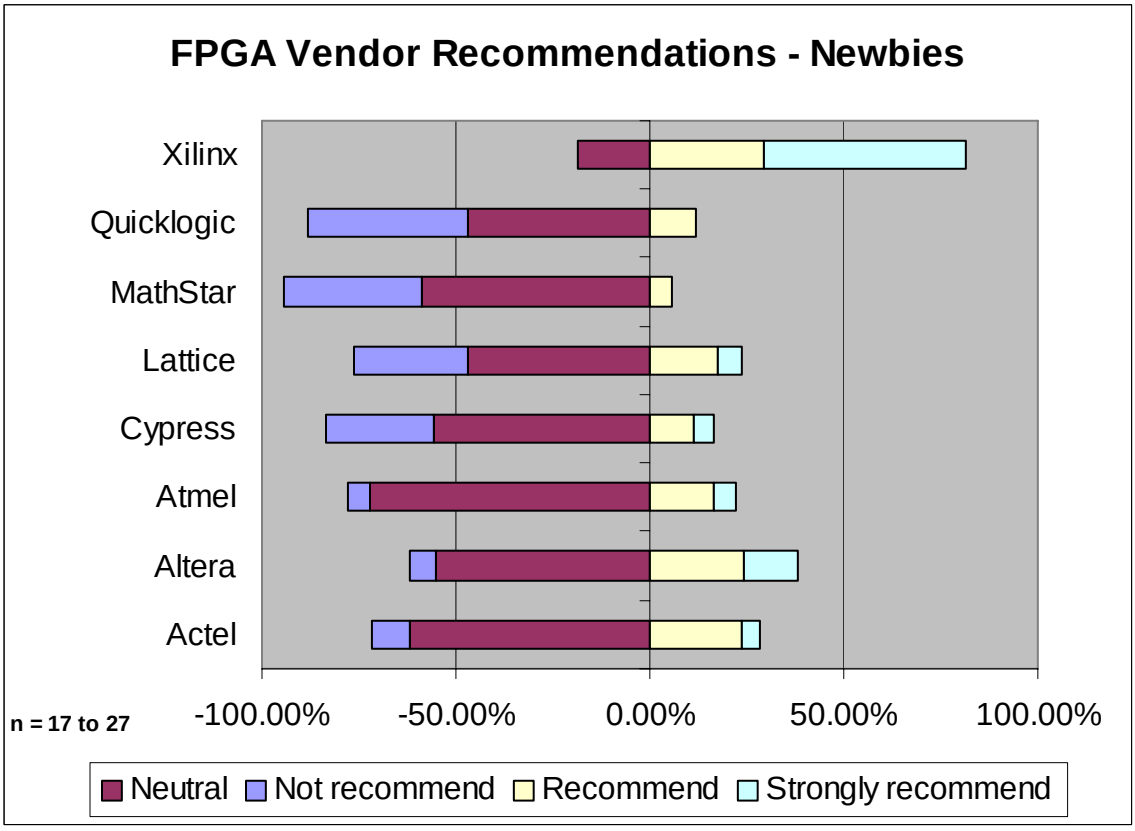
On the other hand, having a robust ecosystem is important and having a large user community is part of that ecosystem. Xilinx and Altera have the largest. A robust ecosystem means many third party tools, a vibrant user community, and larger pool of possible technical hires or consultants, and a larger market commitment to product longevity. These may "trump" the technical merits of FPGAs from smaller vendors or start-ups.

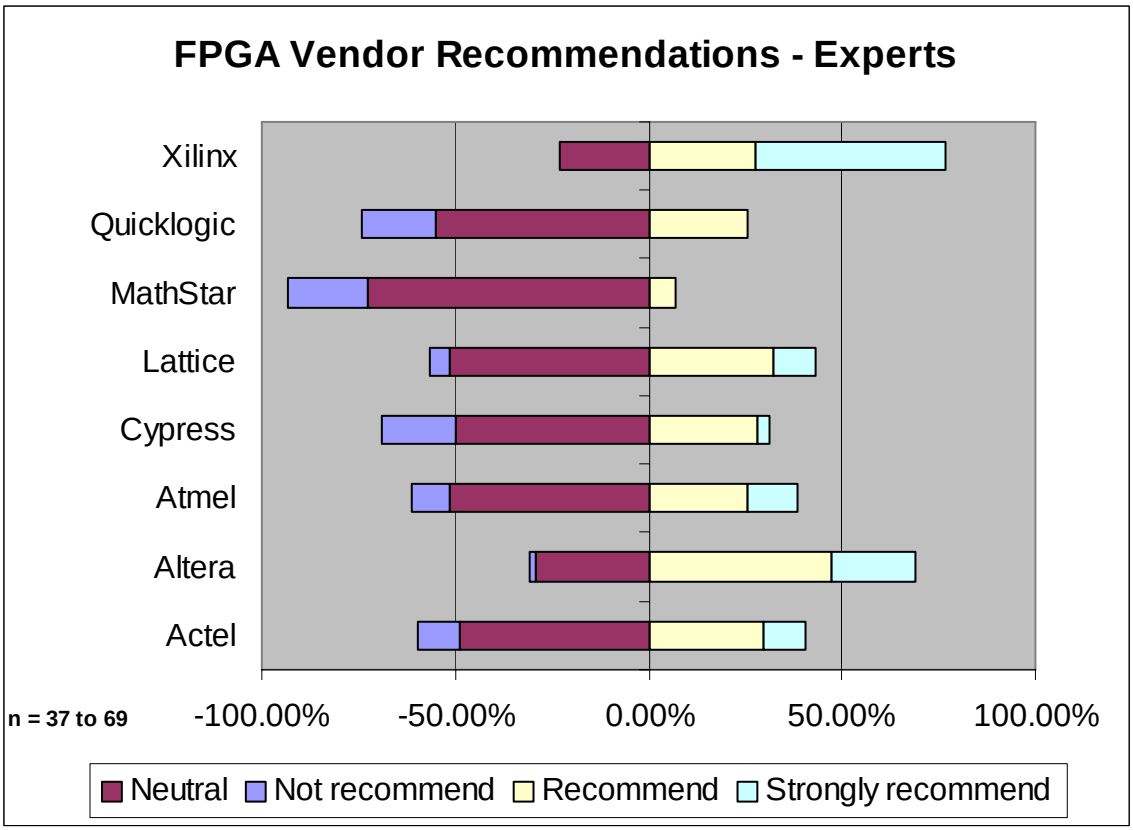
Looking towards the future, consider Lattice as an example. In terms of engineers "evaluating" their FPGAs, this company had the highest percentage at 13.43%, if not the highest raw number. This indicates a lot of interest in Lattice at time of survey. Altera also has disproportionately more engineers evaluating it than Xilinx. Does this mean anything? It's hard to say, but it might be a an indicator of future design wins. The leaders of the past in technology are not always the leaders of the future.

Opinions of the FPGA vendors

Two strands of thought exist about the relationship between familiarity and opinion. One is that "familiarity breads contempt," meaning that designers will tend to have negative opinions of those FPGAs with which they are most familiar, and idealize those that they only hear about in advertisements. The other is that "familiarity breads success," meaning that the most familiar FPGAs will enjoy the highest popularity. What does the data say, and how does the newby group differ from the expert group?







Survey conclusions indicate that familiarity breeds a strong customer experience, and that FPGA design engineers do not tend to romanticize alternative choices. In fact, one can argue that deciding to choose a Xilinx, Altera, or Actel FPGA is a major choice in terms of self-education and that once embarked, you are making a major design **and** educational commitment. This is all the more reason to conduct thorough research before your first FPGA design.

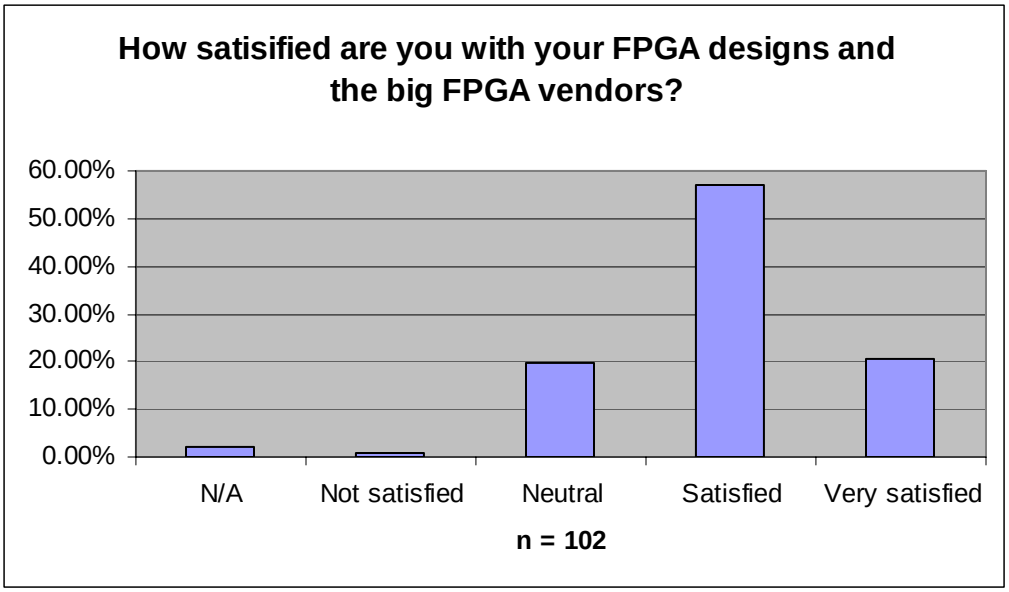
- **Take away:** familiarity with an FPGA vendor tends to create customer loyalty and positive opinions.

Differences among the total group, newby subgroup, and expert subgroup are not very pronounced. That said, let us draw your attention to Xilinx's high marks among experts in terms of "strongly recommend" at 49.28% and 27.54% indicating "recommend" vs. Altera at 21.82% ("strongly recommend") and 47.27% ("recommend"). Both of the big vendors have happy customers, but Xilinx's seem to be "even happier!" Indeed, all of the FPGA vendors get generally good marks in terms of recommend.

Strongest negatives are for MathStar, Quicklogic, and Cypress, which may be just as indicative that these companies have "niche" or "specialized" products as they may be of customer dissatisfaction. Often times, products are presented as fitting a wider variety of applications than they really fit, and then customers become frustrated when their design applications are not a good fit for the FPGA, tool, or board involved.

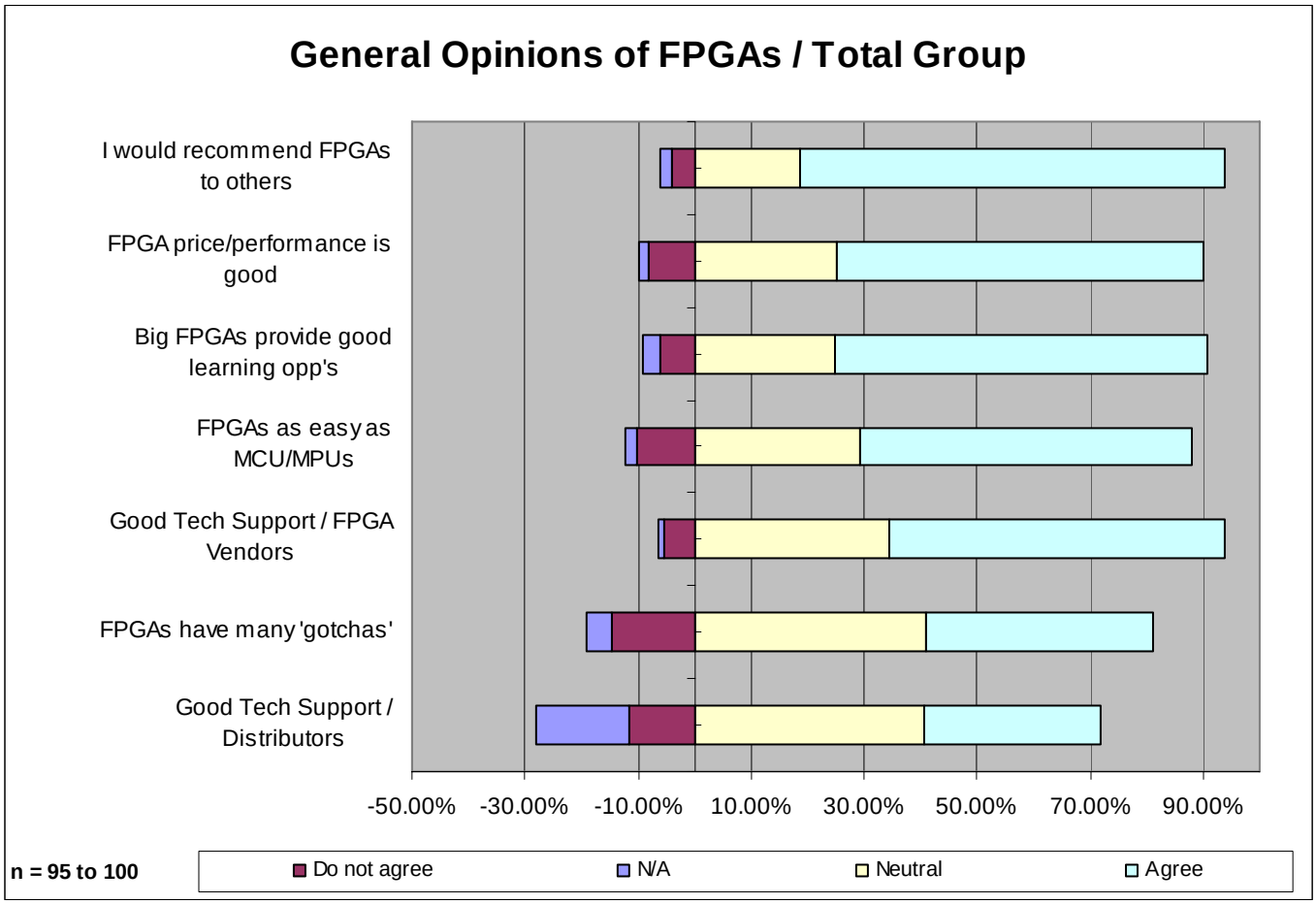
- **Take away**: Be sure to match each FPGA vendor's product strength (e.g., signal processing or low power) with your design need, as a blanket match might not be a good design fit.

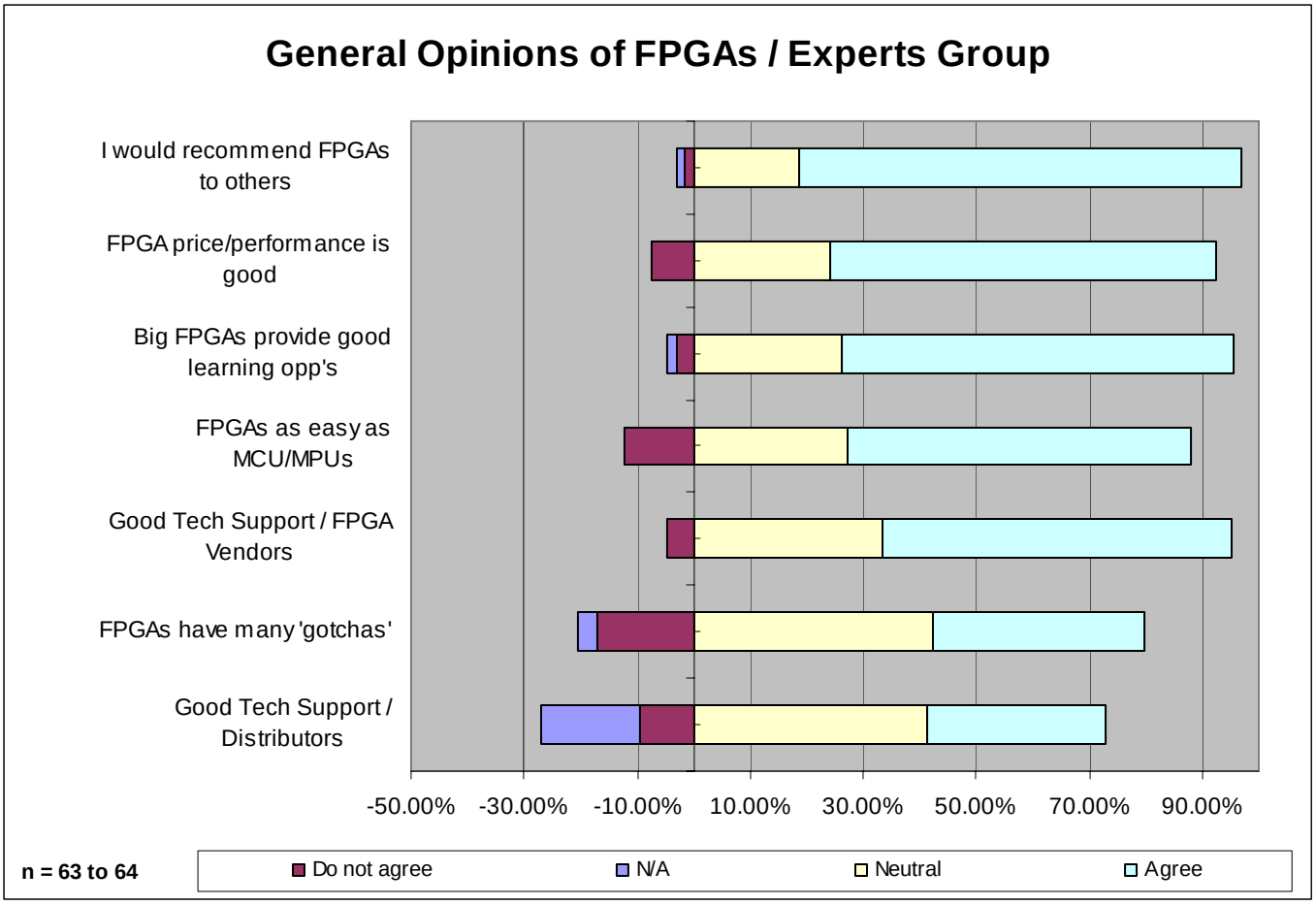
Looking at the big picture of "customer satisfaction," comparing the positive scores among newbies vs. those of experts, the newbies are consistently *less* positive than the experts. This is good news for those involved in FPGAs, because generally the FPGA experience is a good one.



Satisfaction in General with FPGAs

How satisified, in general, is the community with FPGAs? Would they recommend them to their peers? Is it a generally pleasant and productive design experience? We asked a range of general questions, and here are the breakdowns for the total group and the expert subgroup.





Generally, there is little difference between the opinions of the expert group and the newby group. To someone considering FPGAs, the strongest warning is the negative score of "FPGAS vs. MCU/MPUS" with 12.12% of the experts and 10.10% of the newbies saying that they are not as easy as MCU/MPUs. On the other hand, these are actually pretty low negatives given the common perception of FPGAs as difficult to program. Indeed, over 75% of both groups say that they would recommend FPGAs to other engineers and almost 70% say that the big FPGA vendors like Altera and Xilinx do a good job providing training and learning opportunities.

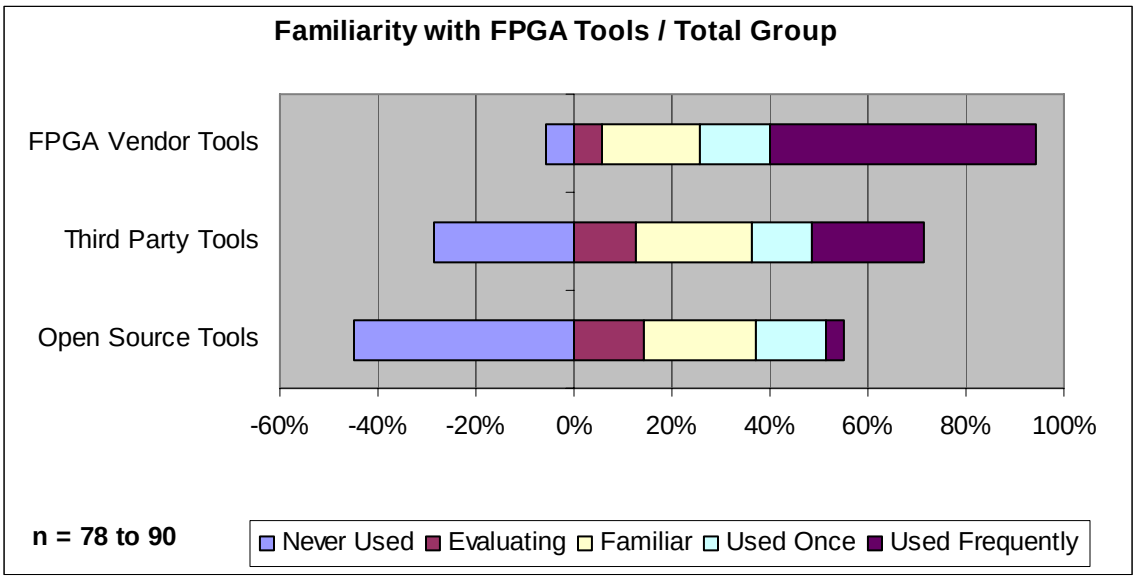
- **Take away:** The general satisfaction with FPGAs is high, and it is slightly higher among experts than among newbies. If you are new to FPGAs, this is a good sign that you have a good chance of having an altogether positive design experience.

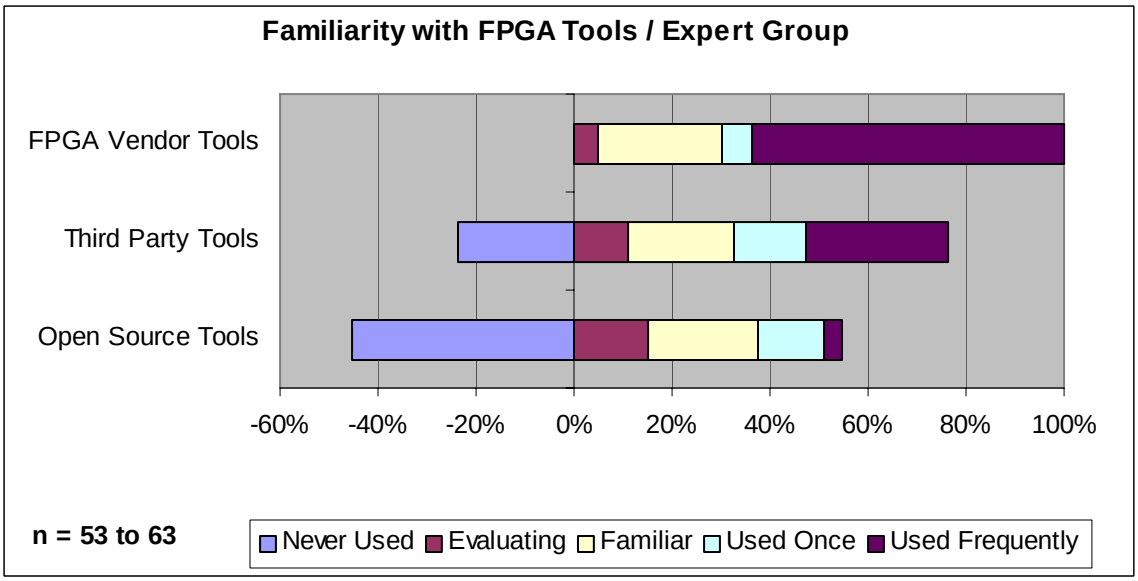
One area, however, for which there are high negatives is "gotchas." A significant percentage of developers agreed with the statement, "FPGAs have many 'gotchas,'" American slang for unforeseen design problems.

FPGA Tools: Familiarity and Opinions

FPGAs are nothing without tools, and as a result the FPGA vendors provide a wide variety of free and low-cost tools to encourage the "design in" of their FPGAs. In addition, third party companies like Mentor Graphics, Celoxica, Synplicity, or others compete to offer paid tools that either work with the "free" tools and/or substitute for them. (See the Interview section for some interesting vendor perspectives on FPGA tools, free vs. third party).

From the community perspective, we asked developers their opinions about FPGA tools and the tools ecosystem focused on three big groups: "free" tools from the FPGA vendors themselves, commercial third party tools, and "open source" FPGA tools.

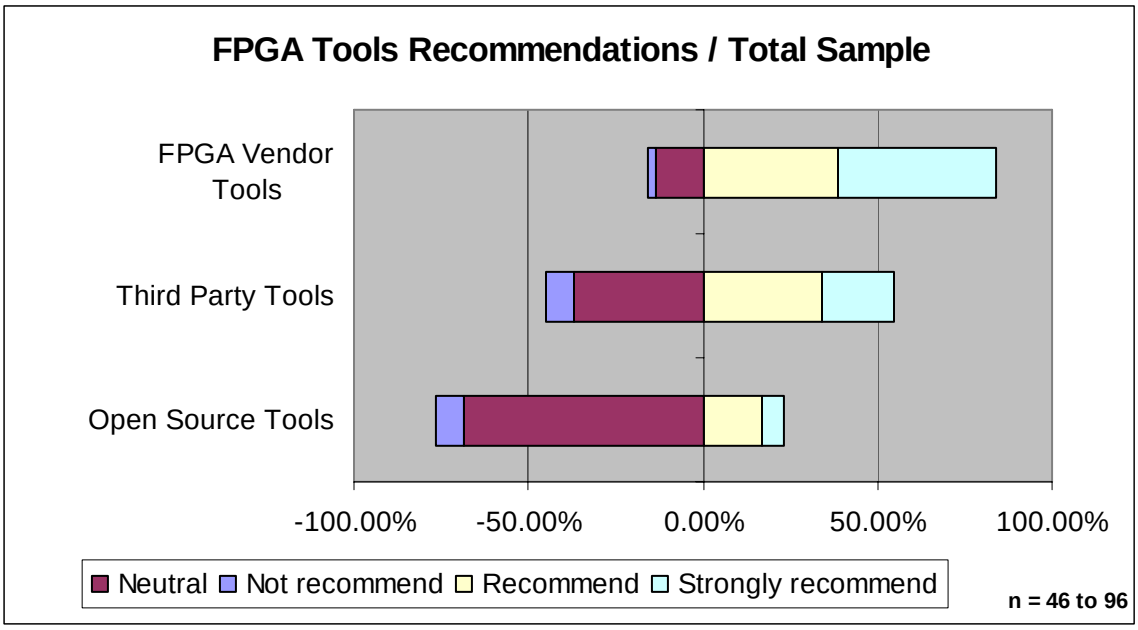


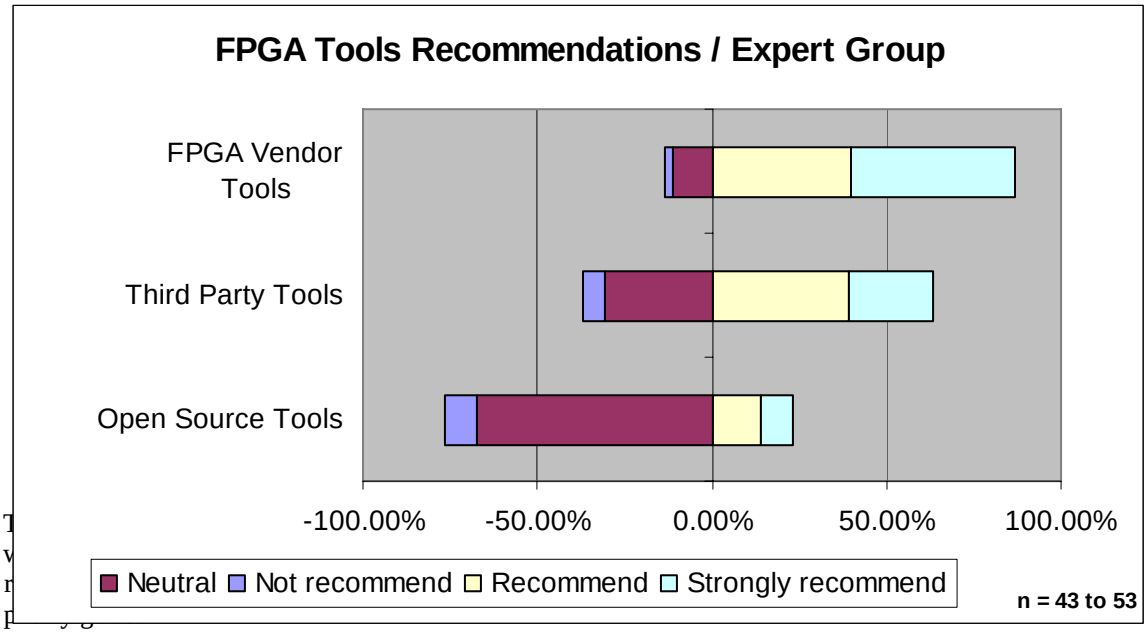


There are not, of course, great differences between the total group and the experts. What stands out most dramatically is that 100% of the experts are involved with the FPGA vendor tools: these tools are **critical** to using FPGAs. In other words, when you are evaluating an FPGA vendor you should also evaluate their tool chain. Download their "demo" or "free" evaluation tools and make sure that you like the look, feel, and usability of their tools and IDEs. It is not just the technical specifications of an Altera, Lattice, Actel, or Xilinx but also the usability of their tools that are important in getting your design to market efficiently and on time.

Following that, 65.45% of experts actively use at least one third party tool, with only 39.62% using open source tools. Clearly, therefore, the third party tools are most often "complementary" and not fully competitive with the vendor-supplied FPGA tools. Thus in evaluating an FPGA choice you should consider the third party tool ecosystem as well as a factor.

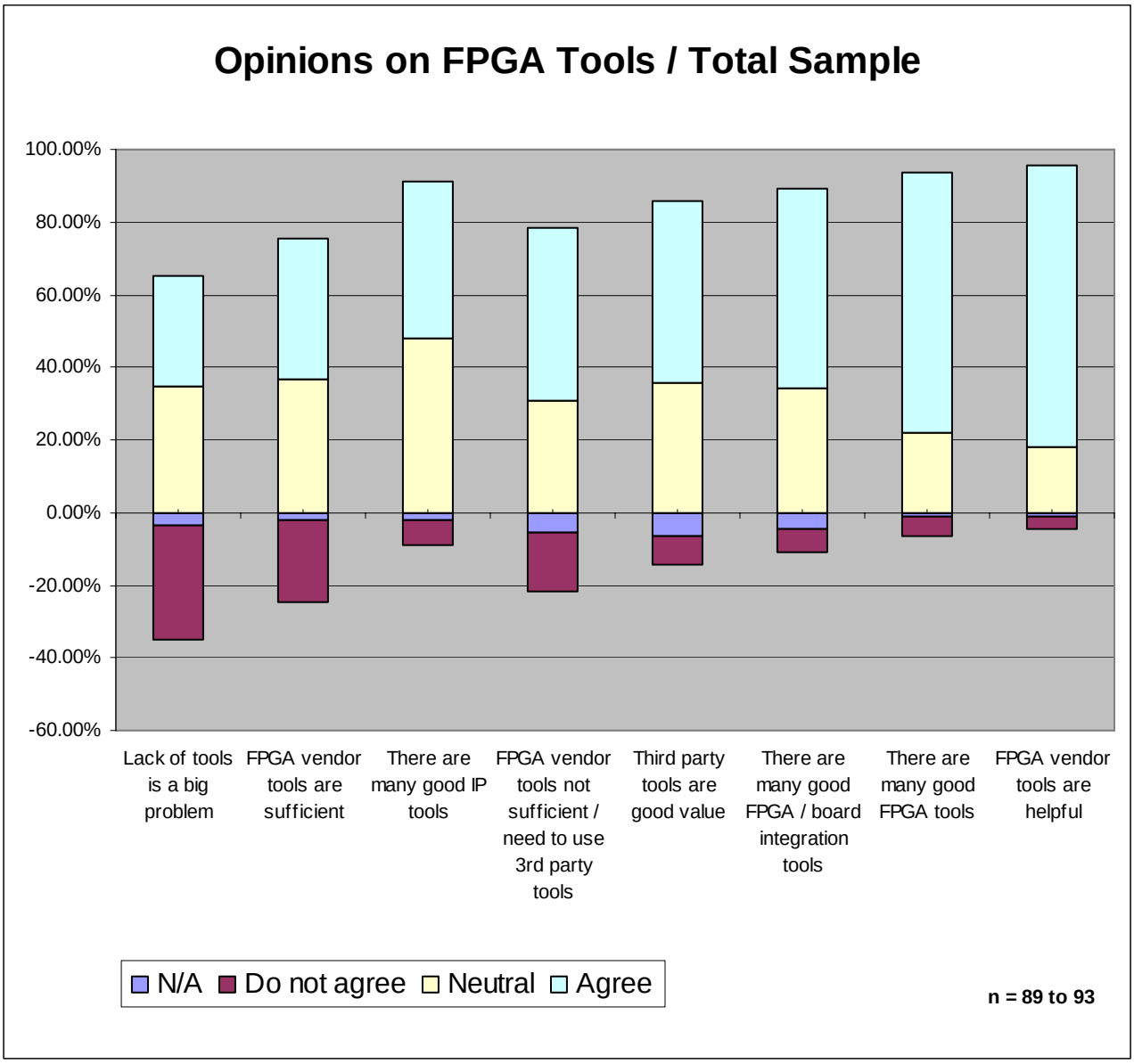
Would the community recommend tools? Are they satisified or dissatisifed with the FPGA vendor tools, the third party tools, and/or the open source tools?

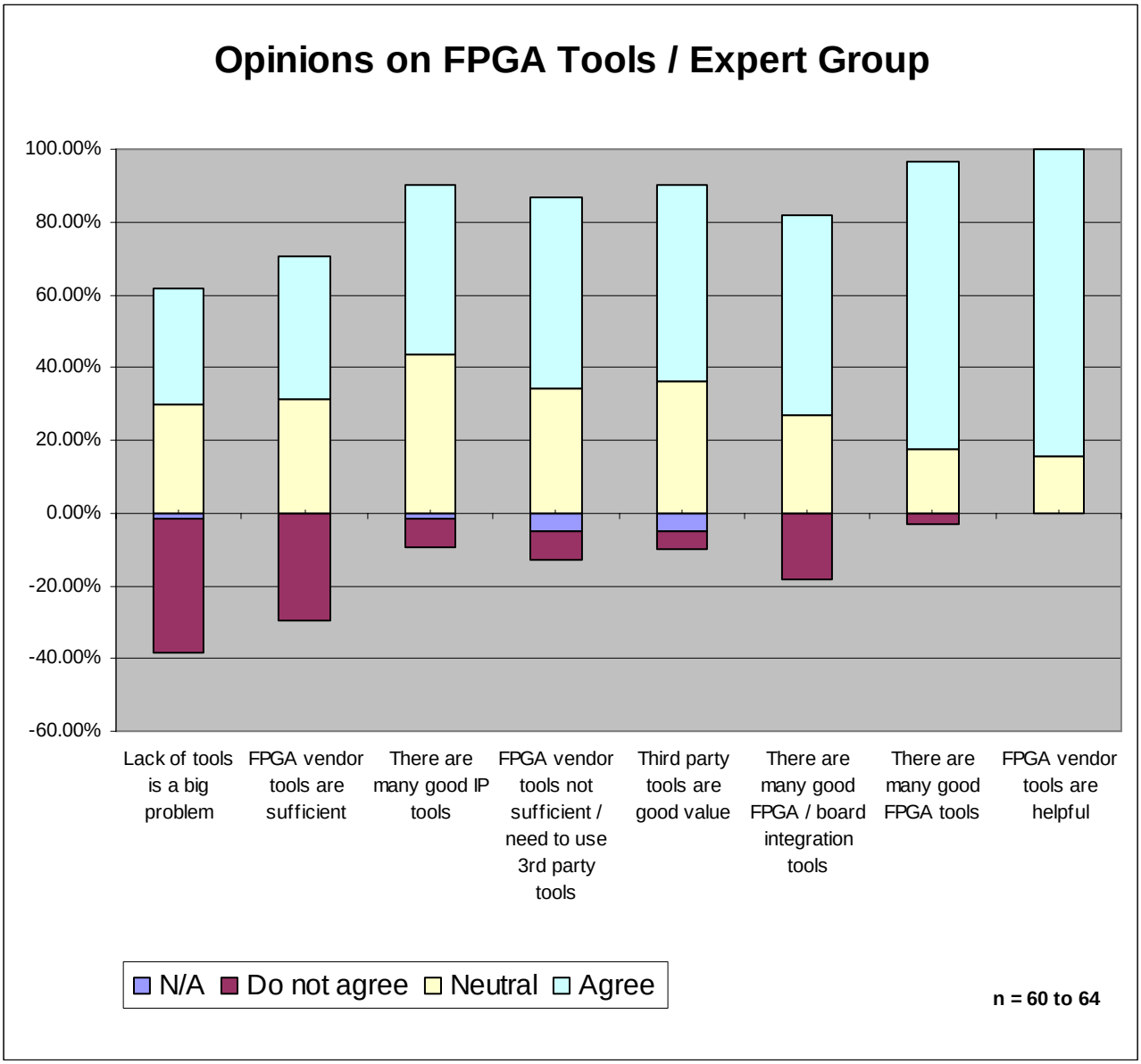




- **Take away.** You might think carefully about open source (in the negative) and about considering third party tools (in the positive).

What are the opinions of tools? We asked a large set of questions about the FPGA tools experience.





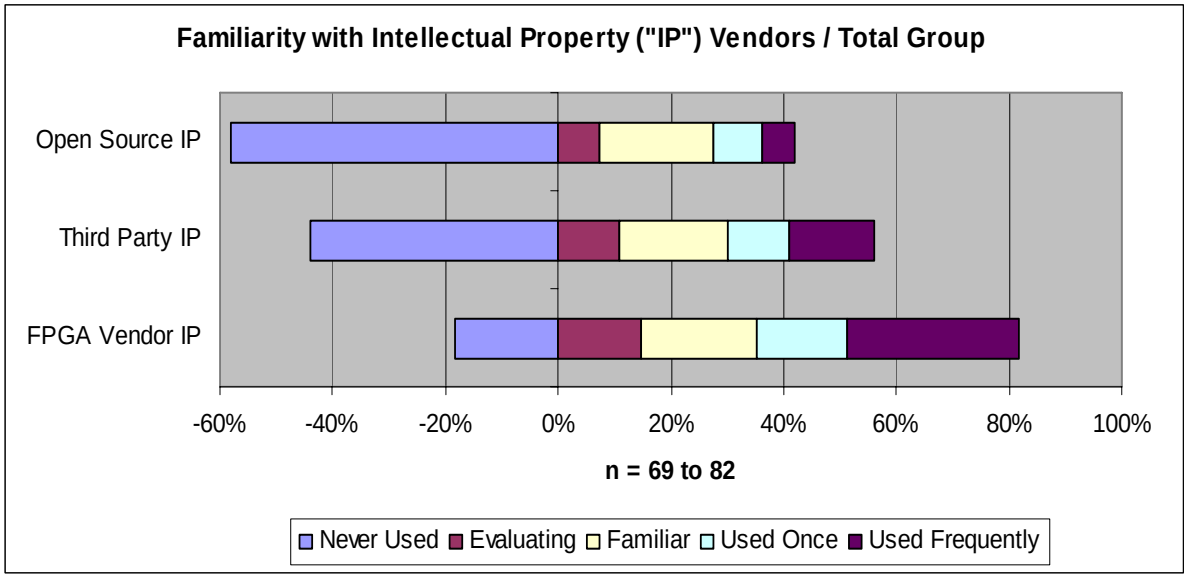
Here again the community is generally satisified with the tools available today, which is a bit surprising given the media buzz that FPGAs are hard to program and that available FPGA tools are not that good. Perhaps it is a case of not missing what you don't have. Perhaps not. Comparing the total group to the experts, the big area of difference are:

1. The expert group is much more *dissatisified* with FPGA / board integration tools, with 18.33% disagreeing that "There are many good FPGA / board integration tools." This compares with only 6.59% of the total sample.
2. The expert group is much more *satisfied* with the FPGA vendor tools with 100% neutral and agreeing that these tools are helpful vs. 3.23% of the total group expressing dissatisfaction.

Note also the large percentage disagreeing with the statement "FPGA vendor tools are sufficient," which indicates that while developers may be satisified with FPGA vendor-supplied tools, there is a significant hunger for
third party and other tools.

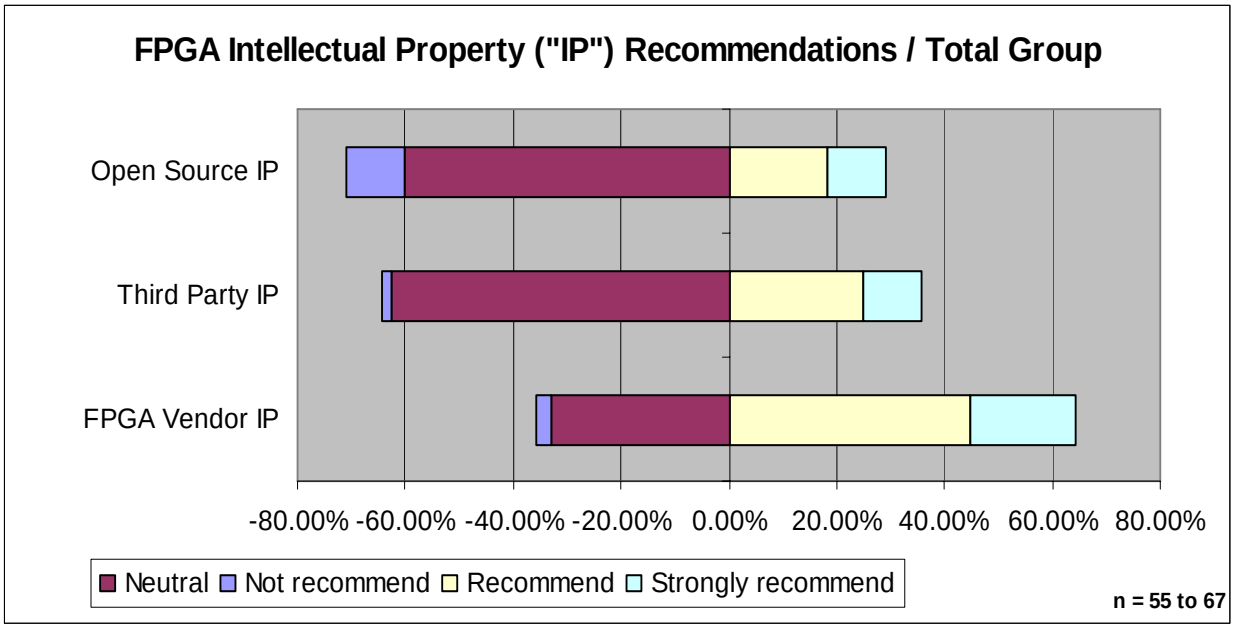
FPGA IP: Familiarity and Opinions

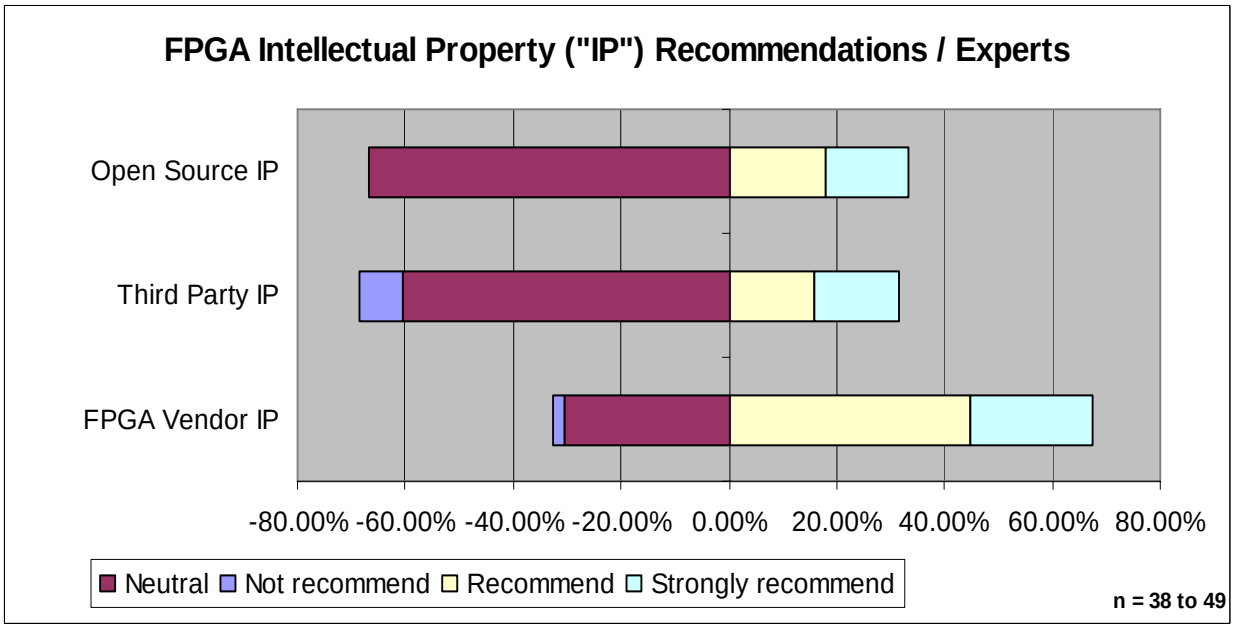
Intellectual Property or "IP" is used in most FPGA designs. Designers often create their own IP, purchase third party IP, and/or use IP provided by the FPGA vendor or board manufacturer (in the case of third party boards). In many cases there are tools and IDEs to help facilitate FPGA IP integration and verification. The downside to IP is there is a lot of distress in terms of IP purchase, integration, and verification. So we asked the survey group about their experiences with IP, specifically IP for FPGAs.



Again, one sees that the FPGA vendor supplied IP is the most known with third party IP in the middle, and open source IP the least familiar. The expert group did not differ significantly from the total group in its relationship to IP.

After the fact what were the opinions of IP? It happens to be one of the more troublesome areas of FPGA designs, more troublesome than tools.



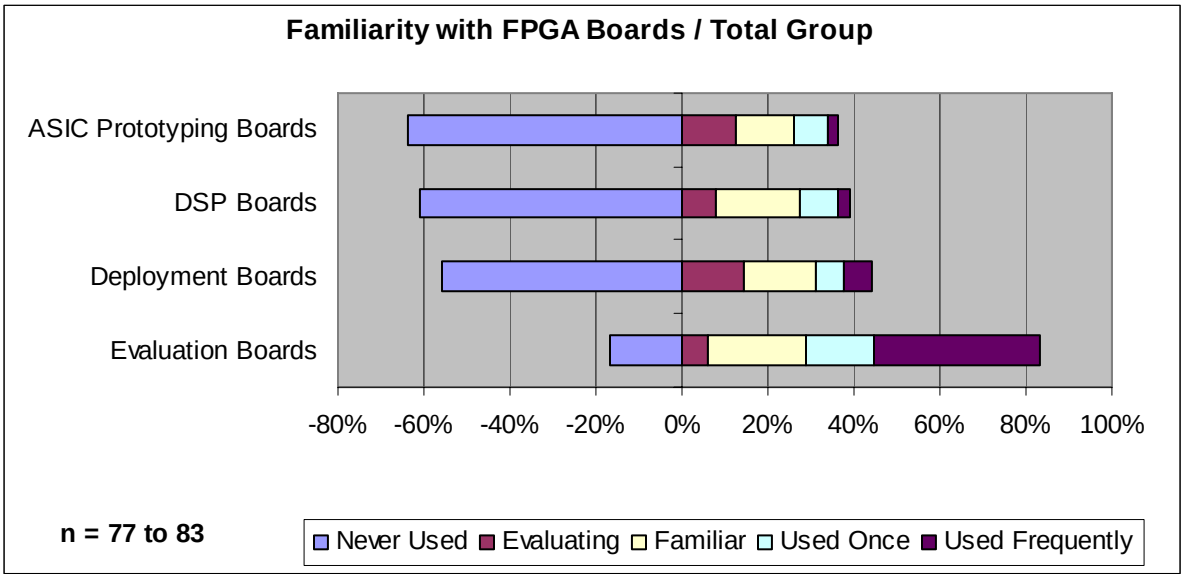


In this case, the expert group was more *negative* about third party IP (7.89% not recommending vs. 1.79% of the total group) and more *positive* about open source (o% not recommending vs. 10.91% of the total group).

- **Take away**. The possible "take away" here is that the variable influencing the IP experience is not the source of the IP itself (FPGA vendor, third party, or Open Source) but rather the IP itself. So choose carefully.

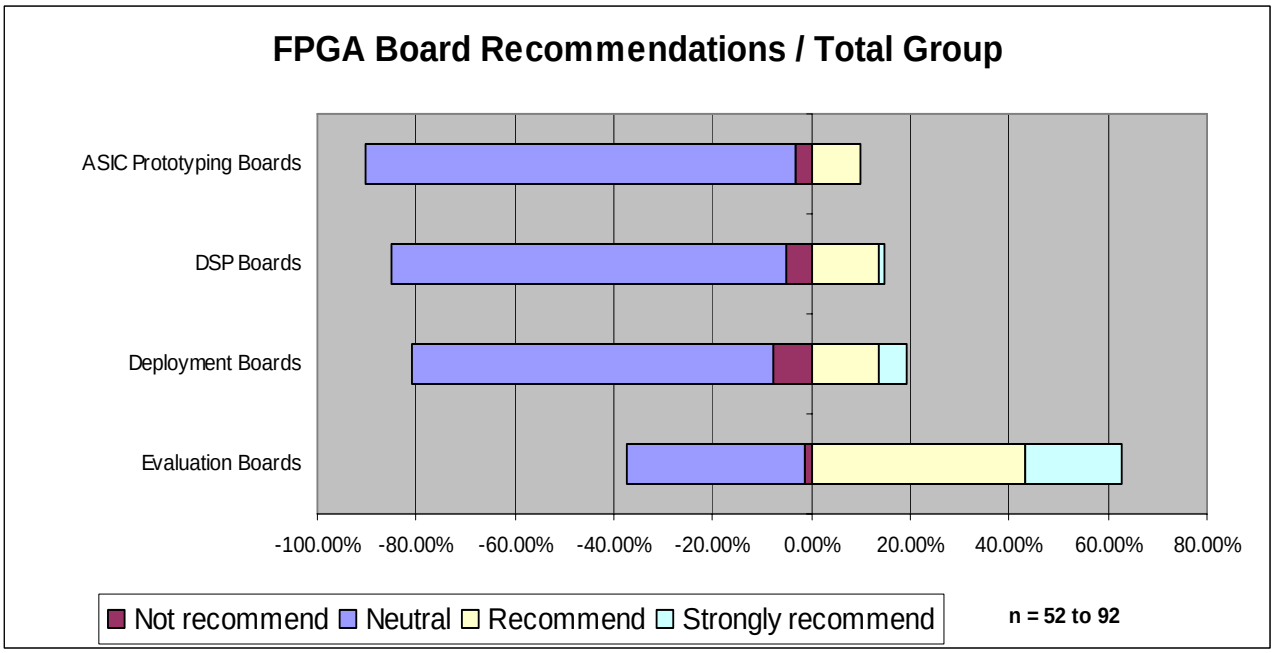
FPGA Boards: Familiarity and Opinions

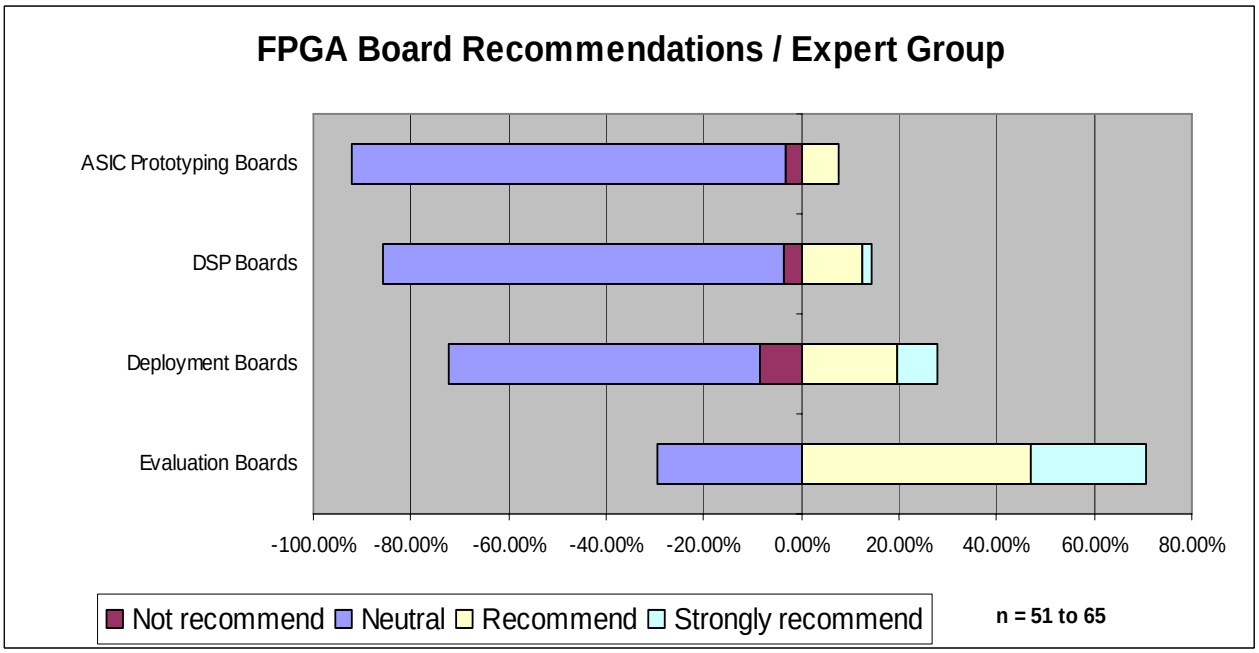
FPGAs are ultimately put onto printed circuit boards or "PCBs." Even if you are only working on the FPGA portion of a desig, your FPGA will probably sit on some PCB somewhere, and there are FPGA/board integration issues. (Consider Mentor Graphics or Altium's products if you want to design your own PCB). In fact, many embedded systems engineers turn to third party boards as either evaluation or deployment boards.



Not surprisingly, almost everyone has used FPGA "evaluation boards." Fewer have used FPGAs in deployable boards, about the same have used DSP boards with FPGAs, and the fewest have used FPGAs for ASIC prototyping. There are no real surprises here.

But how happy are designers with FPGA boards? Here there are some surprises - some of which might be very relevant to your FPGA board choice.



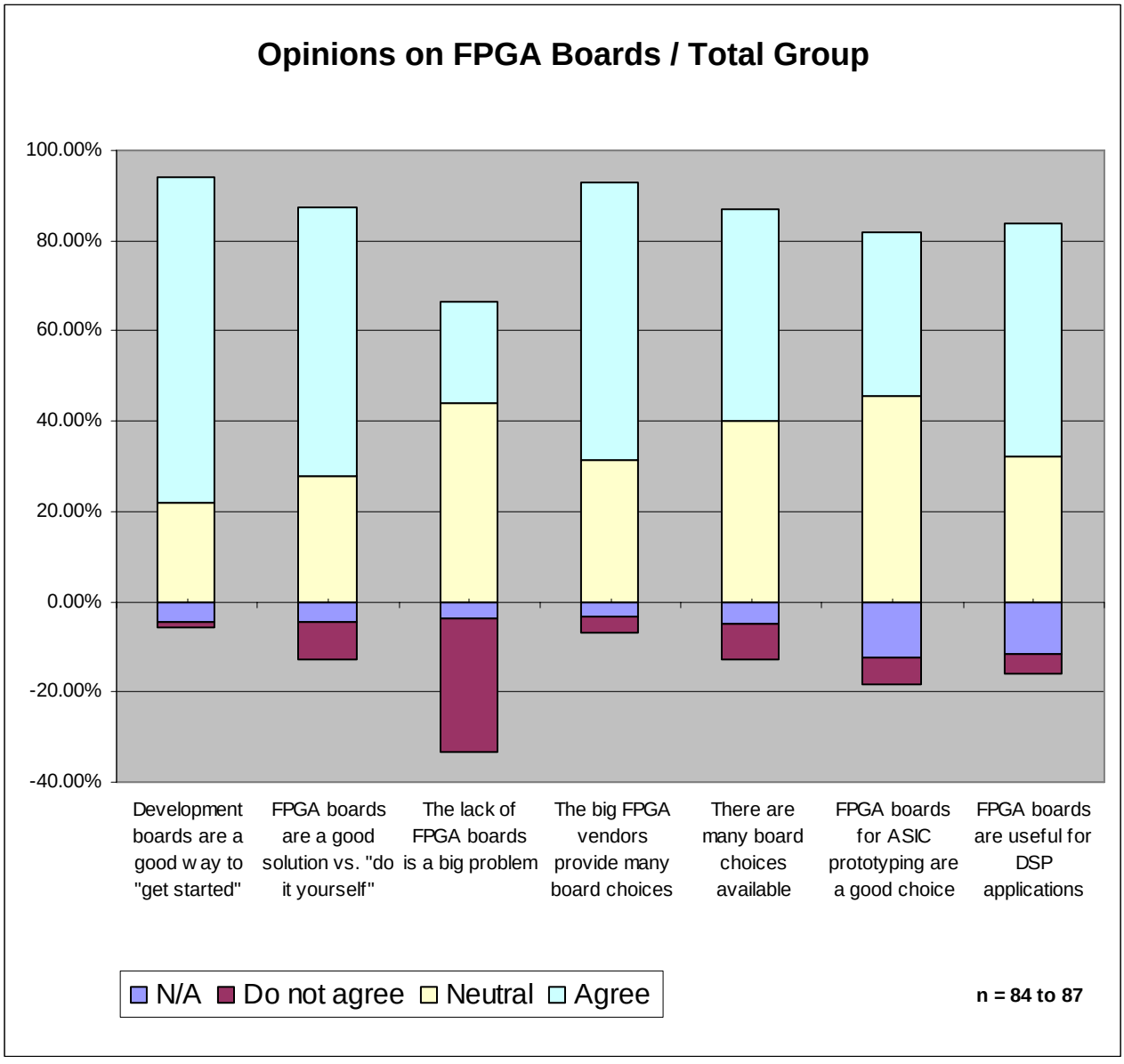


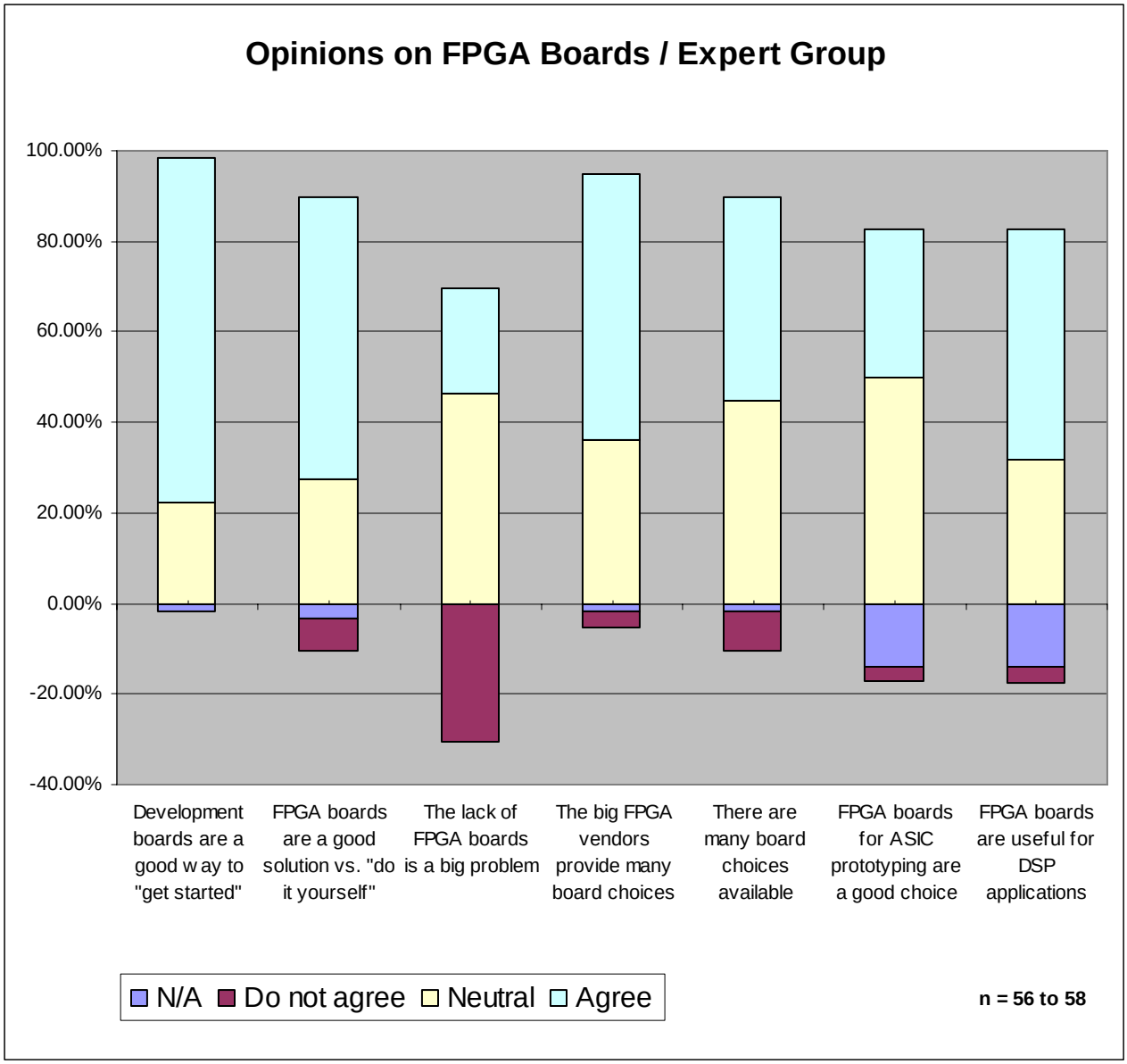
Compared with FPGAs, tools or even IP, the boards area has the highest negatives. 8.33% of the expert group said that they would "not recommend" FPGA deployment boards and a huge 63.89% were "neutral," or lukewarm towards their FPGA deployment board choice. Negatives for ASIC prototyping boards and DSP boards were also not insignificant.

- **Take away.** When choosing an FPGA deployment board do your research carefully as to board specifications, FPGA capabilities, and post-purchase or technical support from the

board vendor. Evaluation boards, in contrast, enjoy pretty good positives but of course the choice of an evaluation board is not as mission-critical as the choice of a deployment board.

What then were the "general opinions" about FPGA boards? As for the other research areas, we asked a series of questions on the topic.





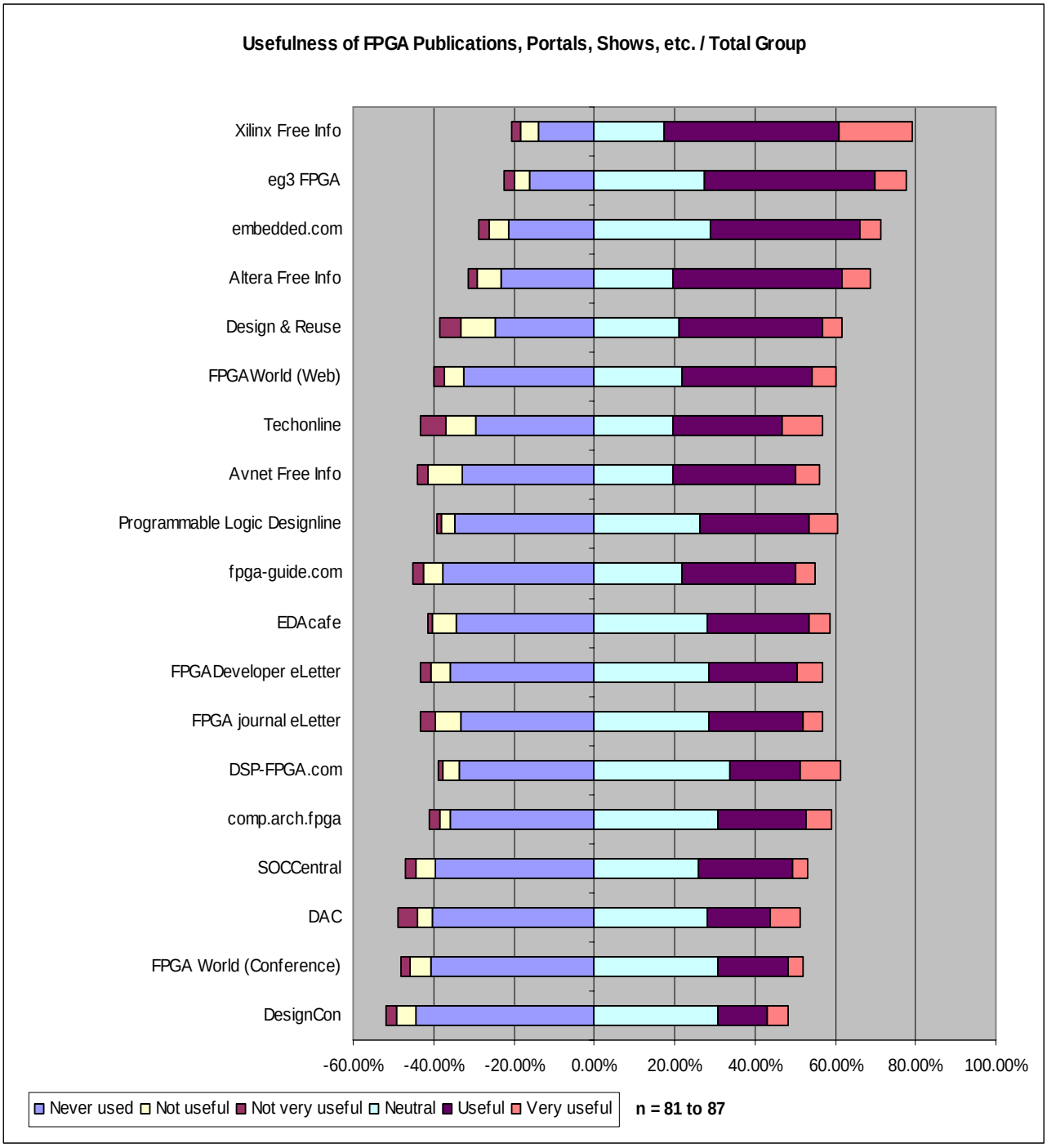
There are not really huge differences between the experts and the total group on the subject of boards. The main area of agreement is that the "lack of FPGA boards" is a problem with 22.62% saying that they agree and 44.05% neutral. Clearly there is market opportunity for more FPGA boards for deployment, and there is a warning to engineers to choose carefully when selecting an FPGA board choice was one area in the survey with relatively high negatives.

FPGA Design Information

eg3.com is all about finding the best information on the Internet for topics in embedded systems, and in this case about FPGAs. Our information on FPGAs is updated weekly and each week we

send out new alerts via e-clips to interested engineers based on keyword topics, including FPGAs (h t t p : // w w w .eg3.com/eclips/). That said, it was interesting to poll the audience on what sources of information they have found useful in their hunt for FPGA educational information.

Here is one final graph in the survey indicating the relative popularity of various sources of information, both on and off the Internet.



Again what is surprising and pleasing here is that the Number 1 and Number 4 most popular resources were Xilinx and Altera's websites.

- **Take away.** The vendor sites themselves are excellent resources of FPGA information, but when using vendor sites do not forget that they are not "neutral" but rather biased as sales tools to sell their own products.

Among media sites, eg3.com did well, but this is not a surprise given that we were surveying our own audience (a self-selected group). On the negative, real-world trade shows have large numbers of engineers that have never attended them, indicative of the expense and difficulty for engineers of getting to these useful but expensive events. No single FPGA site did very well - indicative that there is not (yet) a really effective portal or email service for FPGAs.

FPGA Anecdotes

Finally, we wanted some qualitative opinions about the FPGA experience. Imagine you were at a trade show event, drinking beers with fellow design engineers or programmers, and you asked them their "best" and "worst" experience with FPGAs. Obviously this would not be a scientific sample - the ones who chimed in with their worst or best experience might be the most gregarious or just the most drunk. But nonetheless it is always interesting and valuable to hear word-for-word what others have experienced on the long road to a successful electronic design.

We therefore asked three anecdotal questions:

1. *As a potential user or evaluator of FPGAs, what has been your biggest difficulty so far? What sort of information would you like to find available?*
2. *As a user of FPGAs, what WARNING message would you like to convey to other, future users of FPGAs? What has been your greatest problem(s)?*
3. *As a user of FPGAs, what POSITIVE message would you like to convey to other, future users of FPGAs? What has been your greatest success or positive experience with FPGAs?*

Here are some anecdotes:

Biggest Difficulty

"Tools are not widely available."

"Big companies tools are device-oriented offering closed solutions, e.g. there is no "pure" HDL simulator, rather a HDL-to-device translator plus device simulator."

"No difficulties faced so far."

"Nothing is bad in fpga..... but please make it to understand quite simply!"

"Need more support, such as free ip cores!"

"Troubleshooting self-customized boards during initial stages. My personal feeling is that there are lots of troubleshooting procedures that many don't address and is known with experiences. Such information can be provided sequentially from [the] hardware and software design point of view."

"In my country which is not USA [I have] found that it's not easy to get devices or evaluation boards if you're starting with a small team on a small device. Simply put evaluation is not an easy way without getting into big $$$, distributors simply refuse to work with you unless you're a big company. This puts in my opinion a lot of braking on the propagation of FPGAs as a mean to express logic, often something else gets used instead of a simple FPGA design."

Warning Messages

"Raise the abstraction level not starting at the RTL level, debug it using any HDL simulator and then move to the vendor's tools."

"It is hard to start your first FPGA project."

"Select your platform & related tools carefully. Proper understanding of FPGAs is neccesary for optimized performance."

"Incompatibility of latest software versions with older FPGAs. I faced a problem when I wanted to upgrade the code/program for very old/almost obsolete FPGA device on an old hardware board, but had only latest version of program software that does not have this device library. I [had] to dig back for the older software to complete the task."

"User of FPGA [requires a lot of] abilities, that is: S/W programming, H/W programming, Logic design, Computer architecture and others. Very difficult field."

"As the RTL platform keeps on changing from Verilog to system verilog and System C, etc., one should keep on learning all these RTL languages to stay in the market. Also one should be aware of all the evaluation and commercial boards available in the market, so that he can develop newer ideas in the awarded time like 'software defined radio boards.'"

"If you're a beginner try to avoid [the] marketing stuff of vendors and get to the real things: it's not always easy to find what you're looking about but still there's a lot of information available."

Positive Messages

"FPGAs are good for: 1. high speed designs; 2. IP protection for low volume; 3. prototyping for ASICs."

"[There are] very stong tools available for DSP applications!"

"SOPC is so wonderful - you will love her!"

"Though everyone learns from problems, I too learnt a lot of things from the problems faced during the experience of my FPGA designs. We should take it as positive as there is a lot of online support and offline support from all the FPGA vendors to solve problems. If any[thing], FPGA designing confidence increases from your hands-on experience."

"FPGA is a great platform for design and prototyping. Testing is very easy. It saves lot of production time. The ongoing available high performance processors on FPGA allows to implement complex projects. It should be compulsory in all the universities as by using this FPGA platform one can get practical feel of some exciting applications based on embedded systems."

> "Get you hands dirty fast! It'll pay off even if sometimes you'll have to advocate the usage of FPGAs. Note that there's a misconception of FPGA power in circles extern[al] to the hardware domain - most people [who have] heard about programmable logic still think in 80's style about FPGAs like it's still "glue logic," although it's much more than this now."

And, our all time favorite user feedback on the FPGA experience:

> **"One can perform thousands of mistakes, [and] every mistake is a great experience!"**

Email Interviews with Key FPGA Vendors

One of the hassles in selecting an FPGA is going from vendor to vendor asking different questions and trying to compare notes. In addition, it is the FPGA vendor community that really has the most in-depth experience in FPGA design issues and customer relations. Thus, in this section we provide "email interviews" with major FPGA vendors on various important topics.

In each case, keep in mind that the vendor is putting his or her best foot forward. These are informative but polemical pieces explaining one or more sides of an issue. In some cases we have more than one interview per topic, which allows comparison of responses.

In all cases, remember to check with the vendors that interest you directly – as the technical details of your project as well as their FPGA offerings are subject to change.

Actel: FPGAs and FPGA Design Tools

12 August 2007: Actel: FPGAs and FPGA Design Tools

Interviewee. Stephanie Mrus, Sr. Mgr, Public Relations
Tel. 650/318-4614
Email. articlefeedback@actel.com
Company. Actel Corporation
Web. http://www.actel.com/

Q. **Obviously, this guide is focused on FPGAs. Can you please give a quick overview to the Actel FPGA product line?**

A. As a company, Actel is focused on attacking power consumption from both the chip and the system levels. The company focuses its power-smart programmable solutions on three key market segments called Value-based FPGA, Programmable System Chip and System Critical. The value-based market is the sub-$10 market where the FPGA can often serve as an ASIC replacement (i.e. flash-based reprogrammable ProASIC3 and ultra low power IGLOO for consumer, industrial, automotive and communications). The programmable system chip market is made up of system developers needing integrated functionality on a single chip (i.e. flash-based mixed-signal Actel Fusion Programmable System Chips for consumer, industrial, automotive, communications). And, the system-critical market is that where failure and security breach are unacceptable (i.e. radiation-tolerant RTAX-S and low-power RTAX-SL for military and aerospace).

Q. **There are other FPGA choices such as those from Altera or Xilinx. Is it possible to briefly highlight the ways in which the Actel offerings differ?**

A. Compared with traditional volatile SRAM-based FPGAs, Actel's nonvolatile FPGA solutions offer several consistent advantages -- single chip, low power, live at power up, security and neutron immunity.

Single Chip

Flash-based FPGAs store the configuration information in on-chip flash cells. Once programmed, the configuration data is an inherent part of the FPGA structure and no external configuration data load is required at system power-up. Unlike SRAM-based solutions, nonvolatile FPGAs do not require additional system components such as configuration serial nonvolatile memory (EEPROM) or a flash-based microcontroller in order to load the device configuration data at every system power-up.

Low Power

The Actel flash-based devices exhibit power characteristics similar to an ASIC, making them an ideal choice for battery-operated and other power-sensitive applications. With these devices, there is no power-on current surge and no high-current transition; these do occur on many SRAM FPGAs. Flash FPGA devices also have low static and dynamic power consumption, further maximizing power savings. These devices support sleep and standby modes of operation to greatly reduce power consumption.

Actel flash-based FPGAs offer:

-20x more battery life

-15x lower active power than "low-power" CPLDs

-200x lower static power than SRAM FPGAs

-1000x less leakage per flash cell over SRAM

For more information about power, visit Actel's resource site at

h t t p : / / w w w . actel.com/products/solutions/power/default.aspx.

Firm Errors

Firm errors occur when high-energy neutrons, generated in the upper atmosphere, strike a configuration cell of an SRAM FPGA. The energy of the collision can change the state of the configuration cell in SRAM FPGAs and thus change the logic, routing, or I/Os in an unpredictable and uncontrollable way. These errors are impossible to prevent in SRAM FPGAs and can result in failure-in-time (FIT) rates in the thousands. The consequences of these types of errors may result in a complete system failure and major support and product liability issues. The configuration element of the flash cell cannot be altered by high-energy neutrons and is therefore immune to neutron effects.

For more information about firm errors, visit Actel's resource site at

h t t p : / / w w w . actel.com/products/solutions/ser/default.aspx.

Live At Power-Up

Flash-based devices are live at power-up (LAPU). As soon as system power is applied and within normal operating specifications, these devices are working. The live at power-up feature greatly simplifies total system design and often allows for the removal of complex programmable logic devices (CPLDs) from the system. Glitches and brownouts in system power will not corrupt the device's configuration, and unlike SRAM-based FPGAs, the device will not have to be reloaded when system power is restored. This allows designers to reduce or completely remove the expensive power sequencing, voltage monitor, and brownout detection devices from PCB. Simplifying the total system design by using flash-based devices reduces cost and design risk while increasing system reliability and improving system initialization time.

Visit the live at power-up resource center for more information at

h t t p : / / w w w . actel.com/products/solutions/lapu/default.aspx.

Security

Actel's flash-based FPGA devices incorporate the Actel FlashLock® feature, providing a unique combination of reprogrammability and design security without external overhead. These advantages can only be offered by an FPGA with nonvolatile flash memory. Devices with AES-based security, such as Actel Fusion, allow for secure, remote field updates of both system design and flash memory content (over public networks such as the Internet), and ensure that valuable intellectual property remains out of the hands of system overbuilders, system cloners, and IP thieves. The FPGA design of programmed flash-based devices cannot be read back, though secure design verification is possible. Many device design and layout techniques have been used to make invasive attacks extremely difficult. For example, flash cells are located beneath seven metal layers, making tampering with the flash elements extremely difficult. Care has been taken to remove single points of attack in the device's programming control logic.

For a discussion of security and a listing of additional resources, visit Actel's security resource center at h t t p : / / w w w . actel.com/products/solutions/security/default.aspx.

Q. **Assume for a moment that you were a humble engineer, investigating which FPGA would make the best choice for his next design. You confront the many FPGA players in the field, and all of them insist that their FPGAs are wonderful for his next designs. Can you name three or four "pain" points by which a good engineer might differentiate the FPGA offerings, and thus hopefully select the "best" choice?**

A. Some of the "pain" points we see are related to: power; a renewed attention to the impact of neutron-induced errors; and the adoption of highly flexible and integrated solutions for system and power management functions.

Power

System designers are more power conscious than ever. This can be attributed to stricter system power limits, specifications and standards that put a cap for the total power consumed by the system. Power budget is a way to define the life time of the application, product reliability considerations and compliance with standards in a similar way as bill-of-materials is set. Simultaneously, dramatic growth for battery-operated applications such as wireless handhelds and multi-media players drives the demand for low power semiconductors and that trend will continue to drive semiconductors to the nano-amp range.

Programmable semiconductor platforms have become a preferred solution as product life time shrinks, competition is intense, and time to market has a significant impact on product success. It is easiest and quickest to get to market and to revenue using a programmable solution however these programmable platforms should meet all other design requirements such as cost, performance, size, security and not to forget power.

FPGAs have been adopted widely in recent years due to advanced technology that lowered the unit price, but the price reductions have come at the cost of higher power due to higher transistor leakage. The various FPGA technologies have significantly different power profiles, and these differences can have a profound impact on the overall system design and power budget. Added to this fact Moore's law effect on shrinking process geometries and the side effect of hiking static power consumption contributed by high transistor leakage and see a negative divergence between market expectations and semiconductor technology.

Compared with today's "low-power" best-of-breed, SRAM-based FPGAs, Actel's flash-based IGLOO FPGAs deliver between 100 and 1,000 times improvement in power reduction. The two to three orders of magnitude lower static power consumption can translate into weeks and months of standby battery life. For designers of battery-operated portable applications, other advantages of flash-based devices include flexible power saving modes with rapid recovery to operation, low dynamic power consumption, and clock management.

Power-smart chips can offer more than low-power consumption. They also can be used to intelligently control and reduce total power consumption in the overall system. For example, the mixed-signal Actel Fusion Programmable System Chip (PSC) offers the integration of FPGA logic with other elements used in system management, such as flash, analog, microprocessors, and clock management. This integration enables designers to remove parts from the board, reduce total power consumption and bill-of-materials (BOM) costs, and enable sophisticated power management of the system.

Actel also offers various other power-related resources including power calculators

(h t t p : / / w w w . actel.com/products/solutions/power/docs.aspx#calc), white papers, etc.

Neutron-induced Errors

The need for component reliability data is essential to ensure the proper function of the various systems in today's vehicles. Traditionally, automotive developers have relied on microcontrollers, ASICs and bulky wiring harnesses to implement and control these

systems and expand the capabilities of each automotive generation. Today, these solutions are reaching their technical limits as well as creating increased reliability concerns as complexity grows exponentially. To solve these problems, many designers are turning to FPGAs as a flexible, low-cost solution for their next-generation automotive electronics designs.

However, technology decision makers are beginning to anticipate sources of failure that will impact systems in the future. Neutron-induced errors can pose a significant reliability risk for many different types of electronic equipment. An upset to one cell in an SRAM-based FPGA could potentially result in the FPGA losing its configuration. When this occurs, it may cause the host system to malfunction. Neutron-induced firm errors have progressed from being a nuisance to being a significant problem. Future deep submicron manufacturing processes will create substantial challenges for designers of automotive electronics.

Neutron-induced errors have significant implications for mission-critical applications that utilize an SRAM-based FPGA. Because existing detection techniques, reliant on reading back FPGA configuration at regular intervals, may let corrupt data enter the system, the widespread deployment of susceptible FPGA technology could create the need for a new quality evaluation system to check the immunity of systems to neutron-induced errors. The read-back circuits that enable detection of a corrupted configuration are themselves subject to SEUs or damage. Additionally, schemes to detect and correct FPGA firm errors add extra complexity to the system design and significantly increase board space and bill-of-materials cost.

Neutron-induced firm errors can contribute significantly to the overall system failure in time (FIT) rate. Difficult to diagnose and detect, soft and firm errors could create maintenance and service issues with the potential to escalate. Of the three main FPGA technologies -- antifuse, flash and SRAM -- only antifuse and flash are immune to the effects of neutron-induced errors, making them eminently suitable for applications where reliability is a concern.

Today, engineers are finding that it can be a tremendous advantage to use an FPGA supplier who has a history of providing 'mission critical' products, as does Actel, and are already engaged in ensuring high performance and reliability in extreme environmental conditions.

System and Power Management

Nearly every electronic system requires system and power management. These tasks include power and thermal management, voltage monitoring, data logging and system diagnostics. While many designs can require hundreds of components to handle system management, designers are searching for system management solutions that reduce system cost while improving reliability. The Actel Fusion PSC can integrate these system management functions and provide programmable flexibility – all in a single chip. As a result, Fusion PSCs can offer cost and space savings of 50 percent or greater relative to current implementations.

Q. **What's the big deal about "single chip" FPGA solutions? Why is this "better" or "worse" than those from the larger FPGA providers?**

A. Flash-based FPGAs store the configuration information in on-chip flash cells. Once programmed, the configuration data is an inherent part of the FPGA structure and no external configuration data load is required at system power-up. Unlike SRAM-based solutions, nonvolatile FPGAs do not require additional system components such as configuration serial nonvolatile memory (EEPROM) or a flash-based microcontroller in order to load the device configuration data at every system power-up.

Q. **Are there particular vertical markets or application areas in which Actel has found a niche? I.E., are there particular applications that have historically been Actel's "sweet spot?"**

A. Actel has global customers across its three key market segments -- Value-based FPGA, Programmable System Chip and System Critical. For cost- and power-sensitive customers, the company's ProASIC3 and IGLOO devices can serve as an ASIC replacement. For those customers requiring integrated functionality on a single chip, the Actel Fusion Programmable System Chip can be leveraged to monitor and control system and power management. And, for system-critical applications like military and aerospace or under-the-hood automotive applications where failure is unacceptable, the company's RTAX-S/SL or extended temperature ProASIC3 can serve these needs, respectively.

Q. **How does Actel's offering differ from the of Quicklogic, another (former?) FPGA vendor that has touted low power as the key to many future designs?**

A. Actel flash-based FPGAs offer:

-20x more battery life

-15x lower active power than "low-power" CPLDs

-200x lower static power than SRAM FPGAs

-1000x less leakage per flash cell over SRAM

Compared with competitive solutions, IGLOO will likely be the preferred choice for customer that needs features, lower power behavior, user-friendly power modes, reprogrammability, and lower total system cost.

IGLOO FPGAs provide broader range of products that span from 30,000 system gates to 3 million system gates, are reprogrammable, secured, single-voltage solution and have lower power characteristics and better low power modes. IGLOO's Flash*Freeze technology offers worry-free low power mode implementation with I/O and clock management, ability to tri-state the I/Os, rapid recovery to operation mode.

For more information about Actel's power advantages, please visit:

http://www.actel.com/products/solutions/power/default.aspx

Q. **What about pre-sales learning? How can an engineer "try before buying" your products and/or participate in online learning or seminars? What offerings do you have for pre-sales or low cost learning before he or she makes a major commitment?**

A. One area of the Website has the information you've requested (Webinars and webcasts).

Also, Actel offers several amazing starter kits/evaluation boards to "try before you buy". These hardware solutions including the Fusion starter kit, *IGLOO* starter kit, *ProASIC3* starter kit, *ProASIC Plus* starter kit, *AX* starter kit. Check out:

http://www.actel.com/company/events/default.aspx

Q. **Let's talk about IP ("Intellectual Property"). Tell me about Actel's IP offerings, especially your recent partnership with ARM. What is great for**

the design community in your new ARM-based offerings vs. those from Altera or Xilinx?

A. As part of our ongoing partnership with ARM, we continue to explore current and next-generation technologies, like ARM7, Cortex-M1 and Cortex M3, that will benefit our mutual customers, thereby increasing the choices available to designers regarding which part to use in their application and enabling designers to take advantage of the industry-standard ARM architecture and its ecosystem of tools and support.

Cortex-M1 has been optimized for size and speed specifically for use in Actel's flash-based FPGAs. This gives designers easy access to the ARM industry-standard architecture even for low-volume applications. In addition, Actel makes these ARM cores available without out license fees or royalties. By lowering the cost of entry to the price of an FPGA, Actel and ARM are making industry-standard available to the majority of designers who do not have the volumes necessary to justify the high cost of using an ASIC.

Q. **What about after the sale? What is your technical support like? Are their different support options? And what about design services - does Actel offer design services to help with a design?**

A. Actel offers design service support via its Protocol Design group out of New Jersey.

H h t t p : / / w w w . actel.com/products/services/protocoldesign/default.aspx

Actel Corporation's Protocol Design Services provides hardware and software design services, providing varying levels of design services to customers.

- FPGA, ASIC and System Design
- Software development and implementation
- Development of prototypes, first articles and production units

The team has participated in the development of Optical Networks, Routers, Cellular Phones, Digital Cameras, Embedded DSP Systems, Automotive Electronics, Navigation Systems, Compilers, Custom Processors and Avionics Systems.

Q. **Thank you, Stephanie, for this informative interview.**

Altera: FPGAs and FPGA Design Tools

15 August 2007: Altera: FPGAs and FPGA Design Tools

Interviewee. Danny Biran, SVP, Product and Corporate Marketing
Tel. 408-544-7000
Email. catalog@altera.com
Company. **Altera Corporation**
Web. http://www.altera.com/

Q. Obviously, this guide is focused on FPGAs. Can you please give a quick overview to the Altera FPGA product line?

A. Altera Corporation is the pioneer of programmable logic solutions, enabling system and semiconductor companies to rapidly and cost effectively innovate, differentiate, and win in their markets. Altera understands programmable devices are part of a bigger picture, and that true design success requires an array of other tools. To that end, we complement our complex programmable logic devices (CPLDs) and field programmable gate arrays (FPGAs) with sophisticated software tools, pre-verified and configurable intellectual property (IP) cores, development kits, and reference designs.

The Altera product lines are as follows:

- *MAX CPLDs:* Instant-on capability, combined with single-chip, non-volatile, and ease-of-use characteristics in a wide range of packaging options, make MAX® CPLDs ideal for meeting the rigorous low-power and low-cost requirements of today's high-performance systems.
- *Cyclone FPGA Series:* For cost-sensitive, high-volume applications, Altera offers the Cyclone® FPGA series—the industry's only FPGAs designed from the ground up for low cost. The density range for the Cyclone FPGA series is 2,910 to 120K logic elements.
- *Arria™ GX FPGAs*: Arria GX FPGAs provide a risk-free, transceiver-based, low total-cost-of-ownership design path for applications requiring the PCI Express, Gigabit Ethernet, or Serial RapidIO™ serial interface protocols. The Arria GX family is comprised of five devices ranging in density from 21,580 to 90,220 logic elements.
- *Stratix® FPGA Family:* Altera's Stratix series of high-density, high-performance FPGAs feature unmatched core performance, memory capacity, and time-to-market advantages to help designers get state-of-the-art products to market faster with lower risk and higher productivity. Stratix devices are the only FPGAs with support for 256-bit Advanced Encryption Standard (AES) volatile and non-volatile security key to protect designs from copying, reverse engineering and tampering. The Stratix FPGA family is comprised of devices ranging in density from 10K to 340K logic elements.
- *HardCopy Structured ASICs series:* Through its unique FPGA front-end design flow, the HardCopy structured ASIC series enables designers to use Altera's Stratix® series FPGAs to develop, verify, and finalize their system design before they commit to production volumes. Structured ASICs are ideal for volumes in the 100s of thousands to millions.
- *Quartus II Software:* Altera's *Quartus II* design software is #1 in performance and productivity for CPLD, FPGA, and structured ASIC designs.

- *Nios II embedded processor:* As a 32-bit soft-core processor, our *Nios II* offering can be implemented in any of Altera's FPGA or structured ASIC device families, insulating your embedded software investment from processor obsolescence. Used by each of the world's top 20 OEMs and with more than 20,000 development kits sold worldwide, the proven *Nios II* processor is the most popular configurable soft processor in the industry.
- IP: Altera and its intellectual property (IP) partners offer a large selection of off-the-shelf IP cores optimized for the highest performance and lowest cost to increase productivity by reducing FPGA design and test time.

Q. **There are other FPGA choices such as those from Xilinx, Lattice, etc. Is it possible to briefly highlight the ways in which the Altera offerings differ? What technical pointers would your recommend to an engineer doing an evaluation of your products vs. those of other FPGA vendors?**

A. At Altera, our customers' market requirements drive our product definition. We listen carefully to our customers through in-depth customer interviews to uncover their design and business challenges, making their goals the inspiration for our leading-edge programmable solutions. And, we'll keep on listening—from product definition through design to delivery. We define, design, and deliver a portfolio of programmable device solutions with the ideal features for our customers' market needs—nothing more, nothing less.

After product definition, Altera uses a very thorough product development process, working hand in hand with our foundry partner TSMC. We validate functionality with test chips to ensure quality and on-time delivery, so our customers can design their next generation products with confidence.

The best way to test Altera's offerings is to download the free web edition of our Quartus II design software from our site at http://www.altera.com/products/software/sfw-index.jsp. It is the industry's only complete design solution for CPLDs, FPGAs and structured ASICs. With Quartus II, engineers can create and test their designs in software before moving to silicon.

Q. **Many "embedded" designs will never have the product runs to justify an ASIC. What Altera products are best suited for "deployable" FPGAs? Do I work with Altera or with a distributor to get pre-sales support?**

A. You are correct that many embedded designs will never have the product runs to justify the costs of an ASIC. Our 32-bit *Nios II* embedded processor is a versatile solution that allows embedded developers to get their designs to market quickly and cost effectively. Implemented on an FPGA, designers can upgrade system performance at any stage of the product life cycle without having to redesign the board or develop hand-optimized software. For presales support, interested customers should contact our distributor Arrow.

Q. **Altera emphasizes the use of FPGAs in DSP applications. Talk to me specifically about your DSP-related solutions. Why are these better than using a standard DSP in an application?**

A. Altera overturned the DSP community's conventional wisdom about what is possible with FPGA-based DSP solutions. Compelling third-party benchmarks show that Altera devices provide 10x the DSP performance per dollar compared to the industry's most widely used digital signal processor solutions. In addition, *Altera's Stratix® III* and *Cyclone® III* FPGAs outperform competitor FPGA solutions on common DSP benchmarks.

System architectures with FPGA coprocessors can offload a digital signal processor and efficiently execute the computationally intensive blocks of DSP algorithms, greatly boosting system-level DSP performance.

DSP system design in Altera's FPGA devices requires both high-level algorithm and HDL development tools. Altera's *DSP Builder* integrates these tools by combining the algorithm development, simulation, and verification capabilities of The MathWorks *MATLAB* and *Simulink* system-level design tools with VHDL synthesis, simulation, and Altera development tools.

DSP Builder shortens DSP design cycles by helping developers create the hardware representation of a DSP design in an algorithm-friendly development environment. The existing *MATLAB* functions and *Simulink* blocks can be combined with Altera *DSP Builder* blocks and Altera IP core functions to link system-level design and implementation with DSP algorithm development. *DSP Builder* allows system, algorithm, and hardware designers to share a common development platform.

Q. **What differentiates Altera's DSP offerings from those of competitor Xilinx? What is Code:DSP?**

A. Code:DSP is a major Altera® technology initiative to provide industry-leading solutions for the next generation of digital signal processing (DSP) applications. Featuring leading-edge devices, software tools, intellectual property (IP) cores, and development platforms, Altera's line of DSP products are enabling designs that demand premium performance in areas such as video and image processing and high-speed digital communications while delivering the lowest-cost per channel.

High-density Stratix III FPGAs push the envelope of DSP performance. Featuring embedded DSP blocks running at 550 MHz, these devices can provide up to 492 giga multiply-accumulate operations per second (GMACS). Combined with a revolutionary logic architecture and speed-optimized interconnect, Stratix III FPGAs are ideal for enabling the highest performance DSP applications.

Low-cost Cyclone III FPGAs provide the benefits of DSP performance, flexibility, and faster time-to-market, all at ASIC prices. The least expensive member of the family, the EP3C5 device, has enough embedded multipliers and logic resources to perform real-time 7 x 7 pixel filtering on HDTV 1080p video. The Cyclone III family is the right choice for cost-sensitive DSP applications compared to digital signal processors and other FPGAs.

For higher volume applications, Altera offers a simple, turnkey migration from a Stratix II FPGA to pin-compatible HardCopy® II structured ASICs. Developers are guaranteed functionally equivalent drop-in replacements for DSP system designs. Altera's latest generation structured ASIC features up to 2.2 million ASIC gates for system logic and an additional 1.4 million dedicated gates for DSP blocks with over 8 Mbits of embedded memory.

The Altera DSP Solutions Center has comprehensive, up-to-date information and resources for DSP designers who want to reap the benefits of programmable logic. Additionally, Altera offers training courses targeted to DSP designers who want to get up to speed quickly on the latest tips and techniques for creating efficient, high-performance DSP designs. Altera's DSP support network includes internal and partner organizations from all over the world who are experts on Altera products and can provide localized DSP application expertise.

Q. **Tell me about your *Hard Copy / Structured ASICs*. How is this product line a useful alternative to the FPGA / ASIC dichotomy?**

A. Altera's HardCopy® structured ASIC series delivers unmatched product development flexibility and speed, enabling designers to fully capitalize on their engineering resources and budget. HardCopy structured ASICs are the market's only devices to offer a seamless prototype-to-production process for guaranteed success of high-volume production devices. Through its unique FPGA front-end design flow, the HardCopy structured ASIC series enables designers to use Altera's Stratix® series FPGAs to develop, verify, and finalize their system design before they commit to silicon.

Compared to standard-cell ASICs, structured ASICs offer faster development time and lower NRE costs. With the continued shrinking of process geometries, the NRE costs for standard-cell ASICs are rising dramatically, and structured ASICs are proving to be an attractive performance and cost effective alternative.

Q. **Let's talk about design tools. FPGAs can be difficult to program - What design tools does Altera offer? What are their most salient features?**

A. Altera's Quartus II software is the industry's only complete design solution for CPLDs, FPGAs and structured ASICs. The Quartus II software offers complete, automated system definition and implementation , all without requiring lower-level HDL or schematics. The Quartus II software also is the only software from an FPGA vendor offering multi-processor (e.g., the Intel Core 2 Duo and Quad and AMD Athlon 64 X2) support, taking advantage of today's dual- and quad-core computers.

Key features include:

- SOPC Builder: Automates adding, parameterizing and linking IP cores.
- TimeQuest timing analyzer: Allows creation, management and analysis of complex timing constraints as well as advanced timing verification
- Compile time advisor: Recommends compile-time saving settings during the design flow to improve productivity.
- In-system sources and probes editor : Reduces verification time by allowing designers to drive stimuli to the device and sample internal nodes during run time.

Q. **What about pre-sales learning? How can I "try before buy" your products and/or participate in online learning or seminars? What offerings do you have for pre-sales or low cost learning before I make a major commitment?**

A. The best way to try Altera's devices before buying them is to download the free web edition of our *Quartus II* software. The *Quartus II* software provides a real customer experience by allowing the developer to create and test their CPLD, FPGA or structured ASIC designs.

For low-cost learning, Altera has a series of free online training modules. You can access that training by going to: h t t p : / / m y support.altera.com/etraining/.

Q. **Let's talk about IP ("Intellectual Property"). Tell me about Altera's IP offerings, especially *NIOS II*, as well as your offerings in Ethernet, RapidIO, PCI Express, etc.**

A. Altera offers a broad portfolio of easy-to-use intellectual property (IP) cores. These IP cores are high-quality "building blocks" that can be dropped into system designs, increasing productivity by avoiding the time-consuming task of creating complete designs from scratch. Altera's extensive IP portfolio includes communications and I/O interconnect technologies (such as Ethernet, PCI, PCI Express and Serial RapidIO) and a broad range of cores for embedded systems and DSP applications.

Easy-to-use, pre-verified, and configurable, Altera® IP cores are optimized for the latest Altera devices and are fully supported in Quartus® II design software. Some of the IP cores are from leading third-party IP vendors who have developed, optimized, and qualified their IP products for Altera devices, licensing them directly to our customers.

The 32-bit Nios II embedded processors are backed by a full range of embedded software tools and operating system support from Altera and industry-leading embedded partners. The Nios II soft-core processor can be implemented in any of Altera's FPGA or structured ASIC families. Used by each of the world's top 20 OEMs and with more than 20,000 development kits sold worldwide, the Nios II processor is the most popular configurable soft processor in the industry.

Q. **What about after the sale? What is your technical support like? Are their different support options? And what about design services - does Altera offer design services to help with my design?**

A. For design services, Altera has Certified Design Centers (CDCs). These are Altera's premier partners that are highly trained and Altera-certified in the design and use of Altera products, tools, and IP. They have the highest level of experience and training among partners and have an excellent relationship with Altera. For more information on the CDC, go to h t t p : / / w w w . altera.com/products/design_services/dsv-index.html.

For technical support, Altera offers both online support information at

h t t p : / / w w w . altera.com/support/spt-index.html as well as support centers around the world in San Jose, the UK, Penang and Shanghai.

Q. **Thank you for this informative and helpful interview.**

Lattice Semiconductor: FPGAs and FPGA Design Tools

20 August 2007: Lattice Semiconductor: FPGAs and FPGA Design Tools

Interviewee. Brian Kiernan (contact)
Tel. 503-268-8739
Email. brian.kiernan@latticesemi.com
Company. Lattice Semiconductor Corporation
Web. h t t p : / / w w w . latticesemi.com/

Q. **Obviously, this guide is focused on FPGAs. Can you please give a quick overview to the Lattice FPGA product line? Tell us a little bit about yourself and your company.**

A. Lattice is focused on delivering FPGA solutions in three distinct areas. The first is low-cost FPGAs that integrate high-end features such as 3.125Gbps SERDES, DDR2 and full-feature DSP. This combination saves customers money by negating the need to move to full-featured, high cost FPGAs.

The second area is non-volatile FPGAs. By combing SRAM and Flash memory on a single die, we provide customers with single chip solutions that provide instant-on characteristics and high design security.

Finally, we are delivering high performance FPGAs that, through the use of embedded hard ASIC functionality, speed customers' time to market while reducing power consumption and cost.

Q. **There are other FPGA choices such as those from Altera or Xilinx. Is it possible to briefly highlight the ways in which the Lattice offerings differ? What technical pointers would your recommend to an engineer doing an evaluation of your products vs. those of other FPGA vendors?**

A. Much of our answer is included in the above. However, the bottom line is that if you are looking for low-cost FPGAs with SERDES, high memory content, high end DSP or DDR2, then the LatticeECP2M is the industry-leading device. For those looking for single chip, high security and instant-on in a standard FPGA the LatticeXP2 is the only true 90nm non-volatile solution in the industry. The Extreme Performance LatticeSC provides a quick to market, low-power solution for those customers looking to implement PCIe, SPUI4.2 or Ethernet within FPGAs.

Furthermore, Lattice provides the broadest, lowest cost and most feature-rich serial protocol solutions in the industry. The LatticeECP2M is the only true, low-cost SERDES-based FPGA in the industry, whereas the LatticeSC provides serial protocol stacks in embedded hard IP, reducing cost, power and footprint.

Engineers typically look at cost factors, power consumptions and dissipation as well as design footprint when they evaluate Lattice FPGAs.

Q. **Are there particular vertical markets or application areas in which Lattice has found a niche? I.E., are there particular applications that are your company's "sweet spot?"**

A. Lattice is enjoying considerable success with PCI Express and Ethernet-based applications. These two are ubiquitous in the Communications, Storage, Medical and Industrial vertical market segments.

Q. **Tell me about Field Programmable System Chip (FPSC). How are these a useful alternative to the FPGA / ASIC dichotomy?**

A. The FPSC concept was pioneered by Lattice to bring together the benefits of off-the-shelf, flexible programmable logic with the cost and power consumption benefits of an ASIC device. The philosophy is to embed ubiquitous, complex and high performance blocks in ASIC gates that have broad appeal in many vertical market segments and marry them with the industry's highest performance FPGA fabrics. As already discussed, the embedded IP centers around PCI Express and Ethernet-based application. Unlike custom ASICs, FPSCs have no NREs.

The FPSC is not an alternative to an FPGA. Rather, an FPSC utilizes an architecture that dramatically improves FPGA performance and utility. The latest evolution of the FPSC is the LatticeSC and LatticeSCM FPGA families.

Q. **Let's talk about design tools. FPGAs can be difficult to program - what design tools does Lattice offer? What are their most salient features?**

A. Lattice offers a suite of design tools for FPGA design, embedded processor design and device programming. The primary FPGA design tool suite is called *ispLEVER*, which supports all of our latest FPGA technologies. *ispLEVER* is designed to be an easy to use, complete front-to-back solution that includes leading 3rd party synthesis tools *Synplify*, from Synplicity, and *Precision RTL*, from Mentor Graphics, as well as timing and functional simulation using Mentor Graphics *ModelSim*. Project navigation, revision control, map, place and route and design planning are done using *ispLEVER* as well. The Lattice design tools offer significant advantages in 3rd party synthesis, HDL rule checking, hardware logic analysis and exceptional performance in the form of fmax, utilization and enhanced runtime. ispLEVER is an all-inclusive tool suite offered at the industry's best price.

The LatticeMICO32 Embedded design tools offer a unique open source model for users. The 32-bit microprocessor and peripherals are supported by the MICO System Builder (MSB) for platform development, and the open source Eclipse-based C/C++ Software Project Environment (SPE) for software development and debug. Packed with peripherals and based upon the Wishbone bus, the solution's open system approach makes it easy to access, use and maintain.

The Lattice ispVM System is a comprehensive programming tool for programming all in-system programmable devices from Lattice and other vendors, and supports SPI boot PROM programming for SRAM-based FPGAs.

Q. **What about pre-sales learning? How can I "try before buy" your products and/or participate in online learning or seminars? What offerings do you have for pre-sales or low cost learning before I make a major commitment?**

A. All of our datasheets and application notes are available on the Lattice website

(h t t p : / / w w w . latticesemi.com/), allowing customers to easily learn about our products. This information is supplemented by a number of free web seminars that also can be accessed via our website.

All the latest Lattice-supplied IP is provided through a capability known as *IPexpress*. This capability lets designers download the IP, incorporate it in a design, simulate and create a bitstream without purchasing the IP. Until a license is purchased, the bitstream operates for approximately four hours before the chip resets.

Lattice offers quite a comprehensive tool suite supporting a significant portion of our FPGA portfolio for download from our website. This product is called *ispLEVER Starter* and may be licensed for 6 months' use. In addition, Lattice offers a host of tutorials on the use of various tools, "How To" topics covering the use of specialized silicon features in software, and over 40 prerecorded web seminars ranging in subject from "Retargeting FPGA Designs" to "GPON Solutions."

Most of our devices have low-cost development boards available, allowing designers to rapidly prototype without the cost of developing their own board. For more expensive boards, we offer a 30-day evaluation period.

Q. **Let's talk about IP ("Intellectual Property"). Tell me about Lattice's IP offerings, especially *LatticeMico8, ispLeverCORE*™, etc., as well as your offerings in ethernet, RapidIO, PCI Express, etc.**

A. Lattice offers several types of IP and works directly with more than a dozen 3rd party IP providers specializing in DSP, PCI Express, WiMax, SATA, uP and peripherals, and much more.

- Lattice ispLeverCORE IP is developed and supported by Lattice and includes more than 50 functions and over 300 unique IP. Examples include our Tri-Speed MAC 10/100/1G Ethernet MAC IP, PCI Express x1 and x4, DDR/DDR2 and many others. These IP are also offered in Lattice's unique IP Suites that cover widely used functions (the "Value Suite"), 1Gb, 10Gb, DSP, System Design and WiMax applications.
- Reference designs, like the LatticeMICO8, are available for download from the Lattice website and include source code and documentation to assist users in optimizing for their specific needs or porting to other Lattice FPGA architectures.

Finally, Lattice works in concert with more than a dozen 3rd party IP leaders specializing in IP that augments the Lattice IP portfolio. In keeping with our silicon strategy, the flagship IP products for serial protocol solutions are centered primarily around Ethernet and PCI Express. In selling these, we strive to not only provide an IP core, but a "solution" that includes boards, compliance testing, report, API/drivers and reference designs to provide a complete "out of the box" solution.

Q. **What about evaluation boards? Does Lattice offer low-cost evaluation boards and/or work with distributors to provide these boards? Do any have associated learning seminars?**

A. Lattice offers over 50 evaluation boards ranging in price and complexity to support the evaluation and demonstration of basic device functionality and I/O characteristics to LVDS I/O, PCI Express, CPRI, OBSAI, multiple SERDES channel loop-back testing and complex video applications. Specialized microprocessor, memory, PCI-SIG compliant, and communications interface boards are also offered.

Q. **What about after the sale? What is your technical support like? Are their different support options? And what about design services - does Lattice offer design services to help with my design?**

A. Lattice has a world class after sales support infrastructure. Lattice customers can talk directly to a Lattice Applications engineer via the Lattice Hotline (1-800-LATTICE) or via email (techsupport@latticesemi.com). Lattice also provides comprehensive documentation, including datasheets, application notes and software user guides that fully describe product features and provide design tips to simplify the design process.

Lattice sponsors Webinars and Forums and is the only PLD company with its own Blog site featuring postings from senior Lattice engineers and product planners.

Regarding design services, Lattice has a powerful, worldwide network of 3rd party design houses, called the Lattice LEADER Design Services Partners. Our LEADER partners are fully trained on Lattice silicon products and development tools and are fully capable of complementing a customer's own design resources.

Q. **Thank you for this interview.**

MathStar: FPOAs in the FPGA Ecosystem

12 August 2007: FPOAs in the FPGA Ecosystem

Interviewee: **Sean Riley,** Vice President of Marketing, MathStar
Tel: 503-726-5500
Email: sean.riley@mathstar.com
Company: **MathStar, Inc.**
Web: **h t t p : / / w w w . mathstar.com/**

Q. **Obviously, this guide is focused on FPGAs, and MathStar positions itself as a vendor of "Field Programmable Object Arrays" (FPOAs). Tell us briefly about FPOAs.**

A. MathStar's Field Programmable Object Arrays (FPOAs) are high-performance, reprogrammable integrated circuits based on proprietary Silicon Object technology instead of a pile of gates as you'll find in FPGAs. Silicon Objects are 16 bit configurable machines, such as an Arithmetic Logic Units (ALU), Multiply-Accumulators (MAC), or Register Files (RF). Both the Silicon Object behavior and the interconnection among Silicon Objects are field-programmable. FPOAs can process logic functions at a clock rate up to 1-gigahertz, much faster than current commercially available programmable logic devices. The Arrix™ MOA2400D FPOA, MathStar's flagship product, represents a powerful solution that is ideal for digital signal processing and filtering applications in the machine vision, video processing, medical imaging and military/aerospace markets.

Q. **Where did FPOA technology come from? What is its primary technical difference vs. the mainstream FPGAs like Altera or Xilinx?**

A. MathStar developed the FPOA technology as an evolution in the programmable logic space. The FPGA architecture, developed decades ago, is not sustainable over the long term as performance demands increase. Hence, why you see many FPGA vendors moving full-speed ahead into the consumer market where the performance demands will remain relatively low at least for the next several years.

There are a few technical differences between FPGAs and FPOAs, which affect designers of performance-demanding applications. First, the advertised operating frequency of an FPGA is typically two to three times higher than the actual operating frequency of a real design. This is because the process of porting a design to an FPGA and making all the interconnect timing work tends to force the designer to reduce the operating frequency. The actual operating frequency for a high-performance application on an FPGA is generally between 150 and 250 MHz. The operating frequency of an FPOA is deterministic and can be as high as 1 GHz. Said another way, a 1 GHz FPOA will always run at 1 GHz if needed.

Second, FPGA programming requires synthesis, placement and routing, and timing closure. Because the FPOA is clock-cycle based and it's interconnect structure is deterministic, there is no physical timing closure required. The functionality of the program is consistent and guaranteed by construction.

Third, because an FPGA requires timing closure, migrating an FPGA design to a larger capacity device or newer generation (i.e., 130nm to 90nm) device, requires the designer to re-synthesize, perform placement and routing, and close timing again. This isn't a problem at 100 Mhz but at 250 MHz it starts to become a real burden. In contrast, since

the FPOA is cycle based, migration to a larger capacity or newer generation device requires no re-design, as long as the required object arrangement is a subset of the target device.

Fourth, FPGAs use memory bits for programming and tri-state buses for interconnection. Even when only a portion of the entire device is used, power is consumed for the entire chip. In contrast, on an FPOA, unused Silicon Objects are shut down. In the future, fine-grain power control will automatically shut down the unused portion of logic for each Silicon Object, reducing the overall power consumption.

The programming time for an FPGA takes seconds, particularly for the larger devices; it takes less than 20 milliseconds to program an FPOA.

Of course, given that the FPGA market is rather large, they have one primary technical advantage over FPOAs. An FPGA can be programmed at the gate level with arbitrary bit precision and functions, making it more flexible than an FPOA. An FPOA is a medium-grained device and programmable at the object level, making it much faster than an FPGA.

Q. **Do you see FPOAs as alternatives to FPGAs, competitive, complementary? What sorts of applications or design pressures do you feel make an FPOA a particularly attractive choice?**

A. We view FPOAs as complementary to FPGAs. Many of our customers choose FPOAs to sit right alongside FPGAs on a board. The FPOA handles the performance-demanding task, while the FPGAs – and it usually requires several – take care of the tasks that are less performance-intensive.

We're very focused on the performance-demanding markets such as professional video, medical imaging, machine vision, security/surveillance, military/aerospace, and test & measurement. If a customer comes to us needing very low-performance – anything under 600 MHz – we generally refer them to an FPGA.

We're not trying to make FPOAs the end-all-be-all today. They're just the highest-performance, reprogrammable option on the market for the designers who need it. When consumer applications require higher performance someday – and it will happen – FPOAs will be very common.

Speaking of re-programmability, many designers value the FPOA's ability to reprogram on the fly to handle a number of applications.

Q. **How do FPOAs compare vs. ASICs, ASSPs, or structured ASICs?**

A. Structural ASIC is a recent trend in the semiconductor world. The general idea is to reduce the design time and mask costs by reducing the number of mask levels for the customization step. The general technology still requires some kind of placement and routing, and timing closure. These are inherently the most time consuming tasks and the tools are some of the most expensive. Finally, as with ASICs, once a design has been taped out, any changes require a re-spin.

Q. **And, how do FPOAs compare vs. DSPs?**

A. DSPs have become so practical that dedicated DSP devices have been developed to deal with some of the lower performance applications. For higher performance DSP applications like high-sample-rate complex Fast-Fourier Transforms (FFTs) and Finite Impluse Response (FIR) filters, more specialized hardware like the FPOA is needed. In an FPOA, the application is in total control of the memory. This is similar to an FPGA but much different than a DSP or CPU, where the memory accesses are abstracted away from the application. With an FPOA, you can read and write on the same clock cycle to a register file object. You can write every cycle to an IRAM. Overall, the memory access will be much faster and much more predictable than with a DSP.

Q. **Many engineers will not be familiar with FPOAs and certainly not versed in their differences vs. more traditional FPGAs. What resources does MathStar provide for an engineer to "try before buy" and educate him or herself on your technology?**

A. MathStar provides onsite technical training that is user interactive so that the target designer can get firsthand experience using the FPOA tool set. We can also supply the customer with a 30-day evaluation license -- so that they can work through designs, simulate, and place -- that in most cases may be run on the development system that MathStar has designed and sells. MathStar will also supply first-class technical support to give the designer the best possible experience.

Q. **Let's talk about development tools. The big FPGA vendors, namely Xilinx and Altera, provide a wealth of free development tools to encourage designers to design in their products. How does MathStar compete in terms of development tools? Are they free? Are they easy to use?**

A. The MathStar FPOA design tool flow begins with design entry using Mentor Graphic's Visual Elite Integrated Development Environment (IDE). MathStar provides templates demonstrating the different programming options for each of the FPOA Silicon Objects, and users simply edit these templates to configure the ALU, MAC, RF and other objects. MathStar augments the Visual Elite IDE with high-performance simulation models for rapid functional verification of FPOA designs. Visual Elite's built-in simulator and waveform viewing tools aid the designer in debugging the design through functional simulation.

Once the logic design is completed, the designer may proceed with physical design of the FPOA implementation. MathStar's COAST tool provides a graphical user interface for placement and connection of the Silicon Objects on the Arrix FPOA. COAST allows the user to place the functional blocks and supports routing of the communication paths. COAST also contains a tool to compile the application created in Visual Elite with the physical mapping created in COAST to an FPOA load image file that configures the FPOA. COAST provides a debug tool to download via JTAG to the chip or create a PROM image.

Q. **And let's talk about "intellectual property" or "IP?" Again, Xilinx and Altera offer a range of IP - some of it free - for design in to their FPGAs. Does MathStar have similar IP offerings?**

A. MathStar has the largest IP library out of any programmable logic startup – hands down. Our Professional Video and Machine Vision Libraries boast many IP cores from MPEG-2 encoders and decoders to JPEG-2000 and H.264 codecs.

Q. **What about third party tools or IP? What is MathStar's relationship to other third party tool vendors like Mentor Graphics, Synplicity, or others?**

A. This year, when Mentor Graphics acquired our primary tool provider, Summit Design, we sealed a partnership with Mentor. The partnership gives MathStar the stability, consistency, and support of a widely recognized tier-one EDA tools provider. Standardizing on industry recognized tools and design flow enhances the features and performance that are provided by using the FPOA. MathStar also continually seeks ways to meet our customers' needs and requests by exploring various methods to enhance and optimize our tools. With regard to third-party IP the FPOA is a coarse grain architecture that may not lean to a direct port of your application or algorithm. However, we are able to supply examples on how a designer could port from another technology to ours.

Q. **Is FPOA a MathStar-only technology? Shouldn't it concern an engineer that he is investing his technical training and his company's design on a single company's technology? Is this different, or about the same, vs. a design choice of an Altera or Xilinx FPGA?**

A. Despite launching our production chip in late 2006, MathStar already has 20 customers who chose our FPOA technology because they simply could not achieve the performance goals they had with other programmable logic options.

The FPOA was invented by MathStar; however, we and many experts expect that it's the first in a long line of upcoming improvements on the programmable logic concept. The FPGA architecture is simply not sustainable for many more years. There will be many "arrays of X" that will spring up as more and more industrial applications require higher performance and, ultimately, more consumer applications do.

Q. **An engineer's management often has a preferred vendor list that includes Xilinx, Altera, and a few other of the traditional FPGA vendors. How do you suggest he persuade them to look at a newer, less traditional approach to the design? What tactics would you recommend be used for the internal "selling" of FPOA technology to upper management?**

A. Preferred vendor lists are built over years of consistent successful usage and support. Being added to the list does not come easy in many cases. The first step in the process is to fully understand the problem the design team is trying to solve and educate both the design team and management on how the FPOA can effectively solve their problem and also meet their time-to-market goals. This can be accomplished by completing a written assessment that targets their specific application with performance metrics to actually designing a portion of the algorithm with their team that can be demonstrated on the MathStar development system so that they can get real-time performance numbers.

Q. You mentioned that the FPGA architecture wouldn't be sustainable forever. Why is that?

A. There seems to be a trend where FPGAs vendors are hardening more internal IP blocks to capitalize on the speed benefits of a more controlled coarse-grain architecture. They are consistently hitting the maximum frequency wall with a full random logic approach and the ever-shrinking geometries are not affording the speed bump they expected. One way of moving forward is to minimize the randomness and control the routing and speed paths, as MathStar has done.

FPGAs, Tools, and Boards: Tool Vendor Email Interviews

Email Interviews with FPGA Tool Vendors

One of the hassles in selecting FPGA Tools or IP is going from vendor to vendor asking different questions and trying to compare notes. In addition, it is the vendor community that really has the most in-depth experience in FPGA tools. Thus, in this section we provide "email interviews" with major FPGA tool and IP vendors on various important topics.

In each case, keep in mind that the vendor is putting his or her best foot forward. These are informative but polemical pieces explaining one or more sides of an issue. In some cases we have more than one interview per topic, which allows comparison of responses.

In all cases, remember to check with the vendors that interest you directly – as the technical details of your project as well as their tool or IP offerings are subject to change.

Altium: Unifying FPGA and PCB design

2 August 2007: Altium: Unifying FPGA and PCB design

Interviewee. Rob Irwin, Product Marketing Manager
Email. rob.irwin@altium . c o m .au
Company. Altium Limited
Web. h t t p : / / w w w . altium . c o m /

Q. **First of all, tell us a little bit about yourself and your company.**

A. I have more than 20 years experience in the electronic design industry including a role as Senior Electronics Test Engineer with the Australian Consumers' Association and several years as editor of *Australian Electronics Engineering*. I completed my Bachelor of Engineering (Electrical) degree from the University of Sydney, Australia.

Our CEO, Nick Smith, founded Altium in 1985 with the mission that still guides the company today: to provide every engineer and system designer with easy access to the best possible design tools. We develop, market and support unified electronic product development solutions that help all electronic engineers and designers to turn their design ideas into products as easily, efficiently and cost-effectively as possible.

Altium is headquartered in Sydney, Australia with sales offices in the United States, Europe, Japan, China, and resellers in all other major markets.

Q. **Altium's flagship product, *Altium Designer*, claims to unify FPGA and board design. First of all, why are FPGA and board design interrelated problems? What factors make these difficult?**

A. All FPGAs ultimately must sit on a PCB. Because FPGAs have unique physical characteristics – programmable pinout and I/O characteristics in particular – and because they tend to come in high pin-count packages, they represent unique challenges, and indeed opportunities, at the board level.

For example, most FPGAs offer extensive LVDS (differential pair) I/O. While these signals are easily defined at the FPGA level, they must also be routed as a differential pair on the PCB. The FPGA and PCB design flows must be linked in order for this information to be automatically propagated and properly dealt with in both domains. Similarly with the FPGA pinout. Unifying the design flows enables the inherent pin reprogrammability of FPGAs to be used at the board level to enhance board routability. Tradeoffs can be made via an iterative process to balance FPGA time constraints and board routing concerns.

These sorts of features and capabilities are not possible if the FPGA and PCB design flows are not unified.

Q. **How does *Altium Designer* address the problems of FPGA and PCB design?**

A. The *Altium Designer*'s unified platform brings together hardware design, software development and programmable hardware design within a single design environment. This opens up new possibilities for both board-level engineers and embedded designers to utilize the unique attributes of FPGAs in new and innovative ways.

Altium Designer includes extensive FPGA IP in the form of pre-synthesized, pre-verified components that allows board-level designers to capture design intent and target it for FPGA implementation using familiar graphical entry techniques. The IP includes large scale functional blocks, including 8- and 32-bit processors and peripheral devices, to allow designers to quickly build an entire embedded system within and FPGA target. What's more, the supplied IP is FPGA vendor neutral, meaning designs are portable between FPGA families and vendors.

Features that support FPGA-PCB co-design include:

- Automatic FPGA pin optimization for routing
- Bidirectional pin synchronization between FPGA and PCB designs
- System level support for differential signaling from definition in the FPGA through to routing on the PCB and interactive differential pair length tuning
- Ability to do full board-level signal integrity analysis with programmed FPGA

In general, the unified nature of the environment supports the design of the circuitry inside the FPGA and on the board, and the layout and routing of the PCB, not to mention the development of any software targeted at soft or discrete processors in the design, all within a single environment.

Q. **If an engineer's responsibility is solely for the FPGA (not FPGA / PCB), do Altium's products help her? Or are you closely focused on FPGA / PCB design integration issues only?**

A. If you're involved in any sort of system design within the FPGA then *Altium Designer* can help you greatly. We include a wide variety of IP, including processors and peripherals, that allow designers to quickly define and implement a complete embedded system within an FPGA.

Also, connecting large functional blocks together can be very inefficient in an HDL. *Altium Designer* allow engineers to define functional blocks using Verilog or VHDL and then use *Altium Designer*'s graphical design capabilities to link these blocks together. Functional blocks can even be packaged up within the system and put into libraries for reuse in different projects.

So *Altium Designer* does provide many advantages for designers focused purely on the FPGA, but the system really makes a big difference when used across the FPGA/PCB disciplines.

Q. **What about team hardware/software efforts? If my team has both FPGA designers and FPGA/PCB lay out designers, how does Altium help me? Does it support collaborative development among groups, and if so, how?**

A. If the entire team is using *Altium Designer* for development then the unified environment provides a number of features to help team collaboration.

It natively supports document version control through protocols such as CVS or Subversion. The *Altium Designer* environment provides direct check-in/check-out, etc. capabilities, and also includes the ability to do differencing of versions of design files for collision arbitration. This includes special comparison of graphical file types such as schematics or PCB layouts.

At a local level, each designer can keep a local history of changes to design files and generate full documentation of changes between different versions of documents. File locking is also supported when multiple designers are working on a single source file.

At a structural design level, PCB design can proceed with a 'stub' FPGA design while the real FPGA design is completed independently. The FPGA and PCB designs can then be linked and synchronized at a later point in the design cycle.

Q. **How do Altium's products relate to the "free" tools provided by the FPGA vendors themselves, as for example Xilinx or Altera? Are they complementary, competitive or both?**

A. When preparing a design for download to an FPGA, *Altium Designer* uses the vendor supplied tools to handle the low level mapping and place-and-route functions for the specific target devices. This is done transparently through the *Altium Designer* GUI and the designer does not need to manually run the vendor tools to create the necessary bit files or download to the FPGA device. In other words we use specific functions of the vendor tools as device-specific 'drivers' for low level functions.

From a design perspective, however, we would expect *Altium Designer* would be used as a replacement for the vendor tools. Because the system works with and creates vendor tool compatible projects, designers can move between the two environments for specific tasks if necessary.

Also, while *Altium Designer* has its own target-independent synthesis engine, it does support both the vendor synthesis engines and some popular third-party synthesis tools as well.

Q. **What about other third party FPGA tools like those from Mentor Graphics? How do Altium's products differ? Do they address different problems or needs?**

A. As far as I am aware *Altium Designer* is the only system that provides a unified design environment that brings together hardware design, software development and programmable hardware design. *Altium Designer* therefore allows engineers to approach design in a different way and opens up avenues of design not possible with point tool solutions.

One example of this is the way *Altium Designer* allows engineers with limited or no FPGA design experience to utilize the potential of programmable devices as a system design platform. This is only possible because of the close coupling of the various design disciplines involved.

Q. **Do your products work only with certain FPGAs from certain vendors, or are they part- and/or vendor-neutral? Tell me about your support for third-party evaluation boards, in particular.**

A. *Altium Designer* is completely part and vendor neutral and supports a wide variety of devices.

In terms of development boards, Altium has available its NanoBoard reprogrammable platform that supports swappable target devices housed on plug-in daughter boards (a new generation of NanoBoard that supports plug-in peripheral boards as well is scheduled for release shortly). This provides a high degree of automated functionality when used with *Altium Designer*.

Altium Designer can also be used, via our Universal JTAG Interface module, with a wide range of third-party development boards. A full list of boards that have been tested with *Altium Designer* can be viewed at

h t t p : / / w w w . altium . c o m /Community/ThirdPartyBoards/.

Q. **What is "LiveDesign?" How is this similar, or different, from other promises of hardware/software codesign?**

A. "LiveDesign" is the ability to interact, debug, probe and modify the design as it's running inside the programmable device. This is facilitated in *Altium Designer* in a number of ways.

Firstly there is the ability in *Altium Designer* to monitor the status of the pins of the FPGA and reflect this status 'live' back to the source schematic and PCB layouts. This allows you to visually troubleshoot some logical operational problems with the circuit by monitoring the signals to and from the FPGA.

Secondly, *Altium Designer* includes a range of "virtual instruments" such as logic analyzers, frequency counters and generators, and I/O blocks that can be included in a design at the schematic level and linked to monitor or stimulate signal lines within the FPGA. The hardware portions of these virtual instruments are instantiated within the FPGA along with the circuit under development and communicate with and are controlled by *Altium Designer*, along with other active devices such as processors, via a secondary JTAG chain established with the FPGA. Soft front panels within *Altium Designer* allow you to interact with the instruments. This gives a powerful platform for interactive implementation and debugging of systems at a 'component' level within the FPGA and allows for rapid system development.

One of the main advantages of LiveDesign is that it bypasses the need for simulation at the system level, and it allows simultaneous debugging of both system software and hardware. It gives "live" and hands-on interaction with the system inside the FPGA during development.

Q. **What opportunities do I have to "try before buying" any of the Altium products? What sorts of pre-sales learning opportunities do you provide, and how would you recommend that someone new to Altium get started investigating your solutions?**

A. We believe that "seeing is believing," so one of the best ways to start investigating *Altium Designer* is to sign up for one of our regular live Web conferences. Altium engineers will demonstrate the system while you watch and ask questions from the comfort of your own computer. Follow the link from the Altium home page at h t t p : / / w w w . altium . c o m / .

We also have a very comprehensive set of on-demand demo videos available at the Altium DEMOcenter, which can be found at

h t t p : / / w w w . altium . c o m /Evaluate/DEMOcenter/.

For more detailed product evaluations, we recommend customers contact their nearest Altium Sales and Support Center or Value-Added Reseller, who can arrange for special evaluation kits and licenses. h t t p : / / w w w . altium . c o m /Contacts/ .

Q. **Explain how much Altium's products cost? What are the various pricing options?**

A. Altium sells all its solutions as complete, "all-in-the-box" offerings at prices that are affordable for the majority of engineers and companies involved in electronic product development.

For detailed pricing, we recommend customers contact their nearest Altium Sales and Support Center or Value-Added Reseller. Details can be found at

h t t p : / / w w w . altium . c o m /Contacts/.

Q. **Engineering management often tells engineers to use the "free" tools provided by the major FPGA vendors as well as "free" or "open source" tools on the Internet. How do you suggest an engineer convince management that buying FPGA tools is a good idea?**

A. Buying FPGA tools is not a good idea! Buying a unified design solution, however, is a great idea.

The name of the game today is innovation and time to market. As designs become more complex, designers need to be able to work at higher levels of abstraction in order to put more 'intelligence' into their products in realistic time frames. Increasing the level of abstraction within individual design disciplines can help to a certain extent, but tends to make the problem of coordinating and bringing together all the parts that make up the final product more complicated, time consuming and error prone.

The only way to make the design process faster is to raise the level of design as a whole. To do this you need to start with a design system that encompasses this whole.

By unifying the design and bringing together the different design disciplines – hardware, software and programmable hardware – within a single design environment, *Altium Designer* allows engineers to concentrate on designing the functionality and intelligence of the design first without becoming bogged down in implementation details, and then targeting that intelligence for implementation in the most optimum medium – software or hardware. In doing so *Altium Designer* allows engineers to work at an overall higher level of abstraction and develop more intelligent electronic products faster.

Q. **What does *Altium Designer* offer embedded systems developers**

A. A unique aspect of *Altium Designer* is that it provides an environment in which embedded developers can easily make use of FPGA technology to accelerate both their applications and their development process.

Altium Designer supports FPGA-based system design by providing FPGA-based soft processors and support for both third-party soft, hybrid and discrete processors linked to FPGAs. Using the FPGA as programmable resource, the IP supplied with *Altium Designer* and Altium's NanoBoard as a reconfigurable hardware platform, embedded developers can quickly define and implement system functionality, including dedicated hardware co-processing, without the need to become hardware or FPGA designers.

Within *Altium Designer* they can move functionality between hardware and software, change the processor execution platform, implement the system hardware, and develop and debug the software on the real hardware. In short, they can manipulate hardware with the same speed and interactivity with which they traditionally manipulate software. This allows the intelligence of a product to be embedded not only in the system software, but the within the system hardware as well.

This possibility opens the door to developing more intelligent and responsive embedded systems faster than previously possible.

Q. **Thank you, Rob, for this interview.**

CAST: Practical IP for FPGAs

1 August 2007: CAST: Practical IP for FPGAs

Interviewee. Bill Finch, VP Sales
Tel. (508) 655-9928
Email. b.finch@cast-inc . c o m
Company. **CAST, Inc.**
Web. **h t t p : / / w w w . cast-inc . c o m /**

Q. **First of all, tell us a little bit about yourself and CAST.**

A. First a few bullets about CAST.

1. Founded in 1993 as a spin off from Racal Redac. The initial intent was simulation libraries, which morphed into "cores" in the mid 90's, so we have been around since the beginnings of the IP business.
2. The company is privately held and all ownership is in the hands of the employees. This has allowed us the freedom to adapt as the IP business has grown and changed.
3. We have over 600 core sales to over 400 customers around the world.
4. Our success has been based on high quality, great support and reasonable pricing. Our goal has always been to be a profitable enterprise and to serve our customers with an eye to having a long running successful business. CAST has definitely not been a typical get rich quick operation.

As for me, I am a long time veteran of high tech having worked in test and measurement most of my career in both semiconductor and PCB test. I have an electrical engineering degree from Purdue University, but spent most of my time in sales, marketing and product management before joining CAST 6 years ago.

Q. **Tell me about the processor IP that you offer. I know, for example, you offer 8051 cores, Z80-compatible, and DSPs. How do these compare / contrast with *NIOS II*, *Microblaze*, or even *PowerPC* or *ARM* now available for certain FPGAs?**

A. Most of our processor IP that you mention has been aimed at the ASIC rather than the FPGA market. The NIOS/ Microblaze have, up till now, dominated the FPGA usage mainly due to pricing. It's tough to compete with something that is basically free and that has no royalties attached. We have sold a few processors where the customer was concerned about compatibility with an older application/software set, but we really haven't pursued this much in FPGA. We have a new 32-bit core called the *APS3*, which may make us more competitive here.

Q. **Oh, well then can you take moment and tell us about *APS3*?**

A. First, let's be clear on what we are seeing in the market. There are many users of typical 8051s where their next design needs more horsepower. If a customer is going to upgrade, he probably wants a 32 bit machine. We have known this for some time. It took us a

while, but we finally found a partner to supply such a core. Cortus SA of France is a three year old company of experienced and talented processor folks. They had developed one of the smallest 32 bit RISC machines we had ever seen with a highly optimized tool chain so it produces very compact code. At between 10,000-20,000 gates it is not much bigger than an 8051, but it's as powerful as an ARM 9. It draws about 10x less power than the usual suspects in this market so that is a real plus for people doing modern deeply embedded designs. We have several customers already. It's pretty exciting.

Q. **Tell me about your non-processor IP. What varieties do you offer, and what are the advantages to getting this from you as opposed to from the FPGA vendor or, in some cases, tools vendors like Mentor Graphics?**

A. We have over 100 cores in the whole catalog. We cover encryption, image compression, standards based I/O, communications cores and a lot of what we call replacement series cores for people dealing with obsolescence issues. We have been very successful with these because customers like buying from a company that is knowledgeable and where they can get significant application support. To most FPGA customers, IP is still really a new thing. We have built a good reputation for support and people who buy from us come back. And they tell their friends whom they trust.

Q. **CAST is known as a third-party IP provider. What are the advantages to getting IP from CAST directly vs. getting IP from Altera, Xilinx, or other FPGA vendors? And isn't IP from those vendors "free" vs. your IP which is not?**

A. For the most part it comes down to what I already mentioned. Knowledgeable support. You have to know how the core works and how to apply it to really help your customers. Being a small company that has a close coupling between engineering and our customers, we can supply the type of help and advice that customers need to be successful. This is much more difficult than it sounds and it is even more difficult if the customer has to wade through layers of organization to find the guy who really knows the answer. We're definitely not free, but we do quite well selling to people who know that the true price of anything is more than just the out-of-pocket sales price. Missing project dates costs money. If you save $5,000 on the price and miss your dates by a week or two have you actually saved anything?

Q. **Assume an engineer is going to use IP from a number of sources. How does your process / technical support work with IP from other vendors including, but not limited to, IP from Xilinx, Altera, and other FPGA vendors or our own internal IP?**

A. Our IP is developed as RTL, which is intended to be portable across a wide variety of processes both ASIC and FPGA. We generate the netlists for FPGAs from the same RTL being used in high-end ASIC designs. Since we don't start out trying to optimize the cores for some particular silicon we stand a much greater chance that our stuff and IP you buy from other sources or design yourself will work together. Optimized IP is great if you only use that core, but how many designs do you see like that today? You see a lot of articles about IP not being compatible. I have often wondered if that isn't a function of trading optimization for integration ease. Back to what I said before: if you miss all your dates it's more of a problem than anything you gain in performance or save in price.

Our support network has been tuned for years to provide service around the worlds in 24 hours or less. People don't believe us but we usually make it. Our support guys take great pride in getting real answers real quick. Most of our customers totally agree.

Q. **IP integration and verification are notoriously hard - how does your technical support work? What does it cost? What do you do about IP integration issues (your IP vs. other IP)?**

A. I've pretty well covered the support issues already. We include 30 days of total support with a netlist core and charge for support after that. We think 15% per year of the core's price is about the industry average, so that's what we charge. The big trick is that we actually have customers talking to engineers who are willing to discuss the whole application even if it isn't all CAST cores. You can't be effective at support unless you take the problems in the customer's context. Clearly, we can't be total experts on everything, but we do know a lot about how to build a good design and we try to help the customer succeed. But you are totally right about it being hard especially when you are a customer doing your first or second design. We don't abandon our customers. We have guys who know tools as well as cores so we can address a lot of different issues.

Q. **I notice on your website that you work with both Altera and Xilinx. What is the *Altera Megafunction Partners Program* or the *Xilinx Alliance Program*? How does any of that make it easier for me, the engineer?**

A. All of the FPGA providers have programs and we have been charter members of most of them. The programs are, in general, very similar. The idea is to provide you with the knowledge you need to pick the right core with the right attributes and to make finding the solution as easy as possible. All the companies generally do a good job vetting suppliers so the quality of what you see is high.

Note that also on our website we provide representative implementation results for ASIC and multiple FPGA vendors for nearly every core. This helps the designer who is (A) trying to choose amongst the different FPGA providers, or (B) already committed to one provider, and just wants to see sample results for that provider's devices.

Q. **What is your business model? How does your customer pay for the IP? Is technical support included? What about device royalties? Are there different models depending on different design needs?**

A. We basically sell on a project-by-project basis. There are options for multiuse, but this usually makes the most sense if you buy our RTL so that you can freely move the core from one device family or the other or even change vendors if you want. We include 30 days of support and charge for longer-term contracts. We aren't totally hide bound about our models. We are willing to work with customers to achieve a fit if there is a win-win for both of us. Having said that, most sales are single-project licenses. We don't charge royalties unless required to by patents not held by us. CAN cores for example require royalties be paid to Bosch GmBH.

Q. **What do you offer for me to "test drive" your products? Are there demos, white papers, tutorials, trial versions of your IP?**

A. We have several different evaluation tools. We make all our datasheet-level information freely available without registration or any hassles. We share our technical documentation under NDA, and this is always the place a serious customer starts to dig in. Simulation models are the most popular eval tools. We can provide real netlists, but the customer needs to be sure he's on the right track before heading in this direction.

People forget that making a netlist eval work implies you have all the other parts of the application running correctly before you drop in the core to be evaluated. This is not usually the case. In some cases with our image compression cores for example, we have special models in C code for image quality evaluations. The biggest thing we do is actually have our engineers consult with you to make sure we all agree on how your application will work. This isn't strictly an evaluation, but it generally beats the hell out of white papers. It's hard to ask a white paper a question.

Q. **My management says we should "do it all ourselves," or if not that "do as much of it ourselves as we can" to save budget. How can I convince them that purchasing third party IP will save us time? Money? Stress?**

A. I think this is the attitude that we see changing the most in the last few years. Most managers realize that the complexity of next-generation designs preclude a do it yourself philosophy. They are also learning that it is false economy to compare internal engineering cost vs. external IP costs. The real issue as I have said is will you bring the chip in on time. No doubt you'll pay more out of pocket for purchased IP, but you get it back by hitting your time to market goals. There really isn't another answer. If you can't sell this to your management, then there's not much else you can do. I phrase it this way on the assumption that it isn't possible to go in and admit the "inconvenient truth" that just maybe you don't really know how to do it in the first place.

Q. **Thank you, Bill, for this informative interview.**

Celoxica: From C to FPGAs Quickly and Efficiently

2 August 2007: Celoxica: From C to FPGAs Quickly and Efficiently

Interviewee. Jeff Jussel, Americas General Manager
Tel. 512 795 8170
Email. sales.americas@celoxica . c o m
Company. Celoxica
Web. **h t t p : / / w w w . celoxica . c o m /**

Q. **First, to get started, can you tell me where the name "Celoxica" came from? What does unique design challenges does Celoxica seek to address?**

A. Celoxica was originally spun out of Oxford University over ten years ago under the name Embedded Solutions, Ltd or ESL for short...before ESL was an EDA acronym. How is that for irony? For whatever reason sometime after that it was decided the company needed a more memorable name. Whether it is more memorable or not, the name Celoxica does have an appropriate meaning. It was derived from the Latin words for "rapid" and "silicon", with an "ox" in the middle to honor the Oxford heritage. Celoxica enables the addition of "rapid silicon" to embedded systems. The C-to-FPGA tools, implementation libraries and APIs, and FPGA development cards are all part of a solution that allows software developers to use FPGA devices as very fast, reconfigurable processors. The vision is to make custom logic design in the form of FPGAs available to a very broad spread of software applications in order to increase system performance by off-loading the processor to a fine-grained, massively parallel co-processing engine.

Q. **And a little about yourself - your technical background, how long have you been with Celoxica, what is your position is at the company?**

A. I am an EE by background, originally from Nebraska, followed by an MSEE from UCLA. I did ASIC design for communication systems back when both EDA and sub-micron processes were new. At Hughes Aircraft, I become the expert on EDA tools by virtue of having been the first to open the box on a Mentor DN3000 workstation. That started a long chip design career where design, and design processes and tools were inseparable. I followed the design starts to a semiconductor company and eventually on to Mentor Graphics ASIC Design Centers. Through nearly a decade at Mentor my career became more focused on making the design process better through tools and methodology and I came to lead Mentor's Design Reuse Knowledge Center, which resulted in more management and marketing responsibilities. In that role, it became clear that design reuse would require a step beyond the traditional RTL level and I became interested in system level tools, methodologies and standards. When an opportunity came to join Celoxica, I took on responsibilities for their product strategy, marketing and the business management for their US operations. Our focus today is really on using FPGAs as accelerators for algorithm processing, both in embedded systems and increasingly in off-the-shelf computing environments.

Q. **Celoxica seems to have hitched its wagon to ESL. Tell us about ESL and why ESL is good for people designing FPGAs.**

A. As I mentioned, Celoxica was ESL before EDA started using the acronym. ;-) There has been a lot of confusion on what is the Electronic System Level, but there is agreement that

it refers to design methodologies that occur before RTL in the design process. It also implies recognition that there are groups involved in system design other than the chip designers. I know, as a chip guy myself, that sounds like blasphemy! But we have to realize that much of the time, the reason an ASIC is needed in a system in the first place is because the system needs to do something faster or more efficiently than could easily be done on in software in a standard processor. That implies that quite often the original functionality was designed as software, in a software language. By using a tool that can tie that software language to the custom hardware design, the designer can come up with a better implementation for the entire system rather than taking a guess at what should be in hardware and throwing it to a hardware team. In EDA we have many tools to optimize the chip size, speed and power but these can do very little if the original assumptions about the system hardware partition were not optimal. C-based synthesis tools are not about replacing RTL. Instead our ESL tools are there for the designer to optimize the system partition and ultimately system processing performance. So why then use FPGAs? Because like the standard processors we are augmenting, FPGA devices are reprogrammable. Using a tool like Celoxica's DK Design Suite, designers can program both the system processor and the FPGA co-processor from a software language. Add in FPGA development boards with software APIs and this provides a very quick path for the embedded system designer to accelerate their system performance to custom logic. Augmenting processors, custom logic – FPGAs in this case – provide performance and power advantages. The FPGA can serve as prototype in the system, or given the trajectory of FPGA device cost, capacity and performance at 60 nm or below vs. ASIC NRE costs, the FPGA can often serve as the production co-processing engine. The FPGA has the additional advantage of being reprogrammable in the system, which makes design changes possible after production – just like with software processors. ESL and FPGA together are a perfect fit to address this design opportunity.

Q. **Many companies in the ESL market seem to target ASIC designs. Is Celoxica primarily targeted at ASICs, at FPGAs used for ASIC prototyping, and/or for designs that will ultimately deploy as FPGAs?**

A. Celoxica's focus is definitely C to FPGA, not just C to RTL. We see FPGA as the ultimate fine-grained processing engine for algorithm implementation. Most of our customers are software/system designers that are adding FPGA hardware to the system in order to accelerate the system performance. They use FPGA accelerator cards in their systems, or they design a custom system with the FPGA embedded. For certain consumer markets, our customers products have enough volume to justify hardening the design to an ASIC. In those cases, the customers use the RTL output features of our tools to generate code which then drives traditional ASIC design flows.

Q. **Are your products FPGA-independent, or do they only work with certain FPGA vendors such as Altera or Xilinx?**

A. The tools have a built-in understanding of the FPGA design resources so we can take C software directly to optimized FPGA implementations. In fact, our tools generally pass the design data via EDIF directly to the FPGA vendor design tools automatically, so that the designer doesn't have to be aware of the place & route process. Because of this tight relationship between the tool and the FPGA, we need library data for the specific devices. We support the most popular devices from Altera and Xilinx and cover select other FPGA or reconfigurable logic providers as needed for specific projects.

Q. **Many FPGA tools are "free" at least from Xilinx or Altera. Where does your product fit in vis-a-vis these "free" tools?**

A. I think Altera and Xilinx might argue with your characterization of their tools as "free". In reality they do charge for those tools, inside the device part price if not separately. However, the FPGA vendors are actually our best partners. The Celoxica tools provide a robust compilation environment from C for their devices with functionality that goes far beyond the design tools that the FPGA vendors provide. Also, Celoxica's tools broaden the market for FPGA devices, allowing more people to use FPGAs in their systems. So the device providers are very supportive of ESL tools. For example, Xilinx has had an ESL Initiative program for about a year now that promotes the use of third-party ESL tools and Celoxica has been a leading partner within that program. The FPGA vendors will always need to provide basic flows, especially P&R tools. But they also recognize that an active third-party ecosystem of tools is valuable. In Celoxica's case, by extending a software flow to a new market, we are providing the absolute fastest way to get from algorithm to FPGA.

Q. **Where does your *DK Design Suite* fit in vis-a-vis other tools such as those from Mentor Graphics, GiDEL, or Synplicity? Is it competitive or complementary to other third party tools, and which ones?**

A. Celoxica is focused on the C software flow directly to FPGA. Think of the tool as a software compiler to FPGA, with the end goal being co-processing acceleration in the programmable logic. There are several other companies that have also recognized the potential for letting software programmers use FPGAs as co-processors, such as Impulse and Mitrionics. Though these tend to be smaller companies without the full breadth of the solution that Celoxica has built over the years, they do have their niches and we welcome the competition as it grows awareness of the market. The bigger EDA companies are focused on other markets and revenue streams. Synplicity is a long-time partner for Celoxica and our RTL output has been designed to flow to Synplify for those customers that use that tool. Mentor is more focused the ASIC flow and for that reason we rarely compete directly. Even though their Catapult tool does synthesize C code to RTL, it is not set up as a compiler directly to FPGA and so we address different design opportunities. Gidel is one of several partners for Celoxica in the FPGA hardware arena. Our tools make it easy for customers to design to FPGA cards, and we have libraries and board support packages for several third-parties, even as we also sell some of our own acceleration cards.

Q. **I have heard that FPGAs are being used more and more for parallel computing, and that Celoxica offers FPGA boards for acceleration. Tell us about this product line.**

A. Celoxica's customers have for a long time used FPGAs to accelerate embedded systems. We have also had PCI-based FPGA accelerator cards for years working with AlphaData. When customer started accelerating applications such as genome processing and medical imaging using these cards, and using the DK software as a compiler, we realized there was a much larger market for these types of ESL tools if we could make it accessible to a wider range of software designers. This has led to a robust solution for what we call the Accelerated Computing market – proving FPGA acceleration cards to the HPC server market along with the compilers, interfaces and IP necessary to easily accelerate their software applications. The key to growing this market beyond a few PCI applications was finding an interface between the FPGA co-processor and the system processor that was both fast and standard. We found this with Hypertransport. Our RCHTX card provides a robust acceleration solution for servers with HTX slots. For these applications, we have been able to achieve from 10x to 200x performance acceleration of applications, while

using only 1/10th the power for processing the application. The RCHTX cards are now in volume production and have been qualified by major server OEMs for use in their systems. Along with Celoxica's compilers and floating point IP, we have accelerated applications in Financial Services, Energy and Life Sciences. To connect back to the EDA market, we also have several customers now using servers with these cards to accelerate ASIC simulations. It's all connected isn't it?

Q. **Is Celoxica then more an FPGA board vendor, or an FPGA tools vendor?**

A. Celoxica thinks of itself as a solution integrator for FPGA-based acceleration. The big enabler for that solution is still the C to FPGA compilation technology. We will provide the entire solution including hardware boards, services and IP as much as the customer needs. We also work with third-parties who can supply hardware or services, and in some cases even complementary software tools. Our goal is to always be the company that the customers can count on to make the solution work around FPGA acceleration, no matter what other parties the customer may also need to work with.

Q. **How much do your product cost? Explain the pricing options for both your design tools and your FPGA deployment boards.**

A. Like the solution we provide, the pricing also depends on the exact configurations the customer needs. For example, we have software configurations from trial versions, to one-year term licenses, to full perpetual licenses – all with various functional differences such as which FPGA devices are supported, and which simulation or analysis or IP features are required. We also have FPGA development boards, and FPGA acceleration boards. Some of our packages bundle these software and boards together into complete systems, and we even sell complete computing acceleration workstations. So the range of our products run from our ESL Starter Kit with an evaluation license and RC10 demo board at $750, to a full perpetual license with development board and training for nearly $100K. We base pricing on value, but we work with our customers to make sure they are getting the performance and productivity boost they need.

Q. **Thank you, Jeff, for this great interview.**

Eridon: UnifiedLogic for FPGA Design

2 August 2007: Eridon: UnifedLogic for FPGA Design

Interviewee. Eric Schneider, President
Tel. 612-802-6178
Email. eric_schneider@eridon . c o m
Company. Eridon Corporation
Web. h t t p : / / w w w . eridon . c o m /

Q. **First of all, tell us a little bit about yourself and your company.**

A. I originally founded a company back in 1979 where we designed PC software and embedded systems for our own products as well as others. In 2000 we were acquired by Adaptec and over the subsequent years part of the group re-formed as Eridon. With a variety of funding sources, we dedicated ourselves to building a modern software-centric tool for embedded system design around the emerging ability of FPGAs to be essentially a "liquid" circuit board, provide gate-level logic, and a CPU. After years of development, we are now marketing our UnifiedLogic development platform. In one way, you can think of Eridon as the company introducing a new configurable RTOS with integrated hardware design automation.

Q. **What is the concept of "modularity"? What is a *uCard*?**

A. It is through UnifiedLogic's advanced modularity that an embedded system concept is rapidly turned into a working prototype, on its way to becoming a production design. It bridges the hardware and software worlds by encapsulating into a "module" all the parts required to implement a given subsystem (e.g., USB or NTSC video): its supporting circuit design, the gate-level logic that drives it, the glue logic to interface it to a CPU, and the software drivers to control it. A UnifiedLogic module is essentially a hardware reference design along with software drivers that can self-integrate with other modules. For many modules, off-the-shelf *uCards* containing a given subsystem's circuitry are available. They are unique in that many *uCards* can be easily plugged together and automatically drive their self-integration (by the Eridon IDE) into an application-ready prototype. This prototype is powered by a custom chip configured specifically for your needs. Various traditional third-party evaluation boards and mezzanine cards are also being supported.

Q. **How does FPGA technology figure into this technology?**

A. Traditionally, modularity meant the use of a standard bus (e.g., the PCI bus in a PC) where significant cost and design considerations have been made around this bus. Such designs don't translate to the cost-sensitive single-chip centric world of embedded systems. However, UnifiedLogic is designed around the use of FPGAs. An FPGA is unique in the role as the heart of an embedded system. It not only contains a CPU, but also the gate-level logic that interfaces to and controls the attached supporting external circuitry. Additional gate-level logic also internally connects the subsystems to the CPU inside the FPGA. The FPGA consolidates much of the digital logic and simplifies the resulting circuit board. However, most important, under the UnifiedLogic framework, all of this digital logic is generated automatically—thus, its modules are self-integrating. It is easy enough that a software engineer in some cases can even get a custom prototype

assembled and working, though it still takes a hardware engineer bring the design to production. When working with UnifiedLogic compatible FPGA-based development boards and add-on cards (such as Eridon's *uCards*), the circuitry on the add-on cards is directly routed back to the FPGA without requiring any standardized bus. Because of this, such prototypes from the point of view of what chips are connected to each other, will look very much like the final design.

Q. **Can I use only *uCards* from Eridon, or can I design my own custom *uCards*? Can I mix and match my own *uCards* with those from Eridon? What sorts of *uCards* are available, and how does the product offering expand over time?**

A. Eridon will be releasing the specification in the future for customers to design their own *uCards*. However, a "prototyping" uCard already exists on which custom circuitry can be introduced into a design. And yes, *uCards* are all about mixing your own designs with others that are available. Currently, Eridon provides *uCards* for designs requiring communication (Ethernet, USB, CAN, etc.), audio/video (NTSC/PAL, VGA, DVI, etc.), and low-level buses (I^2C, SPI, etc.). Future *uCards* will be targeting other areas such as wireless communication and motor control.

Q. **Is Eridon's solution only for prototyping? How does an Eridon prototype translate into a deployable product?**

A. One should think of Eridon as offering a complete platform for embedded system design. We create designs that are cost-effective to put in production, but along the way, we have made it possible to rapidly create prototypes of such systems. The experience of creating your prototype is more of an RTOS (real-time operating system) configuration process where out of this, its integrated hardware design automation yields a custom FPGA image to drive all your peripherals (note the FPGA will contain a CPU such as Xilinx's 32-bit MicroBlaze). To put the design in production, you will build an image for the optimum sized FPGA and then, based on the schematics and bill of materials for all the *uCards* involved, including any that you have designed, you will coalesce the design into a single PCB layout (meeting your form factor requirements). From a software point of view, the UnifiedLogic RTOS and your application easily ports from the prototype to the final design. Further, all the download, debugging, file transfer, and other abilities of the IDE are available on your final design by simply including an inexpensive connector (in addition to JTAG).

Q. **Is your solution useful for ASIC prototyping or only for designs focused on ultimately an FPGA-based deployable board? Or both?**

A. It can be used for both.

Q. **Which FPGAs does your company support? Are you vendor specific or vendor neutral?**

A. We currently support Xilinx's Virtex and Spartan FPGAs.

Q. **Tell me about the software development learning curve to use your products. Is there a long learning curve, or is this software easy-to-learn? How does it work for experienced FPGA users *vs.* those new to FPGAs?**

A. Our tools are very software centric, and easy to learn. We have modeled them after Microsoft's *Visual Studio* and included many "Quick Tutorials." A big feature of our tools is that you can quickly get a prototype up and running, often just by plugging cards together, and then minutes later continue to write your application software. Our editor (based on *SlickEdit*) provides auto-completion features so that you can almost begin by typing the name of a peripheral and picking out appropriate functions. We support both C and C++ with a modern object-oriented architecture, and provide much of the system in source form. We have taken great care to integrate the many steps involved in building the FPGA and software images so that users can focus on writing their application—just click "Run" and everything gets built and downloaded. You do not need any FPGA experience to effectively use our tools. We provide a simple configuration process to set up peripherals such as those found on microcontrollers as well as easy integration of complex subsystems like USB or video. For the experienced FPGA hardware engineer, the UnifiedLogic framework offers a way for them to pass along their designs for integration and use by software engineers.

Q. **Does your design software work well with other FPGA-related tools? Is it compatible or competitive with alternative software flows, such as those provided for free by Altera or Xilinx?**

A. We view ourselves as the next level up on the tools offered by Xilinx. Whereas they naturally have a focus on the FPGA and hardware engineer, we are focused more on the embedded system design as a whole, and in particular, the various peripherals that get attached and providing complete support for the software engineer. We bring a powerful real-time operating system (RTOS) along with a rich library of advanced software drivers (much more than just talking to chips—for example, within minutes a software engineer can be copying files from a USB flash drive). We have written a lot of IP to enhance the performance of the peripherals we support, thus taking advantage of the FPGA's ability to do things in hardware. The Xilinx tools will still be used by a hardware engineer in creating new UnifiedLogic modules.

Q. **What about third party IP? Can I purchase or integrate my own IP onto the boards, as well as create new IP via your software? How does that work?**

A. You can use your own or third-party (gate-level) IP in a UnifiedLogic "module." In fact, we already provide IP from Xilinx's library packaged as UnifiedLogic modules. To create this IP, you will use the tools provided by the FPGA vendor (such as Xilinx's ISE and EDK). Once your IP is working, you then "wrap" it with an appropriate UnifiedLogic description (XML). At this point you can then easily use this IP (module) in various designs. The Eridon IDE takes care of integrating the IP with all the other IP and software that makes up a given design. To truly make a UnifiedLogic module, you will also need to add appropriately structured software drivers and documentation. However, these steps are not necessary if you don't intend to publish your module.

Q. **How much does all this cost? What is the business model by which we pay you - do we pay for prototyping boards, services, and/or per unit royalties on deployed products? Please explain.**

A. You pay for the tools (Eridon IDE), development and uCard boards used in prototyping, support in using the tools and moving designs to production (services), and finally there are various licensing charges for using our IP and putting a product in production, depending on what IP you need. You can get started for under $10,000. We will shortly have a free full-featured timeout evaluation version available that will work with various Xilinx, Avnet, and Eridon evaluation boards.

Q. **Thank you for this interesting interview.**

GateRocket: New Solution for FPGA Verification

2 August 2007: GateRocket: New Solution for FPGA Verification

Interviewee. Dave Orecchio, President and CEO
Tel. 781-908-0082
Email. @ h t t p : / / w w w . gaterocket . c o m /contact.php
Company. GateRocket, Inc.
Web. **h t t p : / / w w w . gaterocket . c o m /**

Q. **First of all, tell us a little bit about yourself, and about GateRocket and *RocketDrive*™. What is your background, and what is your company's "value proposition" in a nutshell?**

A. I have been involved with semiconductors and chip design for over 24 years. Many of those years with Viewlogic Systems, Inc. (later named Innoveda) as the company grew from a start up to a major design tools player. During those years, Viewlogic was a major supplier of software tools to the FPGA vendors and I managed those strategic relationships. Since Viewlogic, I have worked with other startups servicing the ASIC market as well.

I met with the founders of GateRocket and immediately loved their product. As a follower of the changing silicon design landscape and the tremendous growth of the FPGA market, I heard users complain about the inability to validate their FPGA design and the inadequacies of FPGA verification tools. The founder, Chris Schalick was one such user and based on his experience he created a product to solve the performance and debugging bottleneck faced by modern day FPGA designers.

GateRocket has created a product that we call a *RocketDrive* that fits in the 5 ¼ inch drive bay of any Linux PC. Inside this *RocketDrive* is the largest of the family of an FPGA wrapped with our special interface which we then integrate with the user's simulator of choice. In essence, we are bringing the silicon into the verification environment and we call this approach "Device Native" verification.

The user benefits by the speed of the hardware, the accuracy of the actual FPGA device and the scalability of a system prototype in one infinitely flexible and productive environment. What's more, this solution fits into their existing verification environment with no methodology change. Our product goal is ease of use, high performance and advanced debugging.

Q. **What do you mean by "Device Native" verification, and how is this helpful for FPGA-based designs?**

A. FPGA designers grapple with the differences between the behaviors that they see in simulation and that they see when the FPGA is programmed in the end-product. The sources of these differences can be numerous. Most importantly the use of vendor or third party intellectual property can be especially problematic since there are often differences in behavior between simulation models and the physical on-chip IP and in many cases the designer interprets behavior one way and the chip behaves in another. Another occurrence is caused by design errors that are not discovered in simulation and materialize in silicon. The in-silicon version of the design is far less forgiving.

By bringing the actual FPGA into the simulation environment, the user can exercise all of their verification tests that they know and love against the actual programmed FPGA in the *RocketDrive*. They get the Native Device behavior, hence the term Device Native verification.

This Device Native approach helps to eliminate the guesswork of how the design is going to function in the system. Since we are coupled to the simulator, the user gains the benefit of all of the tests they have written and can more easily and rapidly find bugs than they can find them in the lab. When a designer is asked - when you first place your programmed FPGA in your system in the lab how often does it work the first time - most users say never or seldom. And when asked - how long it takes to find each bug - they say days or sometimes weeks per bug. Since they have the ability to flush out most of the silicon related issues up front in the design process with the *RocketDrive*, the cost to fix the bugs is significantly lower and the time to market benefits can be tremendous.

Q. **Which FPGA families do your support - Altera, Xilinx, and/or others?**

A. We have decided to focus on Altera and Xilinx at this time. We have been approached by others but plan to stick to the top two vendors for the near term since they represent 87% of the market.

Q. **In your website materials, you position GateRocket's *RocketDrive* between "simulation" and "emulation" in terms of FPGA design. Can you explain each concept, and your position as a "third way?"**

A. Every electronic engineer understands what a simulator is and most understand the concept of an emulator. The GateRocket product fits in between since it can be viewed as an accelerator, but it is much more. Simulators are used by every engineer to create the product design and the test bench to verify the design. Emulators attempt to be copies of the design and the test bench since they want to run at speed or nearly at speed. The challenge with emulation is that it is a lot of work for the designer to convert the test bench into something that can run at speed and placed into hardware. It takes significant time and effort to make them work.

We choose to implement a solution that did not require a methodology change and fits into the users existing methodology and tools and adds value to them. We have made is very simple to place the design into the *RocketDrive* and to connect it to the test bench. It's that simple.

Q. **Is your solution applicable only to designs that will ultimately deploy as an FPGA, or is it applicable as well to FPGAs used for ASIC prototyping?**

A. We believe that it is applicable to both applications; however there are a much larger number of designers of FPGAs than ASICs. I believe that both have pain when it comes to getting working silicon and we can help with that. On the GateRocket blog w w w . DeviceNative . c o m we have a post regarding the FPGA design starts where we reference published Gartner data, you can view the post here

h t t p : / / w w w . devicenative . c o m /2007/02/27/designers-march-toward-fpgas

Q. **FPGAs are ultimately deployed on PCBs, and in most cases are team design efforts. How does *RocketDrive* address the needs of "FPGA/PCB Integration" as well as the ever-present need to have team-based designs?**

A. One of the important benefits of FPGAs is the ability to program the I/O of the device to different interface standards. We enable any configuration that is possible with the FPGA to be the same for the FPGA in the *RocketDrive*. In essence, we wrap a configurable hardware device around the users' FPGA, programmed in whatever form they desire, and then integrate it into the simulator. So we imitate the hardware environment around the FPGA and give the user the infinitely flexible simulation and software environment to program the interfaces.

From a user's point of view, the GateRocket solution is completely scriptable and can be implemented in a server environment. This makes the solution as extensible as a simulator is. We intend the team to use the product, starting with the FPGA design Engineer to the Design Verification Engineer, the Embedded Software Engineer and lastly the System Validation Engineer.

Q. **What about other third party FPGA tools like those from Mentor Graphics, Synplicity, Altium and others? Is *RocketDrive* compatible, competitive, or a little bit of both with respect to the Third Party FPGA tools available today?**

A. We are focused on the big guys, but as with any startup we are aggressive and nimble. If a user needs integration with another tool we are happy to oblige. Currently we have partnerships with the top three simulation vendors, FPGA vendors Altera and Xilinx and Synplicity for Synthesis (in addition to the FPGA vendor synthesis tools). We are also working on Mentor Graphics Precision synthesis integration as well.

Q. **To emphasize the point - tools are very important to all design flows. In the FPGA market there are FPGA vendor tools (often "free"), third party tools, and even "home grown" tools inside a vendor. In addition, there are "Intellectual Property" providers and tools for integrating and verifying IP. If an engineer decides to go with *RocketDrive*, how does he preserve his relationship with the tool and/or IP vendors that he knows best?**

A. Very simply since we do not change the verification environment or the tool chain for synthesis and place and route, we complement their environment. The one tools set that is seldom free is the simulator. Design verification is the one thorny problem that the FPGA vendors have not gone after, especially for large designs. The investment by Cadence, Mentor and Synopsys is enormous and it would be difficult to nearly impossible for the FPGA vendors to replicate that, only to give the tools away. Their strategic focus is on silicon and anything that enables the use of the silicon. Synthesis and Place and Route have a direct impact on chip performance, so they have a strategic need to invest there.

By the virtue of GateRocket placing the commercially available FPGA chip into the verification solution as we do, both leverages the R&D efforts of the FPGA vendors to help them and their customers get to market sooner, we also are a great partner for the simulation vendors since we add value to the simulator by extending the debugging use into the lab (or bringing the lab into the simulator).

Q. **Turning to IP specifically, how does *RocketDrive* help with IP integration and verification? Does it work with all types of IP - vendor, third party, and "home grown?"**

A. This is a very important question. If the customer can program the IP onto the FPGA, meaning they have the right and license to do so, they can also place it into the *RocketDrive*. We do not do any translation, mapping or munging of the IP in any way to disturb it. The users preferred tool flow is used to drive the design into the FPGA that is in the *RocketDrive*. It is this simplicity that sidesteps the complexities that are common with other approaches.

Q. **What opportunities does an engineer have to "try before buying" any of the GateRocket products? What sorts of pre-sales learning opportunities do you provide, and how would you recommend that someone new to GateRocket get started investigating your solutions?**

A. We recommend that interested parties go to the GateRocket web site and request information or our white paper. We have a comment box in the request form to add additional information as well. We will promptly follow up and work with each user to first determine the fit and then help them learn whatever they need before purchasing. Since we are a start-up we will focus on those customers with the greatest need and willingness to partner with us and purchase our product. One of our goals is to deliver great value and first class support so the user comes back for more.

Q. **Explain how much GateRocket's products cost? What are the various pricing options?**

A. The *RocketDrive* list price is $25,000 for the Altera *RocketDrive* and $30,000 for the Xilinx *RocketDrive*. We will explain other details when the user contacts us.

Q. **Other than your web site, are there other resources that our readers can use to learn about your approach and philosophies?**

A. Yes, of course. In addition to our website at w w w . GateRocket . c o m , we have created a blog to talk about FPGA industry related items and trends. You can find the blog at w w w . DeviceNative . c o m . In fact there is a recent post that discusses the increasing trend of embedded processors in FPGAs. I understand from the research data that 40% of all FPGAs will have embedded processors in them by 2010. We believe this is the case and it is a great example of high value-added IP use.

Q. **Thank you for this interview.**

A. It is our pleasure. The GateRocket team has a passion to deliver the best FPGA verification and debugging solution that adds value to their existing tools and methodologies and we hope your readership contacts us to learn more about our product.

Mentor Graphics: FPGA Advantage

8 August 2007: Mentor Graphics: FPGA Advantage

Interviewee. Glenn Perry
General Manager
ESL/HDL Design Creation
Tel. 503-685-7053
Email. glenn_perry @ mentor . c o m
Company. Mentor Graphics Corporation
Web. h t t p : / / w w w . mentor . c o m /

Q. **First of all, tell us a little bit about yourself and Mentor Graphics, especially those products that are helpful to FPGA design issues.**

A. I am responsible for Mentor's suite of design creation products, which form the foundation for our complete FPGA design flow. Mentor is uniquely positioned in the industry, as the only company who develops and delivers every component of a complete FPGA design flow, from concept to PCB implementation.

Q. **Focusing on Mentor's product initiative, *FPGA Advantage*, this product group promises "any silicon, any vendor, any language." These are big promises - what is the primary need among FPGA designers that Mentor is seeking to address?**

A. Fundamentally, our goal is to make our customers more competitive, in an ever growing pressure cooker of time to market, quality, price, performance and functionality challenges. The company who can optimize all parameters consistently wins. Optimizing these parameters requires tremendous design flexibility combined with leading technology. Here at Mentor Graphics, we are focusing on complete design solutions that truly enable the multidimensional optimization. Flexibility is key. Examples of "flexibility" include:

- Flexibility to use the latest IP from any source, which usually means any and every HDL language. Optimize design performance and functionality.
- Flexibility to select any FPGA Vendor or FPGA platform on short notice. Optimize design cost, performance and functionality.
- Flexibility to retarget FPGAs to ASIC when volumes ramp above the ROI threshold for FPGA's
- Flexibility to leverage the latest in HDL design languages and apply the latest in verification methodologies, such as coverage, assertions, transaction- level modeling, etc. Optimize design quality and time to market.

The list goes on and on, but you can see how focusing on a solution that delivers "any silicon, any vendor and any language" is fundamental to helping our customers be number one in their markets.

Q. **How important is "hardware independence" to a good FPGA design flow? Since Xilinx, Altera, and the others offer free design tools, why shouldn't an engineer start his project by "testing" their products with the free tools?**

A. That's a great question. Some of the answers lie in the previous question / answer, but let's talk a little more about "free design tools". There's no such thing as a free lunch, and there's no such thing as free design tools. "Free tools" come at a real and significant cost. The cost is lost flexibility to choose the optimal solution for every design, which can ultimately mean the loss of competitiveness, profit and market share.

The FPGA market (silicon not tools), is highly competitive. The leaders in this market leap frog each other, with price and performance on a very regular basis. Free tools help lock a customer to a FPGA vendor. The "lock" happens in two ways:

First, the free tools promote and drive the use of vendor-specific IP (from the vendor who provides the free tools). Eighty percent of all designs are reused today. Reuse is critical to meet modern design needs. But, when designs are captured and implemented in ways that lock them to vendor-specific IP, the opportunity to retarget the next design is lost. Rewriting the design (or portion thereof) to target another FPGA platform is not feasible, as it essentially forfeits the value of reuse. Our solutions focus on allowing customers to capture designs to maximize portability of code where it can be retargeted to different IP providers, or even different silicon platforms.

Second, all tools require training and expertise. That's no surprise. Once teams are trained on a "free tool", there's a cost associated with moving them to a different tool (free or otherwise). But, there are additional factors here that are more subtle and painful, which increase the cost to move between vendors when locked into a free tool.

- Designers don't like to move between tools. When asked opinions about company X's FPGA platform, when they are already using company Y's FPGA tools and platform, inherent biases are impossible to avoid.
- Designers using company X's FPGA free tools are going to get more visibility into company X's next generation silicon, again, biasing decisions about which platform is optimal in the next design cycle.

Since many companies are using FPGAs from multiple vendors , they can end up supporting multiple tools at a time where there is desire to minimize the supported EDA tools. Additionally EDA tools many times are more "capable" than vendors' tools – for example in the area of languages standard support, such as SystemVerilog support, or in ASIC prototyping where vendors' tools lag in gated clock conversion.

When designers cannot move between FPGA vendors they end up selecting sub-optimal silicon which can delay the project or increase the cost. Also, price leverage with the FPGA vendors is reduced when vendors know that the cost of switching to competitive silicon is high due to tool usage. It's all about locking into their silicon.

Project delays and increased silicon cost usually far exceed the cost of tools from an independent EDA company.

Many customers reached this exact conclusions and are using non-vendor tools – especially after they found themselves trying to switch vendors. The fact that the vendor-independent synthesis market is over $80 million (per Gartner), is a proof that many customers understand the real cost of the "free" tools

Of course, Mentor and all the vendors are cooperating to address customers' needs.

Q. **Looking at the three products that make up *FPGA Advantage - HDL Designer Series™, ModelSim,* and *Precision® Synthesis* - can you succinctly explain what part of the design process each product addresses?**

A. *HDL Designer* is the cockpit, which provides HDL design creation tools, design checking / scoring, integration with simulation, synthesis and place and route (as well as any other downstream tool), team design, data management and design documentation

Modelsim is the verification engine, providing the industry's best performance combined with the most complete language coverage, all in a single kernel.

Precision is the synthesis engine that provides industry-leading quality of results across all leading FPGA platforms.

While it's not explicitly mentioned, it's important to note that *FPGA Advantage* also provides integration with I/O Designer and additional downstream Mentor printed circuit board (PCB) tools.

But the real key to FPGA Advantage is the fact that each core component is a Mentor product, enabling us to provide the best integration of the best in class tools available for FPGA design.

Q. **What languages does *HDL Designer Series* support? Is their one or other "preferred" hardware design language? What about ESL, SystemC, and the plethora of design languages and initiatives in the hardware space - how does it handle those?**

A. VHDL (all flavors), Verilog (all flavors), System Verilog, and limited SystemC / C++. There's no preferred language. We find most designs involve a mix of several languages. We have a comprehensive solution for all HDLs and we invest heavily to maintain leading language compatibility in all areas.

Mentor is also investing heavily in the ESL space. Today, most ESL design flows are in SOC ASIC design. However, Mentor has a complete offering of ESL design solutions, including design, synthesis and verification, which interface nicely to our HDL tool flow.

Q. **Does *HDL Designer Series* enforce "coding standards" or "discipline?" How does this help a team with their design?**

A. *HDL Designer* provides a sophisticated rule checking engine that is optimized for performance and usability. Prior to developing this capability in HDL Designer, our customers told us that they wanted to use design checking solutions, but they found the existing solutions to be too slow, too expensive and way too difficult to use. We recognized this as an opportunity to provide a unique design checking solution.

The key to our solution is that it is intrinsic to the design environment, much like a spell checker in a documentation product. We are also focused on optimized results, by avoiding false negative results, providing outstanding filtering and reporting tools, and integrating error reports directly with the source code for quick editing / resolution.

Our customers really like this approach, especially the speed and capacity of the tool, but the thing they like the best is our quality score. We provide a quality metric on any design analysis that roles up to a score of 0-100%. The metric is customizable so each company can weight and select the rules that are most important to them. It's great to watch design engineers challenge each other on code quality scores. The end result is a tool that design engineers **want** to use for design checking and quality assessment. This is nirvana for the design managers.

Q. **How do Mentor's products relate to the "free" tools provided by the FPGA vendors themselves, as for example Xilinx or Altera? Are they complementary, competitive or both?**

A. Ultimately, FPGA vendor tools are instrumental, as they ultimately provide the P&R functionality necessary to complete the design. This is obviously tied directly to the FPGA vendor expertise and technology. Our solutions complement the vendor P&R tools by wrapping this functionality with a complete FPGA design flow. The flow delivers the functionality that we've already discussed, but equally important, it's designed for team use in enterprise environments. As said before we are cooperating both to assure P&R integration as well as best QoR for all the FPGA devices.

Q. **What about other third party FPGA tools like those from Synplicity, Celoxica, and others? How do Mentor's products differ? Do they address different problems or needs? Can you help orient me as to which other design tools Mentor Graphics is complementary with?**

A. Other third party tools are point tools. Mentor has invested to provide the best in class point tools, within a complete flow for FPGA Design, from concept to implementation. No other provider has the complete suite of technology necessary to deliver the entire flow. Therefore, third-party providers are inherently limited to interfaces and third-party relationships to try to piece together a complete solution.

Mentor Graphics tools comprise a complete design solution leveraging integration between tools throughout the FPGA design flow on to the PCB. Flexibility to integrate other tools already within a design flow process is an indicator of our commitment to our customers and their design environment needs.

Q. **Do your products work only with certain FPGAs from certain vendors, or are they part- and/or vendor-neutral? Tell me about your support for third-party evaluation boards, in particular.**

A. They are part- and vendor- neutral. Mentor Graphics solution is coming from a single company while providing flexibility to target any FPGA device. This is critical in view of the business complexity and technology demands placed upon developers in today's market. Third part prototyping boards, such as ProDesign, have announced support for Mentor tools

Q. **Mentor Graphics is known as a leader in the EDA space. Is *FPGA Advantage* geared only at the "high end" FPGA applications as in consumer electronics? What sorts of verticals and product volumes / budgets are required to justify using the Mentor tools?**

A. Using Mentor tools provides consistent and ongoing support for advancements in FPGA design and technology. Our company initiative is to provide a designer with tools for everything from the simple to the most complex FPGA. Overall the ability to leverage technology advances, reduce development cycles and streamline effort across the organization is where our tools deliver. The tools address all industry segments, are competitively priced and are used for production FPGA as well as for lower volume FPGA-based ASIC prototyping.

Q. **What opportunities does an engineer have to "try before buying" any of the Mentor Graphics products? What sorts of pre-sales learning opportunities do you provide, and how would you recommend that someone new to Mentor Graphics get started investigating your solutions?**

A. There are software evaluations available along with demos and tutorials to experience our FPGA solution.

Q. **Explain how much Mentor's products cost? What are the various pricing options?**

A. There is a core set of functionality, then options depending upon the needs of the designer.

Q. **What about team or multiuser support? Do the Mentor Graphics products have any particular advantages for the ever-present hardware / software team approach to complex FPGA-based designs?**

A. Designs are often developed across time zones and within or outside of a specific team, and our tools provide functionality to facilitate and efficiently leverage this type of development.

Q. **Thank you for the opportunity to better understand Mentor's FPGA Advantage.**

Mentor Graphics: Unifying FPGA and PCB Design

2 August 2007: Mentor Graphics: Unifying FPGA and PCB Design

Interviewee. John Isaac, Director of Market Development, Systems Design Division
Tel. (720) 494-1270
Email. john_Isaac @ mentor . c o m
Company. Mentor Graphics
Web. **h t t p : / / w w w . mentor . c o m /**

Q. **First of all, tell us a little bit about yourself and Mentor Graphics, especially those products that are helpful to FPGA design issues.**

A. Mentor Graphics is the worldwide PCB Systems Design market share and technology leader. We provide front to back design solutions for FPGA and PCB systems design to electronics companies in all major industries.

Q. **Focusing on Mentor's product, *I/O Designer*, this product aims to allow for concurrent FPGA / PCB design. First of all, why are FPGA and board design interrelated problems? What factors make these difficult?**

A. The goal of OEMs is to design the most competitive product in the shortest time to market. Unlike ASICs that require very long lead design times, FPGAs provide the opportunity to implement an FPGA/PCB concurrent design process. This means that during this concurrent process, trade-offs can be made in the FPGA and the PCB design to optimize the product at the system level. Optimize system performance, optimize PCB routing thus reducing PCB designer time and layers (cost), etc.

Q. **How does *I/O Designer* address the problems of FPGA and PCB design?**

A. Designer provides integration between the FPGA and PCB design processes with the following:

- Provides for a concurrent process versus a serial process thus reducing the total design cycle times.
- Provides for automation in creating the FPGA schematic symbols thus removing tedious and error prone manual effort.
- Provides for optimizing the pin-out of the FPGA, following the FPGA vendor design kit rules, but considering how the FPGA is implemented on the PCB.
- Provides integration and incremental trade-off analysis between the FPGA and PCB designer so each party wins.

Q. **If an engineer's responsibility is solely for the FPGA (not FPGA / PCB), do Mentor's products help him?**

A. Yes. The efficient design of FPGAs is one of Mentor's strategic capabilities. Design entry, synthesis and optimization for FPGAs from the leading FPGA vendors are some of

Mentor's strengths. Mentor's believes that just focusing on one or the other does not address the problem at the system level. OEMs design and sell systems.

Q. **What about team hardware/software efforts? If a team has both FPGA designers and FPGA/PCB lay out designers, how does Mentor Graphics help them? Does it support collaborative development among groups, and if so, how?**

A. Yes. *I/O Designer* is a collaborative tool and resides between the disciplines. It is implemented with what-if, trade-off functionality that provides a give and take paradigm where changes are suggested and accepted, not forced. That said, the use of these integrated solutions now requires a closer working relationship between the disciplines than may exist in some OEM organizations. *I/O Designer* eliminates the "design it and throw it over the wall" practice.

Q. **How do Mentor's products relate to the "free" tools provided by the FPGA vendors themselves, as for example Xilinx or Altera? Are they complementary, competitive or both?**

A. Mentor's tools definitely complement the tools provided by the leading FPGA vendors. Thus there is a close working partnership with these vendors on both the technical and marketing fronts.

Q. **What about other third party FPGA tools like those from Altium? How do Mentor's products differ? Do they address different problems or needs? Different vertical markets?**

A. Altium has identified the FPGA – PCB Interface as a design productivity opportunity for their customers. The Mentor approach and the Altium approach differ in their basic assumptions about the design process and consequently the technology each supplier has developed. The Mentor approach does not make assumptions about the organization of the design team and consequently provides a richer functional set to scale from the single engineer "design team" to the globally delocalized "design team." The Mentor strategic approach has been to partner with the FPGA Vendors in the development of leading edge rule based technology so that all of the power and flexibility of every FPGA device is at the design teams' finger tips while providing guidance to assure that illegal FPGA pin assignments are never created. It is this investment in strategic technologies which differentiates the PCB optimization Mentor is able to achieve for our customers routinely reducing PCB trace length connected to the FPGA device by 25% to 50%.

Only Mentor offers simultaneous, concurrent PCB optimization for system designs containing multiple FPGA devices. The challenges associated with multiple-FPGA device based system designs grow exponentially. Mentor's strategic investment to develop leading edge AI technology to address FPGA – PCB Optimization is now paying dividends as customers apply this technology to the most complex system designs (over 20 large pin count FPGAs on a single PCB).

In addition, although Altium has some good FPGA design aid tools they generally serve a different market than Mentor. Altium's PCB design tools serve the low end of the market where the use of FPGAs is present but may be relegated to low-end FPGAs. Mentor's PCB design solutions are targeted at mid to high-end product design that tends to use the high performance, high pin count, high density FPGAs. At the higher end, the ability to trade-off and optimize at the system level becomes very important. Plus, the shear complexity

of these high-end systems benefits from the automation (e.g., FPGA schematic symbol generation) and I/O pin assignment capabilities of *I/O Designer*.

Q. **Do your products work only with certain FPGAs from certain vendors, or are they part- and/or vendor-neutral? Tell me about your support for third-party evaluation boards, in particular.**

A. Mentor's products work with all of the major FPGA vendors (Actel, Altera, Lattice and Xilinx since they all adhere to established file standard formats in their design kits and tools (place and route for example). In terms of device support and device/package intelligence the design challenge demands device/package expertise. Mentor has embedded this device/package expertise into *I/O Designer*. Mentor has accomplished this functional objective while implementing an open and extensible architecture.

I/O Designer will work with any third-party evaluation boards since the Pin Assignment challenge is FPGA device/package specific and *I/O Designer* synchronizes all of the FPGA Vendor data files that are used to create the FPGA boot programming file. Additional benefits may be achieved if the PCB layout for the evaluation PCB is available to the end-user. *I/O Designer* has the ability to incorporate MGC PCB Layout Databases as well as Cadence and Zuken PCB Layout databases.

Q. **What opportunities does an engineer have to "try before buying" any of the Mentor Graphics products? What sorts of pre-sales learning opportunities do you provide, and how would you recommend that someone new to Mentor Graphics get started investigating your solutions?**

A. Mentor has several ways to introduce a prospect to the tools whether that is a webinar, seminar, hands-on local workshop or EDA Tech Forum demonstration (conducted around the world). Once a level of interest is established, personal demos, trial software and training are available on a case-by-case basis.

Q. **Explain how much Mentor's products cost? What are the various pricing options?**

A. Mentor's *I/O Designer* family of products offer a scalable solution with entry pricing starting as low as $4,995 for core "Correct by Construction" and "FPGA-PCB Interface Synchronization".

Q. **Engineering management often says engineers should use the "free" tools provided by the major FPGA vendors as well as "free" or "open source" tools on the Internet. How do you suggest engineers convince management that buying FPGA tools is a good idea?**

A. The FPGA vendors do not supply "free tools" that use the FPGA flexibility to optimize the PCB design simply because they have no expertise supplying PCB design tools. *I/O Designer* has demonstrated that on average it saves our customer one week of design cycle time for every 500 FPGA pins on the PCB. As designs become more complicated using larger FPGA device or multiple FPGA devices the design cycle reduction benefits of PCB optimization increase be reducing the amount of time spent with meeting PCB timing constraints, signal integrity constraints and the amount of time spent routing

traces on the PCB. In some cases *I/O Designer* has reduced the design cycle time by as much as 50% (while increasing the performance of the PCB and minimizing the PCB manufacturing costs).

Q. **Thank you for helping us better understand Mentor's product offerings for FPGA and PCB design.**

PLDA: High Speed Bus IP for FPGAs

1 August 2007: PLDA: High Speed Bus IP for FPGAs

Interviewee. Kate Martin, FPGA Sales Manager
Tel. +33 442 393 600
Email. Sales @ plda . c o m
Company. PLDA
Web. w w w . plda . c o m

Q. **First of all, tell us a little bit about yourself and PLDA.**

A. I joined the company at the end of 2004, and currently as FPGA Sales Manager my role is to promote and extend PLDA's FPGA market worldwide.

PLDA opened offices in France in 1996, then in San Jose, California in 2004. PLDA has also an office in Austin 2006. Recently designated the world's largest PCI IP Core vendor (Gartner , 2006), designs and sells a wide range of ASIC and FPGA interfacing solutions for the PCI Express, PCI, PCI-X, and derivative protocols. Based on a long-term client-oriented strategy, the company offers complete solutions to a global market, including IP cores, hardware, software, consulting services, and comprehensive technical support provided directly by the IP designers.

Q. **Tell me about your IP offerings? You evidently focus on the "high speed bus" IP segment, especially PCI Express these days.**

A. Our success is based on doing one thing very well—Intellectual Property Cores and prototyping boards for ASICs, Structured-ASICs, and FPGAs, targeting high-speed busses such as:

- PCI Express
- PCI-X
- PCI
- PXI
- AHB-PCI

Q. **PLDA is known as a third-party IP provider. What are the advantages to getting IP from PLDA directly vs. getting IP from Altera, Xilinx, or other FPGA vendors? And isn't IP from those vendors "free" vs. your IP which is not?**

A. There are many advantages in obtaining IP from PLDA rather than other sources. Firstly by choosing PLDA you are choosing the PCI market experts with over 2000 companies using our products worldwide. Purchasing a silicon-independent solution means that you are not locked in to one FPGA vendor or another. Migrating your designs to new devices is simple. With a choice of FPGA device vendors open to you, price negotiations become easier.

Our continuing growth is due to a strong commitment to a loyal and growing client base and a long-term strategy designed to meet our clients' present and future needs.

Q. **Many designers use IP from a number of sources. How does your process / technical support work with IP from other vendors including, but not limited to IP from Xilinx, Altera, and other FPGA vendors or our own internal IP?**

A. PLDA's IP's are protocol certified. The customer can easily add on their own application or other IP's. New addition to the PCIexpress family is PLDA's EZDMA IP – softIP that sits on top of the embedded PCIe core on Xilinx V5LXT/SXT devices.

Q. **IP integration and verification are notoriously hard - how does your technical support work? What does it cost? What do you do about IP integration issues (your IP vs. other IP)?**

A. The difference between PLDA and other solutions on the market is that PLDA technical support is provided by the IP and board designers themselves. It is not something outsourced to overseas call-centers. The issues customers may face are issues our engineers had to solve in building the core. With over twelve years experience in the PCI field PLDA offers the highest quality technical support on the market today.

Price-wise twelve months technical support is included with our IP core licenses. This can be renewed on an annual basis if the customer so chooses.

Q. **I notice on your website that you work with both Altera and Xilinx. Are you FPGA agnostic? What about other FPGA vendors like Lattice - does your IP support them?**

A. We have a long history of supporting Altera and Xilinx devices and have extended this field to include the EP2CM devices from Lattice, earlier this year.

Q. **What is your business model? How do your customers pay for the IP? Is technical support included? What about device royalties? Are there different models depending on different design needs? Please tell me about the business models, available:**

A. Purchasing PLDA IP is simple – either directly with our French or US sales offices, or via one of many worldwide distributors such as Avnet or Arrow. Our FPGA licenses are a one-time fee for a lifetime duration. There are no device royalties to worry about. Licensing is available in both single project and multiproject options – something for everybody's budget.

Q. **What do you offer for engineers to "test drive" your products? Are there demos, white papers, tutorials, trial versions of your IP?**

A. The most efficient way for an engineer to get a feel for our IP is to try it out. PLDA offers a two-month trial period during which time the customer also has full access to our technical support engineers. We include reference designs so the engineer can start the test-drive right away. And of course there are our prototyping boards and designkits for those who wish to evaluate quickly in hardware.

Q. **Management often says that the engineer staff should "do it all themselves," or if not that "do as much of it ourself as they can" to save budget. What do you suggest they tell management to convince them that purchasing third party IP will save time? Money? Stress?**

A. The managers are right! By purchasing PLDA core we take out the stress of protocols such as PCIexpress leaving the engineers to get on with their real business – ensuring their application is up and running fast!

Q. **Thank you for this interview.**

Email Interviews with FPGA Board Vendors

One of the hassles in selecting an FPGA board is going from vendor to vendor asking different questions and trying to compare notes. In addition, it is the FPGA vendor community that really has the most in-depth experience in FPGA board design and deployment. Thus, in this section we provide "email interviews" with major FPGA board vendors on various important topics.

In each case, keep in mind that the vendor is putting his or her best foot forward. These are informative but polemical pieces explaining one or more sides of an issue. In some cases we have more than one interview per topic, which allows comparison of responses.

In all cases, remember to check with the vendors that interest you directly – as the technical details of your project as well as their board offering are subject to change.

Acromag: FPGA Boards for Deployment

2 August 2007: Acromag: FPGA Boards for Deployment

Interviewee. Joseph Primeau
Director of Sales and Marketing
Tel. 248-295-0823
Email. jprimeau@acromag . c o m
Company. Acromag, Inc.
Web. **h t t p : / / w w w . acromag . c o m /**

Q. **First of all, tell us a little bit about yourself and Acromag.**

A. Acromag is currently celebrating our 50th year in business and our 25th year as a manufacturer of embedded board products. From the beginning, the company has been focused on the development and manufacture of I/O based products, particularly Analog, Digital and Serial I/O products. When we first started to develop FPGA-based products, it was in response to our customers' needs for a more customizable I/O product. On a personal note, I have spent the last 25+ years working in the embedded board business for several board manufacturers. I am currently responsible for managing the Embedded Board Group at Acromag. Prior to this I held the title of Marketing Manager and International Sales Manager at Acromag.

Q. **Tell us about your *IndustryPack Modules* with *Cyclone II* FPGAs. What user needs does this product address?**

A. With their ability to mix and match different types of I/O modules on a single, low-cost carrier, most Industry Pack Modules are typically used for I/O intensive control applications. The *Cyclone II* FPGA based *Industry Pack* fits well into the environment. As control applications have become more specialized, the need for tighter control response has become prevalent. This means that response to stimulus cannot wait for the typical interrupt driven CPU cycle that has historically been used (i.e. change in state of a signal is determined, bus based interrupt is initialized, CPU processes the interrupt and response back to the initiating board).

With the use of FPGA, the complete change-of-state/control cycle can be contained within the customer developed code on the FPGA. The *Cyclone II* is particularly well suited for this type of application as opposed to high-end applications that might require memory, DSP, or other more specialized features found in the larger *Virtex* or *Stratix* families of FPGA.

Another common application for the *Cyclone II* based Industry Pack Modules is what is commonly refers to as "protocol conversion" applications. Many of our users are involved in updating older equipment with serial communications networks developed back in the 1980's and early 1990's. These communication networks typically used RS422 or RS485 as their hardware interface, but the protocol with which they communicated was either custom or of a standard no longer used. This is particularly true with older military designs. The *Cyclone II* FPGA on an Industry Pack Module offers a low cost means of reproducing this protocol.

Q. **And tell us about your PMC Modules with *Virtex-4* FPGAs. What user needs does this product address?**

A. Acromag's experience has been that the *Virtex* Family of FPGAs is particularly well suited for data intensive applications. This data may come from the I/O, such as a downlink from a camera or satellite link; or sent across the PCI bus in the form of raw data. Our PMC and new XMC modules reflect this type of application fit.

The *Virtex-4* family offers a number of benefits. The LX version of the *Virtex-4* family is optimized for high-performance data and I/O processing. Typical applications include hardware simulations, communication processing, and in-circuit diagnostics. The SX version, on the other hand, is optimized for digital signal processing. Typical applications include sonar and radar processing, image processing and precision positioning systems.

Q. **So I take it that Acromag is "vendor agnostic," supporting both the big FPGA players - Xilinx and Altera. Are there certain applications that favor one or the other, certain board types that favor one or the other? How does that work?**

A. As a designer of board level I/O products, we have developed a broad experience of using FPGAs in our designs. As a manufacturer of board level FPGA products, we have tried to use this experience to match the best family of FPGAs to the sophistication level of our customer applications.

At the lower end of the application scale, we have been very pleased with the high density and price point the Altera *Cyclone* family has offered for I/O control applications. On the other hand, we have found that the Xilinx *Virtex* Family offers the range of high-end features required for our customers with data intensive applications. One of the key features we found with the Xilinx *Virtex* family is that they offered a wide range of FPGA models within a series that were pin compatible. This allowed us, for example, to offer our customer the choice of the *Virtex 4 LX40*, *LX60* and *SX35* from a single board design. This allows the customer to determine the best size, feature and price to meet their application needs.

Q. **What about design tools and software support? Can an engineer use the Xilinx or Altera free tools, do you provide additional tools, or what other options does an engineer have in terms of the software development environment needed?**

A. With Acromag FPGA products, like other FPGA board level products, the customer will need to use a development tool set to develop, simulate and compile their VHDL code. Depending on the family of FPGA incorporated on the board, the customer will typically use either Xilinx's *ISE foundation* or Altera's *Quartus II* development tool sets. Depending on the complexity of their projects and the particular model of FPGA, the customer will be able to choose between using the free online tool set or purchasing a license for the complete package. Both the free version and the purchased version will meet the basic needs of the FPGA programmers; but there are distinct differences in their level of support. For users of the free web based development tool kits, support is often limited to the smaller FPGAs in their respective FPGA family. In addition, support for some of the more sophisticated IP cores are not always provided for in the web based tool set.

Q. **What vertical markets are your boards applicable to? Do you play in certain vertical markets with your FPGA products?**

A. Obviously with our long history of producing products for I/O intensive applications, we have a strong following in certain vertical markets. These markets include Defense, Scientific, Industrial Control, Machine Control and IC Fabrication capital equipment. With the introduction of our FPGA products, we have found an audience for our products in many new areas within the market we were already serving; but we have also successfully developed a customer base in new markets, such as Telecom.

Q. **How do you differentiate yourself from other board makers who offer FPGA-based boards? What is unique about Acromag?**

A. From the beginning we have designed our FPGA products with the typical I/O user in mind. Our customers are concerned about robustness of the I/O, ruggedness of design, tight control over data throughput and, most importantly, long term availability. This also meant developing FPGA products that were more cost sensitive to meet the tight cost constraint typically found in control applications.

Although customers were not always looking for the largest FPGA or expensive specialized feature that were found in high-end applications such as Military Intelligence or Software Defined Radio applications, they still expected to meet or exceed all of their requirements. Acromag tried to address these needs by offering a broad range of FPGA solutions, from low cost Industry Pack modules with Cyclone II; PMC with Virtex II, Virtex IV LX and SX family; up through our latest XMC products with Virtex 5 LX, SX and soon the FX version.

Acromag also tries to carefully match support peripherals such as memory, high speed LVDS and bus interface chips to meet the needs of the low and middle range of users. Quite often it is these peripherals that make the difference in how well an FPGA board meets the customer's needs. Too little memory or the wrong configuration of memory can cripple an application, while too much memory can drive the cost of the product beyond what the customer can afford. For example, on our simplest board we use single ported SRAM to support the FPGA. As we moved up to larger FPGAs, we moved to Dual-Ported SRAM that sits between the FPGA and Bus interface to facilitate high speed movement of data via DMA transfers. Finally, on our *Virtex 4* and *5* products we added DDR DRAM connected to the FPGA to provide for high speed, large volume storage of data. It is all a part of the balancing act that we use to offer our customers the right mix of FPGA size and capabilities, matched with the proper peripherals while still meeting their cost needs.

None of this technology matching means anything to an embedded customer if they cannot be assured of a long-term supply of products. Acromag's policy is to design products with a ten year production life span. This is particularly critical for our military customers whose development cycle can take years. Acromag engineers have to be particularly careful in selecting components and technology to meet this requirement. When necessary, we will purchase multi-years supplies of components that will become obsolete to insure long-term availability. This is a goal that we take seriously and our customers appreciate.

Q. **In what situations is it better to buy an FPGA board in your opinion? And in what situations would an engineer be better off designing his own board? What factors would encourage an engineer to buy vs. build?**

A. If a customer is working with standard bus form factors such as VME, PMC, PCI, cPCI, industry Pack or PC104, they will generally be able to find the mix of FPGA and Memory

they may need for their project. In these cases they are generally better off trying to purchase a "COTS" product. This is particularly true for applications requiring large FPGAs. The latest generation of FPGAs can have as many as 1,700 connections in the form of BGA's and as many as four or five different power supplies. This makes for a very complex design and long development cycles for a project requiring less than a hundred boards with the ultimate design looking very much like a "COTS" product available from an existing vendor.

Two issues typically push customers to consider designing custom FPGA boards – volume and unique I/O requirements. Those customers that work on applications that will require several hundred boards may be able to justify the long develop cycle that an FPGA board level design takes. We often will find that these large volume customers will often use a "COTS" product only during the initial development cycle, but will ultimately shift to a custom design for final production. We have seen this approach taken recently in the design of Software Defined Radio (SDR) based products.

The other reason customers have considered custom designs is to meet their need for unique I/O requirements. Board manufacturers such as Acromag and VMETRO have tried to address this issue by moving the I/O interface to mezzanine board on their base boards. An example of this is Acromag AXM modules. Using this approach customers are able to use the "COTS" portion of the FPGA board, while working with the vendor to create a custom I/O mezzanine to meet their requirements or by designing their own custom design.

Q. **FPGAs offer a lot of reconfigurability and the ability to mix and match IP - both in-house, and third party. What sort of IP does Acromag offer for your boards and/or assistance in developing or integrating IP for use on the boards?**

A. Acromag is not in the IP business, per se. As a manufacturer of FPGA board products, our goal is to provide the customers the tools they will need to quickly test the product, learn its functionality, and then write their VHDL code. To accomplish this goal we provide an *Engineering Design Kit (EDK)* with source and compiled example VHDL code to communicate to the major components on the FPGA board. This EDK provides example code to talk to the I/O; DRAM and SRAM; Local bus; and PCI bus (including DMA and Interrupt examples).

In addition, to be provided on the EDK CD, this example code is preloaded into FLASH memory on the FPGA board so the FPGA board is a functioning product when the customer receives it. Having this code pre-installed allows the customer to test the functionality of the product before they develop their own code. It also means that the customer can download their code directly to the FPGA to test its operation; safe in the knowledge that if their code fails, they can reboot back to a known condition.

As source code, the example VHDL code provides the design engineer a model of the inner working of the FPGA board. This helps the engineers to come up to speed on using the features of the boards so that they quickly move to developing their design. In many cases customers use the example code as-is or with minor changes and then mix in their own code to create the function that they require for their design.

Q. **How much does all this cost? What is the business model by which the engineer pays you - does he pay for prototyping boards, services, and/or per unit royalties on deployed products? Please explain.**

A. As I stated before, Acromag sees itself primarily as an FPGA board manufacturer. We sell Engineering Design Kits and drivers for a range of operating systems as a vehicle to assist

our customers in developing the code to make their projects a success; which in turn allows them to buy more hardware from Acromag. Both our Driver Packages and our Engineering Kits are sold as a one-time purchase with costs well under a $1,000 each. They are sold as a site license so the customer can do multiple developments without additional cost.

Q. **You mentioned a humorous anecdote about cooking from scratch vs. semi-home made cooking. How does this relate to FPGA boards?**

A. The following quick story I think best summarizes how many engineers are now seeing FPGA board products in the embedded marketplace.

About a year ago I was making a presentation at a tradeshow concerning the use of FPGA Board Products. At the end of the presentation, I noticed that one of my favorite customers was in attendance and I ask if he would like to talk about his experience. He replied

"There this TV show on the Food Network, called "Semi-Homemade Cooking" where they take store-bought items and then add their own spices and fresh ingredients to make it special. The idea is that cooking from scratch takes a lot of time and effort that often isn't worth it. Historically, my company was a "make from scratch type of company," but now we are learning that "semi-homemade" using commercial FPGA modules can be just as satisfying and also a lot more profitable."

Bringing this concept of "Semi-Homemade Cooking" to the embedded computing kitchen, engineers are now learning how to use FPGA I/O modules to quickly develop special solutions that may not have been previously feasible.

Q. **Thank you for the interview and this great anecdote.**

BITTWARE: FPGA BOARDS FOR DSP AND OTHER APPLICATIONS

August 2007: Bittware: FPGA Boards for DSP and Other Applications

INTERVIEWEE. KRISTEN ZAFFINI, MARKETING MANAGER
TEL. (603) 226-0404
EMAIL. info@bittware . c o m , sales@bittware . c o m
COMPANY. **BITTWARE**
WEB. **h t t p : / / w w w . bittware . c o m /**

Q. **First of all, tell us a little bit about yourself and BittWare.**

A. BittWare has focused on providing multi-processing, floating point signal processing boards with the highest possible performance. In the past, this has meant using multiple Analog Devices SHARC and TigerSHARC processors on various form factors. That has changed somewhat recently. We started out adding FPGAs to our DSP boards, and now we have moved towards FPGA boards that have DSPs on them. In fact, we recently released an FPGA-only board, with more planned in the future. All of our products going forward will either be hybrid signal processing boards – combining FPGA and DSP technology, or FPGA-only products.

We are particularly excited about the integration of Altera Stratix II FPGAs on our latest VME/VXS, 3U cPCI, and AMC offerings. This has allowed us to implement switch fabrics such as Serial RapidIO and PCIExpress, in addition to leveraging these powerful FPGAs in our new hybrid signal processing architectures. We are also already working with Altera on Stratix III designs.

In the future, you'll see more ruggedized and application targeted boards and systems from us. We will continue to provide essential building blocks that enable our customers to create innovative signal processing systems. These will be primarily focused on switch fabrics, small form factors, and hybrid signal processing, along with the software and frameworks to make them more useable.

Q. **BittWare is obviously in the DSP boards market, and FPGAs seem to be playing a bigger and bigger role in this market. Why is that? What factors are encouraging your customers to consider FPGA-based boards rather than the more traditional DSP-based boards?**

A. We started adding FPGAs to our DSP clusters just to provide reconfigurable interfacing. But as FPGA technology has improved, we've found that they provide complementary signal processing resources to the DSPs. At the risk of oversimplifying, FPGAs are very good at solving well-defined, high-speed, repetitive problems, while DSPs are generally better at implementing highly complex algorithms and applications that require floating point, some sort of decision-making, adaptive processing, or algorithms that may change frequently. Real-world embedded signal processing applications often require both of these types of processing.

Therefore, we now believe the optimal solution for general purpose signal processing boards should have both FPGAs and DSPs - a "hybrid" signal processing architecture – providing more cost- and power-efficient solutions than either alone.

However, even with the latest advances in FPGAs, they will never truly be DSPs or PowerPCs. Nor were they intended to be. They were intended to be FPGAs, which are simultaneously inferior and superior to DSPs and PowerPCs. We believe FPGAs have become an essential building block to address high-performance signal processing problems, but we don't think they should be the only building block.

Q. **Aren't FPGAs a lot harder to work with than DSPs? If an engineer is already experienced with DSPs, what can BittWare do to make the engineer's job easier if this is his or her first FPGA application?**

A. FPGAs are a bit more difficult to work with than DSPs given that they cannot be programmed using "C," so engineers will need to become familiar with VHDL or Verilog to work with them. We've tried to alleviate that, and provide our customers with a couple of different options in regards to the FPGA. They can purchase standard BittWare FPGA loads, thereby removing almost all of the work associated with programming the FPGA. They can purchase IP from their vendor of choice and use BittWare's ATLANTiS framework to load the FPGA and coordinate the IP with other aspects of the design. Lastly, they can program the FPGA from scratch.

Q. **What application areas are especially suitable for FPGA-based boards? I know that software radio, for example, is one area that seems to be FPGA-friendly. What other areas, and why is this so?**

A. High-end signal processing is a unique technology and has many commonalities across applications. As a result, BittWare has primarily been what we call a "horizontal enabling" company; that is, we have been able to provide a broad range of markets with signal processing technology to enable their applications.

That being said, we are now finding more significant differentiation between markets, and are crafting targeted signal processing solutions for the Military/Defense, Telecom/Datacom, and Medical/Instrumentation markets. While these markets have unique challenges and tend to use different system formats and interfacing, they seem to share several key trends:

1. The need to use different technology to address different parts of the problem efficiently; by this I mean DSPs, FPGAs, and GPPs. I think most system designers now realize that a bigger hammer (i.e. more MIPs) isn't usually the best solution for a given problem.
2. Desire to have high-speed serial, or SerDes, switch fabrics for all system level communications. Different markets use different protocols, but they all want SerDes.
3. Size, weight, power, (SwaP) and life-cycle management are becoming more and more critical.

Q. **What is the *ATLANTiS* Framework?**

A. BittWare's ATLANTiS Framework is implemented in an on-board FPGA and handles all data transfer on and off the board, and between itself and the DSP(s) enabling the dynamic connection of every I/O to any other I/O, where connections can be created and broken without the need to recompile or change cables. The options for data interfacing can include: digital I/O (LVDS or single ended), general purpose I/O, flags, interrupts, link ports, high-speed serial links, rear panel connectors, off-board connectors, board to board links, cluster-to-cluster links, and multi-port memories.

The ability to easily connect and disconnect the external data sources to each other, to IP processing modules within the FPGA, and to the onboard DSPs creates an incredibly flexible system that can be instantly modified for an immediate need, while also retaining the ability to be updated for future modification and expansion. When multiple technologies are used on the same hardware, the usual focus is on algorithm implementation, when many times, the real difficulty is in ensuring that the processing units have access to all data coming onto the board. ATLANTiS solves this problem, decreasing TTM and cost, and increasing board processing efficiency.

Q. **It seems that BittWare has chosen to be an Altera-only board vendor. Is this good or bad, and why? What does it mean for your customers?**

A. We actually have experience with multiple programmable logic companies on past products, although the products that we are currently going to market with are Altera-based. Much the same as we worked closely for many years with Analog Devices as a third party supplier for their SHARC and TigerSHARC technology, we are now working very closely with Altera on their current and future generation FPGA technology. As opposed to simply designing Altera's products into our boards, we have actually forged a very close partnership with them. This means that Altera feels comfortable bringing customers looking for COTS-based solutions to us, and we know that throughout our design process, we can rely on Altera to provide support. This is good not only for us and Altera, but also our customers.

Q. **What is your business model? Do engineers pay just for the boards, and if so, how? Is it based on quantity? What about services or additional software? Do your customers pay for that, or is it included, or is their a hybrid model of monies for boards plus additional monies for services / tech support?**

A. BittWare's business model is to provide signal processing HW for the development and deployment of COTS products and application specific products for defense/aerospace, communications, high-end instrumentation, and life sciences industries. Our COTS technology combines Altera's FPGAs, Analog Devices TigerSHARC DSPs with high performance I/O on PCI, PMC, cPCI, VME and AMC form factors. Our application specific product group can provide system integration, custom FPGA design, tailored signal processing boards, specialized and/or custom I/O, application software integration and/or implementation, and technology and IP licensing.

We never charge for technical support – that comes with any product our customers purchase. If a customer is purchasing one board, they will be paying more than a customer purchasing a thousand boards. Our software products can be purchased a la carte or in bundles, so that customers can determine the product grouping that best works for their application.

Q. **There are other vendors of FPGA-based boards out there. What sorts of questions do you recommend engineers ask of other vendors? How do you recommend they try to figure out who would be a good "FPGA board" partner?**

A. It all depends upon the end application, but in general, hardware isn't much use to a customer if they don't have an easily accessible way to take advantage of the on-board resources. Hardware is no longer just hardware – there is always some sort of software support required for the hardware to be usable. Our ATLANTiS framework makes our customers' job that much easier by giving them access to all on-board resources, with the ability to connect and disconnect those resources to each other easily and efficiently. As hardware becomes more and more complicated, with different types of processing taking up the same real estate, the necessity for this type of framework will grow. I would suggest that engineers take notice of the companies that provide these frameworks as they are becoming necessities.

Q. **Many applications involve longevity issues, whether for the military, telecommunications, or medical. What assurance do customers get from BittWare on the end-of-life of its products? How do you deal with regulatory and other requirements that might require long product lifespans?**

A. BittWare is committed to the long term requirements of our customers. It is our policy to use reasonable commercial efforts to provide repair services to our customers for all BittWare hardware products at reasonable cost or supply a replacement product or mutually acceptable substitute at reasonable market cost. BittWare strives to supply a replacement product or mutually acceptable substitute for the same ten year period at reasonable market cost, and will use reasonable efforts to notify our customers if a component is scheduled for end of life. The customer will have the option to perform a lifetime buy on said parts at cost plus reasonable handling charges

BittWare prides itself on its ability to provide its products for extended periods to minimize the impact on our customer's programs. However, in some instances, BittWare may chose to obsolete a product due to component obsolescence, lack of sales performance, inability to support, inappropriate market fit, new version release etc. In all cases, we will make our best effort to give notice of a planned product obsolescence months in advance.

Once a product has been targeted for obsolescence, BittWare will:

- Notify in writing its customers who may be impacted by this decision
- Offer these customers the opportunity to participate in a last time buy program that outlines timeframe for ordering and delivery
- Continue to provide technical support for a specified timeframe beyond delivery of the last units

Q. **What about third party software such as real-time operating systems and application software? Does BittWare have relationships with these vendors? Is that a competitive advantage in using your products vs. those of your competitors?**

A. We have a complete suite of software tools for use with our products – BittWare's BittWorks. BittWorks includes our DSP21k Toolkit which includes all utilities for working with BittWare hardware, our remote VDSP Targe & DSP21k Toolkit via Ethernet (for remote hardware access), board support packages, FPGA developers kits, and a porting kit (for use with other OS'). We also have partnered with various third party vendors: Enea's OSEck (RTOS), and Matlab's Simulink/RTW (graphical development tool). We have worked with both vendors for many years and are familiar with their support channels should any of our customers run into problems.

Q. **Thank you so much for this interview.**

GiDEL: FPGAs for ASIC Prototyping and Board Deployment

2 August 2007: GiDEL: FPGAs for ASIC Prototyping and Board Deployment

Interviewee. Ralph Zak, Director, North American Sales
Tel. 408.969.0389
Email. Z_ralph@gidel . c o m
Company. **GiDEL, Inc.**
Web. **h t t p : / / w w w . gidel . c o m /**

Q. **First, to get started, can you tell me where the name "GiDEL" came from? What unique design challenges does GiDEL seek to address?**

A. GiDEL is a 14 year old Israeli company. The name has no technical significance, but rather personal meaning to the founder, and current President and CTO, Reuven Weintraub.

GiDEL has focused its efforts on addressing two critical challenges of our customers. Our OEM customers simply need more processing power for complex software algorithms than they can get from either conventional PC type CPUs, or DSPs. We provide them the speed and performance they need with our FPGA-based board level products, which they use as embedded, reconfigurable processors for accelerating their algorithms.

SoC/ASIC designs are becoming more complex with each new wave of semiconductor technology. This increase in complexity results in a more than linear increase in the verification testing requirements for these products. To be competitive, these customers use our products to address the need for faster SoC functional verification, for achieving increased verification cycles before product release , and for system integration before first silicon to shorten schedules. We supply these customers our FPGA-based boards as well as a recently introduced family of multiple board systems.

Q. **And a little about yourself - your technical background, how long have you been with GiDEL, what your position is at the company?**

A. I am a bit unusual in Silicon Valley. My technical background is in nuclear engineering. But, I have been working with design tools since the early 1980s. I started in design automation with Calma, one of the first "CAD" companies, and have done stints at several other EDA companies before GiDEL—HHB, Mentor Graphics, Quickturn, Aptix; as well as a semi IP company and an enterprise software business focused on chip manufacturing management. I also led a division of Hitachi Software for a few years.

I have been with GiDEL for just under a year now, and am responsible for North American sales and marketing.

Q. **From your website, it seems that your main product thrust is for ASIC prototyping - is that correct? Tell me, briefly, about *PROC Developers Kit*™ and *PROC_SOC Systems*.**

A. We actually have two balanced business thrusts—ASIC prototyping and an OEM business for FPGA boards used for algorithm acceleration. Our traditional FPGA board level

products, the family of PROC boards, have been used for years in both of these applications.

For the SoC Verification market, this year we launched the family of *PROC_SoC* Systems you mentioned. These provide much better platforms for SoC verification than single board systems for many SoC designs. There are two, multiple board card cage based systems. The *PROC30M* can have ten dual-FPGA modules within it. Each module has a 3 million gate capacity, plus 256MB of on board memory. Going back to my early days as VP of Marketing at emulation system pioneer Quickturn, we were lucky to get 50,000 gates in 100 FPGAs in our first systems. So I am always amazed that a 20 FPGA system can handle 30 million gates, at a lower cost, with far less system complexity.

The uniqueness of the *PROC30M*, and the three board *PROC9M* system, is that all the interboard connections are done by the user, using small bus connectors or high speed cables between six 118 pin connections for each FPGA. This allows high pin count connections between all FPGAs directly, with no intermediate routing chips or programmable backplanes. The designer easily matches the system interconnect to his design's topology, and not the other way around, as in all pre-routed systems. As a consequence, the system will operate at very high speeds relative to traditional "mainframe" emulation systems and satisfies the ever increasing need to run very large numbers of verification cycles before production.

Regarding the *PROC* Developer Kit, it includes our *PROCWizard* software which manages all the top level netlist issues connecting the FPGAs, with large on-board memories, and application specific daughter cards. We also automatically generate wrappers to interface the hardware to host based test benches to allow high speed throughput of data. We include several memory IPs to configure on board memory as multiport memories, FIFOs or as added delay lines. Finally, the Dev Kit includes the Quartus II software from Altera for all the design mapping, synthesis, place and route for the FPGA, and it includes the Signal TapII debug tools for setting trigger conditions and probes, and capturing data for analysis.

Q. **So tell me more about deployment in FPGA-based systems. How does your company address that need as well? Explain a bit more about what *PROC Boards*™ and *PROC Daughter Boards* do as products.**

A. The family of *PROC* boards and the daughter cards are used in development and then deployment. They have 1 to 4 FPGAs, include on board memory, have provisions to hold several GB of memory, and support either PCI or PCI Express busses. As I said earlier, the customer's motivation is typically to run specific algorithms faster than can be done in software on microprocessors or DSPs. In other words, when software implementation runs out of gas, they come to us for speed.

PROC systems are used by engineers to initially verify algorithms they are developing for various applications like optical inspection, medical imaging, radar, and signal processing. Customers convert their software algorithms into hardware description languages that can be implemented in the FPGA hardware. This is done through a few different processes. Our PROCWizard software has debug features that allow visibility into the FPGAs for debugging the implementation of the algorithms. Our development tools also create the system drivers and system wrappers to allow our systems to then be deployed as embedded, algorithm specific accelerators in a real-time system and communicate with the system host processor and memory.

The *PROC* daughter boards support application specific I/O functions, like Camera Link, DVI, Gigabit Ethernet, etc.. There are also special DSP modules for mixed level

processing in software on the DSPs and in the FPGAs. Many customers have unique requirements and can easily build their own daughter boards.

Q. **Tell me about how your products facilitate "easy" algorithm development.**

A. We have a software option, *PROC_HILs*, that supports graphical, model-based design methodologies available in tools from MathWorks and Altera. Our software will take such designs from their source level representation and automatically go through the process of generating the programming files for the FPGAs to represent the design. The software also allows our systems to act as hardware models within MathWorks Simulink simulations to accelerate simulation. It does this by automatically generating RTL code system wrappers to make the use of the hardware transparent during simulation.

For existing C code conversion, we have worked with a couple of vendors of C to RTL software so that much of the translation for FPGA implementation can be done automatically.

Finally, *PROCWizard* provides debug tools to provide visibility into the FPGA implementation so that developer's can quickly identify where there may be errors in the algorithm or the FPGA implementation. We also provide a suite of functions to quickly configure on board memories that are typically required in the system implementation. This Fall we will expand our tools to enable customers to quickly develop their own application specific simulators to help with the development and debug effort.

Q. **Are your products FPGA-independent, or do they only work with certain FPGA vendors such as Altera?**

A. All of our current products are Altera based. We have a great relationship with Altera and we find we can build better products serving more customer needs with the focused effort than we could if we supported multiple suppliers. We have a great focus on customer support. So even customers not familiar with Altera, or FPGAs at all, like working with us.

Q. **What factors and application areas typically encourage an engineer to investigate, and ultimately, use your products?**

A. This gets back to your opening question.

For algorithm acceleration OEMs, the driver is the need for speed. In optical inspection, faster image processing speed may result in higher throughput in a manufacturing line and better resolution resulting in higher levels of product quality. In certain military applications, speed can be the difference in winning or losing. In medical imaging, speed can be the difference between real time viewing, and waiting hours or days for image generation, or simply advance the state of the art in image quality and resolution.

For SoC design teams, the driver is typically the need to run many more verification cycles in a given period of time. This can be driven by both the chip's own functional verification needs and that of the combined system with software before committing to silicon. With mask costs alone in the $1+ million range and silicon spins taking several months, getting an SoC right, with all its software is crucial.

With regard to why SoC design teams purchase GiDEL's specific products, we deliver a unique architecture that we believe provides faster verification speeds than anyone else. We also believe we have a product cost profile that allows our customers to build more testbeds than traditional mainframe ASIC emulation systems, and therefore they run more verification cycles every day of their project schedule.

Q. **The conventional wisdom is that ASIC design starts are declining and more and more designs are started on, and remain on, FPGAs. What is your opinion of this trend?**

A. I do not think there is any doubt about that. I believe the number of ASIC design starts is less than 4000 a year from a peak of about 12,000 ten or so years ago. The project cost and complexity of developing an ASIC really only is justifiable for extremely large volume products. If we look at how the cost of silicon is declining on a gate basis, and FPGAs are taking advantage of new process technologies as fast as they are available, and you look at the shortening of product lives and the need to capitalize the development costs of new products in that shorter life span, one sees that the gap in the total product life cycle cost is clearly moving to the advantage of FPGAs.

Q. **What about the relationship between your product and other third party tools? I understand, for example, that you work well with Celoxica's tools. Are there others?**

A. We have worked with Celoxica to develop a good flow for taking C algorithms and using the Celoxica tools to generate RTL code. Our provided software then synthesizes the RTL and maps it into the FPGAs. We have also worked closely with Impulse Accelerated Technologies to have a similar flow with their Impulse C product. We will be making an announcement in this area later this year.

As we stated earlier, in the algorithm acceleration market, we have worked to build a very productive model-based design flow with both MathWorks HDL Coder and Altera's DSP Builder. Our *PROC_HILs* tool enables algorithm developers to build their algorithms and implement them in FPGAs for verification without knowledge of the FPGA or RTL coding. For the final implementation of the PROC boards in the system as an embedded processor, we see it is good for the team to have both hardware and software engineers involved.

In the SoC verification arena, tool flows are also critical. We support both Verilog and VHDL based designs. We include the Quartus II software from Altera within our PROC Development Kit. Quartus II includes synthesis, place and route, and the Signal Tap debug environment. However, we also support several third party tools such as Mentor Graphics' FPGA synthesis tool. We are also currently working with another company to provide automated partitioning support for our unique hierarchical systems that will greatly assist our PROC_SoC system users. Again, more on that in the coming months.

Q. **How much does your product cost? Tell me about how it is purchased, and what different options there might be.**

A. Prices for products cover a wide range as the systems can have different number of FPGAs of different sizes and speed grades. A PCI bus based PROCSpark II board with a CycloneII FPGA sells for as little as $545. A four FPGA PROCStarII board with the largest, fastest Stratix II FPGAs can be tens of thousands of dollars. Application specific daughter cards, like CameraLink and DVI are typically a few hundred dollars.

Our multi-board SoC verification systems range from the low $20,000's for a 3 million gate system to over $200,000 for a thirty million gate, ten board PROC30M.

For purchasing products, we sell direct in the US, Europe and Israel, and through partners elsewhere in the world. The best way to contact us is through the website, h t t p : / / w w w . gidel . c o m /.

Q. **Thank you for this interesting interview.**

National Instruments: FPGAs via CompactRIO and *LabVIEW FPGA*

2 August 2007: National Instruments: FPGAs via CompactRIO and *LabVIEW FPGA*

Interviewee. Todd Dobberstein, industrial and embedded product manager
Tel. 512-683-5836
Email. Todd.dobberstein@ni . c o m
Company. National Instruments
Web. **h t t p : / / w w w . ni . c o m /**

Q. **First of all, tell us a little bit about yourself and National Instruments. NI is not generally perceived as an "FPGA" company, so how do you fit in the FPGA space?**

A. I am an industrial and embedded product manager for National Instruments. My product expertise is with real-time and FPGA-based control and acquisition hardware and my market experience includes industrial control and monitoring, embedded system design and automotive and in-vehicle applications. I began my work at NI in March 2002 and hold a B.S. in electrical engineering from Kansas State University.

For over 30 years, National Instruments has revolutionized the way engineers and scientists in industry, government, and academia approach measurement and automation. Leveraging PCs and commercial technologies, NI products increase productivity and lowers costs for test, control, and design applications through easy-to-integrate software, such as NI LabVIEW, and modular measurement and control hardware for PXI, PCI, PCI Express, USB, and Ethernet.

FPGAs are an emerging commercial technology that provide engineers, scientists and embedded system designers with the performance and customization of custom hardware without the drawbacks of building custom electronics. FPGAs reduce the development time and cost associated with custom hardware because they are software programmable and upgradeable. Additionally, FPGAs are completely parallel in nature so they can perform a many tasks like processing, communication and control simultaneously at very high speeds. Traditionally, programming FPGAs and interfacing FPGAs to the rest of the world has been non-trivial. Low-level programming languages like VHDL and Verilog were needed and only hardware design engineers knew how to use those tools. The National Instruments *LabVIEW FPGA* Module, that was released five years ago, allows any engineer or scientist program FPGA hardware with LabVIEW graphical programming tools without the need for hardware design or VHDL experience.

Q. **How do FPGAs figure into NI's push towards "Graphical Systems Design?" Is there any interconnect here?**

A. FPGAs and *LabVIEW FPGA* definitely figure into Graphical System Design. The vision of graphical system design is "To do for embedded what the PC did for the desktop." The PC gave us standard hardware interfaces (ie. ISA, PCI, USB, etc..) and software (predominantly Windows) to make the desktop usable by everyone, even my computer-illiterate mother. Graphical system design fundamentally does the same thing for the embedded world; it gives all engineers and scientists the ability to design customized embedded systems with a standard architecture (that includes a processor, an FPGA and I/O) and one standard high-level programming language—*NI LabVIEW*. FPGAs have become a staple within embedded systems over the last decade. With graphical system design tools from National Instruments, **any** engineer or scientist can build an embedded

control or acquisition system leveraging FPGA technology without having hardware design experience that was traditionally needed to use FPGAs. *LabVIEW FPGA* has built-in functions for programming the FPGA to perform tasks like precise timing and control and custom signal processing. Additionally, there is IP within *LabVIEW FPGA* to easily communicate to floating-point processors and analog and digital I/O.

Q. **_CompactRIO_ is one of NI's primary FPGA offerings. Can you give me a quick tour of _CompactRIO_?**

A. The National Instruments *CompactRIO* programmable automation controller (PAC) is an embedded reconfigurable control and acquisition system designed for applications that require high performance, ruggedness and reliability. The system has an open embedded architecture that combines an industrial real-time processor, an FPGA and hot-swappable analog and digital I/O modules within a compact and rugged form-factor. NI *CompactRIO* is powered by *LabVIEW FPGA* and LabVIEW Real-Time technologies allowing engineers and scientists to quickly design, prototype and deploy a custom embedded control and acquisition system.

- www.ni.com/CompactRIO

Q. **Tell me about _LabVIEW FPGA_. If I am new to both FPGA design and Labview what offerings are there to ease the learning curve?**

A. The National Instruments *LabVIEW FPGA* Module extends LabVIEW graphical development to target FPGAs on NI reconfigurable I/O (RIO) hardware. NI LabVIEW is uniquely suited for FPGA programming because of its ability to clearly represent parallelism and dataflow. With the *LabVIEW FPGA* Module, you can create custom measurement and control hardware without low-level hardware description languages or board-level design. You can use this custom hardware for unique timing and triggering routines, ultrahigh-speed control, interfacing to digital protocols, digital signal processing (DSP), and many other applications requiring high-speed hardware reliability and tight determinism. The *LabVIEW FPGA* Module has a variety of built-in IP for engineers to leverage to speed development. Also, National Instruments recently announced the *LabVIEW FPGA IPNet* that allows the *LabVIEW FPGA* community to share IP online. There are 100s of pre-built *LabVIEW FPGA* IP functions available within the *LabVIEW FPGA* Module and at the *LabVIEW FPGA* IPNet for tasks such as:

- Math and Signal Processing
- Data Acquisition
- Signal Generation
- Control
- Communication Buses and Digital Protocols
- Sensor Simulation

- www.ni.com/fpga
- www.ni.com/ipnet

Q. **Can you use _LabVIEW FPGA_ to develop FPGA-based products that are NOT on _CompactRIO_? How would that work?**

A. *LabVIEW FPGA* can be used to program a variety of FPGA-based products from NI. NI has embedded systems like CompactRIO, PCI/PXI plug-in devices, and embedded vision systems , the NI Compact Vision System, that have embedded FPGAs that are programmable with *LabVIEW FPGA*. You can not use the *LabVIEW FPGA* Module to program FPGAs that are not within the National Instruments product portfolio. Although, you can use *LabVIEW FPGA* and NI FPGA-based hardware to quickly test and prototype FPGA VHDL IP (explained in the question below).

Q. **Which FPGAs does NI support? Are you vendor specific or vendor neutral? If I develop a product using *Labview* and/or *CompactRIO* does that "lock me in" to NI hardware or software?**

A. The programmable FPGAs within National Instruments products are Xilinx FPGAs. Customers are definitely not "locked into" a product when using LabVIEW and/or CompactRIO. There are options for migrating code to other FPGAs, to lower the high-volume deployment costs for CompactRIO and to use LabVIEW to program 3rd-party processors. In the *LabVIEW FPGA* Module, there is an HDL Interface Node function that allows engineers to quickly prototype and test their VHDL code with real-world I/O using National Instruments FPGA-based hardware. You can integrate VHDL code into *LabVIEW FPGA* and use the I/O within CompactRIO or other NI FPGA-based hardware to test and prototype IP with real I/O, sensors and actuators. Then, you could either stay on NI hardware such as CompactRIO or PCI/PXI plug-in FPGA cards for deployment or take the tested VHDL code from the prototype to another FPGA.

- Importing HDL Code into FPGA VIs Using the HDL Interface Node

Q. ***CompactRIO* seems to be too expensive per device deployed for many applications. What options are there to use it as a prototyping tool and then deploy to FPGAs or microprocessors directly?**

A. If CompactRIO is not cost-optimized for a particular high-volume application, there are lower cost options for OEM applications. NI recently announced a partnership with Flextronics to offer a custom board-only solution for CompactRIO. For extremely high volume applications, customers can design and prototype on a CompactRIO system with LabVIEW and then have Flextronics create a custom single-board solution that integrates the industrial real-time processor, the FPGA and circuitry from NI C Series modules. This allows for a quick deployment solution for high volumes using CompactRIO and LabVIEW and enables customers to reuse the exact software code between the prototyping and deployment stage to shorten time-to-market and increase reliability.

LabVIEW can also be used to program any 32-bit processor. Engineers can use the National Instruments LabVIEW Microprocessor SDK Module along with a third-party toolchain and an embedded OS to target any 32-bit platform of your choice. With the NI LabVIEW Microprocessor SDK, you can easily incorporate legacy C code as well as analog, digital, and communications I/O drivers through specialized VIs. This module features several example targets for popular processor architectures including PowerPC, ARM, TI C6x, and x86, and Coldfire.

- http://www.ni.com/labview/microprocessor_sdk.htm

Q. **How much does *CompactRIO* cost? If I am not already an NI customer, how is it packaged with *LabVIEW*?**

A. CompactRIO hardware starts at around $2200 USD. For programming CompactRIO, new customers can purchase the LabVIEW Full or Professional Development System, the

LabVIEW Real-Time Module and the *LabVIEW FPGA* Module. The one-time software development costs for all of this LabVIEW software for programming CompactRIO starts at just over $8000 USD. Included within this software costs is a lot of valuable FPGA IP as well as simulation tools for quickly testing your real-time and FPGA software code.

- Multi-channel PID and multi-channel filter IP for FPGA
- Digital Filter Design Toolkit for FPGA and real-time
- Signal generation IP for FPGA
- Execution Trace Toolkit for real-time debugging
- Networking and communication IP
- IP for interfacing to analog and digital I/O

One important thing to note is there are no additional software licensing costs when using LabVIEW embedded software tools and NI hardware. Therefore, a user could make the one-time software LabVIEW purchase and program an unlimited amount Real-Time and FPGA-based hardware from National Instruments at no additional cost.

Q. **What vertical applications has *CompactRIO* commonly been deployed in? Is it more suited to certain types of application areas, and if so, what are those, and why?**

A. With the flexibility, ruggedness and performance of CompactRIO, you can adapt it to solve a wide variety of industry and application challenges. Examples include:

- In-vehicle data acquisition, data logging, and control
- Machine condition monitoring and protection
- Embedded system prototyping
- Remote and distributed monitoring
- Embedded data logging
- Custom multi-axis motion control
- Electrical power monitoring and power electronics control
- Servo-hydraulic and heavy machinery control
- Batch and discrete control
- Mobile/portable noise, vibration, and harshness (NVH) analysis

Some customer solutions include:

- High-Speed Control of Hydraulic Die-Casting Machine Using NI CompactRIO and *LabVIEW FPGA*
- Daewoo Electronics Uses *LabVIEW FPGA* and CompactRIO to Develop World's First High Accuracy Servo Motion Control System for Holographic Digital Data Storage
- Portable Real-Time Vibration Monitoring System
- Drivven Prototypes FPGA-Based Engine Control System Using NI CompactRIO

Q. **What about third party IP? Can I purchase or integrate my own IP onto the boards, as well as create new IP via your software? How does that work?**

A. The *LabVIEW FPGA* Module offers options for integrating 3rd-party IP and creating your own IP. If you have existing VHDL IP or you have purchased any VHDL IP, you can use and leverage that IP within *LabVIEW FPGA*. There is a built-in function, the HDL Interface Node, within *LabVIEW FPGA* that allows you to integrate pre-existing VHDL IP within *LabVIEW FPGA*. You can also create your own *LabVIEW FPGA* IP. National Instruments has recently announced the LabVIEW tools network and the *LabVIEW FPGA* IPNet that allows *LabVIEW FPGA* users to sell and share their developed FPGA IP.

- www.ni.com/labviewtools
- www.ni.com/ipnet

Q. **Thank you for this interesting interview about NI's FPGA product line.**

Pentek: FPGA Boards for DSP and other Applications

1 August 2007: Pentek: FPGA Boards for DSP and Other Applications

Interviewee. Rodger Hosking, V.P.
Tel. 201-818-5900
Email. rodger@pentek . c o m
Company. **Pentek, Inc.**
Web. **h t t p : / / w w w . pentek . c o m /**

Q. **First of all, tell us a little bit about yourself and your company.**

A. Pentek provides open-architecture digital signal processing, software radio, and data acquisition products for high-performance embedded computing applications including radar, communications, real-time control, sonar, signals intelligence, wideband recording, and physics. Our customers are systems integrators and end users who combine our hardware and software with other components to produce systems tailored specifically to each application.

Our software support tools range from intuitive graphical user interfaces for our recording platforms, to high-level APIs, libraries and drivers for custom software development, source code that offers access to the lowest levels of the hardware.

Coming from test equipment product design and management positions at Wavetek, I was one of core team of four that founded Pentek in 1986.

Q. **Pentek is obviously in the DSP boards market, and FPGAs seem to be playing a bigger and bigger role in this market. Why is that? What factors are encouraging your customers to consider FPGA-based boards rather than the more traditional DSP-based boards?**

A. New FPGAs have exciting new features directly targeting all of the functions associated with digital signal processing. These include DSP blocks with hardware multipliers and ALUs, configurable RAM, flexible interfaces to peripheral devices, high-speed parallel and gigabit serial interfaces, and lots of configurable logic.

This allows a single FPGA device to perform the same functions previously requiring a whole DSP board. A DSP processor has a fixed, general purpose architecture for handling a wide range of algorithms. FPGAs have configurable hardware resources that can be highly optimized for a specific processing-intensive task, often outperforming a programmable DSP by a factor of ten.

Q. **Aren't FPGAs a lot harder to work with than DSPs? If an engineer is already experienced with DSPs, what can Pentek do to make his job easier if this is his first application that will involve an FPGA-based or FPGA/DSP board?**

A. Yes, programmable DSP processors are much easier to program, usually with C tools and debuggers that are extremely mature, stable and powerful. The best FPGA designers for DSP applications not only need to be reasonably capable programmers, they also need to have some real-world hardware design experience. After all, FPGA design is really hardware design with timing, propagation, loading, synchronization and pipelining issues to deal with.

We spend a lot of effort developing a *GateFlow FPGA Design Kit* for each product to make it easier for our customers to add their own IP. The kit installs as a project in the Xilinx *ISE Foundation Tool Suite* and includes all of the FPGA design files we use in creating the standard factory product along with full VHDL source code. FPGA modules are organized as functional blocks with well-defined interfaces, so that any block can be modified or extended and new blocks can be installed. New blocks can be created using high-level third party tools including *System Designer*, *Matlab*, and *Simulink*.

Q. **What application areas are especially suitable for FPGA-based boards? I know that software radio, for example, is one area that seems to be FPGA-friendly. What other areas, and why is this so?**

A. Software radio hardware usually involves an A/D or D/A converter at the front end, often with continuous real-time input and output data rates of hundreds of MHz. Because FPGAs are relatively small, they can be placed on the same board to deal directly with these high data rates to handle digital up and down conversion, FFTs, data formatting and buffering, beamforming, filtering and high-speed parallel and serial interfaces.

Radar processing is even better served by FPGAs because of the very intense algorithms required for FFTs, pulse compression, 2-D and 3-D beamforming, and transient capture of radar pulses. In general, any application driven by high speed, real-time transducers and interfaces with any kind of signal processing algorithm can benefit from FPGAs.

Q. **The companies of eg3 . c o m 's audience make their mark by providing cool or innovative new applications. What special value-adds are provided by using FPGA-based boards, what unique features do these bring to the party that will help me make my application especially innovative? Or does this just depend on each application area, and it is too hard to generalize?**

A. The more your application depends upon how fast you can perform digital signal processing algorithms the more FPGAs can help. This can show up as an advantage in your system in being able to handle more channels, higher data rates, wider bandwidths, more complex modulation, and/or more sophisticated encryption techniques.

Another major advantage is the ability to perform field upgrades to your customers' systems simply by installing a new FPGA configuration file without having to remove or replace hardware. This reduces maintenance costs and greatly extends the life cycle of your system.

Q. **Do you work with Xilinx FPGAs, Altera FPGAs, both, or others? Why or why not? If an engineer commits to using one of your boards, is he committing to being a "Xilinx" shop or an "Altera" shop? Is this good or bad, and why?**

A. Pentek uses FPGAs from many different vendors in our products, depending on the function. Each vendor has strengths and weaknesses and Xilinx and Altera both offer an excellent range of competitive products.

However, Xilinx devices are the only ones that we offer as user-configurable FPGAs. This is because we have developed a proven methodology of developing, documenting, and supporting our *GateFlow Design Kits for* Xilinx and we know how to do that quite well. Since each of our customers wants to do something completely unique, a good design kit is essential for successful FPGA development.

Q. **Tell us some more about *GateFlow*. What sorts of software tools or other resources does Pentek provide to make the FPGA board experience "easy?"**

A. We have already described the *GateFlow FPGA Design Kit* for the Xilinx *ISE Foundation Tool Suite* and companion resources. Our *GateFlow* resources also include the *GateFlow* factory Installed IP Cores. We have developed several high-performance signal processing cores for software radio, communications and radar. They include narrow band and wide band digital down converters, interpolation filters, FFTs, and radar pulse compressors. By simply adding an option to the part number of a board level product, we will install these cores at the factory, which are carefully integrated to operate along with the standard functions of the product. The customer receives a fully-tested and characterized module with full software support, ready to use out of the box with zero FPGA development effort.

Q. **What is your business model? Does the engineer pay just for the boards, and if so, how? Is it based on quantity? What about services or additional software? Do he or she pay for that, or is it included, or is their a hybrid model of monies for boards plus additional monies for services / tech support?**

A. We offer all of our FPGA-based boards with standard features and functions including data formatting, synchronization, triggering, buffering, mode control, and full parameter entry. For customers wanting to extend these functions themselves, we offer the *GateFlow FPGA Design Kit* at an additional cost. Alternatively, for customers who want us to install *GateFlow* IP Cores at the factory, we also offer this service at an additional cost.

So, customers pay only for the resources they need, and technical support is included at no additional cost.

Q. **What sorts of "learning" resources do you provide for people new to FPGAs and/or new to your FPGA boards? How can an engineer both pre-educate himself on your offerings, and how - if he becomes a customer - can he easily educate himself after the fact, in terms of training?**

A. Our most successful strategy is recommending our customers take the training course from Xilinx for the Foundation ISE Tools. Once they are comfortable with these tools, we are usually able to support their design efforts with email or phone assistance. In several cases we have offered factory training tailored to the specific requirements of each customer.

Q. **There are other vendors of FPGA-based boards out there. What sorts of questions do you recommend an engineer ask of other vendors? How do you recommend she try to figure out who would be a good "FPGA board" partner?**

A. One key differentiator among vendors is whether or not the FPGA is structured to be user-configurable. Well-specified functional modules with clearly-defined interfaces is essential for customer success. Another critical factor is the quality and content of the FPGA design kit - so be sure to take a thorough look before selecting the vendor. Lastly, be sure to ask about the nature and quality of customer support, and the costs and procedure for getting it. Virtually, all customers will need some support during the FPGA design cycle, so exploration of the process up front is essential.

Q. **Many applications involve longevity issues, whether for the military, telecommunications, or medical. What assurance does your customer get regarding the end-of-life of its products? How do you deal with regulatory and other requirements that might require long product life spans?**

A. Normally our products are in full production for at least five years, and often as many as long as fifteen years. For customers needing a guaranteed availability, we work out a life-cycle management plan based on each customer's requirements. The most common plan involves Pentek procurement of end-of-life components for the customer and placing them in bonded inventory to support the defined future requirements. In this way, the customer does not have to pay for the whole board until he really needs it.

Q. **What about third party software such as real-time operating systems and application software? Does Pentek have relationships with these vendors? Is that a competitive advantage in using your products vs. those of your competitors?**

A. We have numerous third party partner relationships for both operating system software, DSP development tools and FPGA resources. Our hardware products are usually supported by software and drivers for several different operating system environments including *Windows*, *VxWorks* and *Linux*. Having the right software support is often a major competitive advantage.

Q. **Thank you, Rodger, for this helpful interview.**

APPENDIX A: TOP INTERNET FPGA RESOURCES

Appendix A: Top Internet FPGA Resources

The Internet is a confusing, if useful, source of FPGA information. Fortunately, eg3.com organizes the "best sites" on the Web for FPGA. This list is updated weekly on eg3.com, but we reproduce an abbreviated version here (sites rated 4 or higher). For the complete, up-to-date list go to http://www.eg3.com/fpga.htm.

archive

Spectrum Signal DSP/FPGA Published Articles
Software-Defined Radio and JTRS * SCA Framework Puts a CORBA Face on FPGAs * Trends in DSP: Has FPGA Technology Peaked in Wireless Applications? * Catching the Waveform: New NASA Satellite-to-Satellite Communications Take Shape * Software Radio Gets Boost in Canada

Web. http://www.spectrumsignal.com/publications/
Score. 4

conference

International Conference on Field Programmable Logica and Applications (FPL)
The International Conference on Field Programmable Logica and Applications (FPL) is the first and largest conference covering the rapidly growing area of field-programmable logic. During the past 16 years, many of the advances achieved in reconfigurable architectures, applications, design methods and tools have been first published in the proceedings of the FPL conference series. Its objective is to bring together researchers and industry...

Web. http://ce.et.tudelft.nl/FPL/
Score. 4

demo

Aldec Downloads - Demos, White Papers, Tutorials
SystemC-Primer 1.1. HDL / VHDL Tutorials. Evita-VHDL interactive primer. ATP-Verilog 4.6 - Advanced Testing Package Tool. ATP-VHDL 4.6. Advanced Testing Package Tool, designed to test an engineer's competency with the VHDL langauge. Riviera 2007.06 - Powerful, high performance ASIC and High Density FPGA verification environment. Active-HDL 7.2sp2 - Completely integrated FPGA design entry and verification environment for VHDL, Verilog,...

Web. http://www.aldec.com/downloads/
Score. 4

demo

Altium Demo Center - Altium Designer EDA Demo
Altium Designer provides electronic designers and engineers with a single,unified application that incorporates all the technologies and capabilities necessary for complete electronic product development. Altium Designer integrates board- and FPGA-level system design, embedded software development, and PCB layout, editing and manufacturing within a single design environment. Altium's DEMOcenter now gives you the opportunity to walk...

Web. http://www.altium.com/Evaluate/DEMOcenter/
Score. 4

demo

ispLEVER Starter Software
ispLEVER Starter is intended for evaluation & student use. ispLEVER Starter uses the same interface and design flow as the other ispLEVER configurations, and can be used to take an FPGA, CPLD, ispGDX, or SPLD design from concept to device programming.The ispLEVER Starter software is a modular system. The optional downloadable modules include LatticeEC and ispXPGA design tools, synthesis tools from Mentor Graphics and Synplicity, and on-line help.

Web. http://www.latticesemi.com/products/devtools/software/ispLEVER-starter/index.cfm
Score. 4

eletter

Chip Design eLetters
eLetters are targeted to specific EDA and chip development topics. Each monthly e-newsletter includes exclusive viewpoint pieces, detailed technical pieces, timely product and application news (national and international), book reviews, design resources end event listings. Chip Designer / EDA Nation * FPGA Developer * Wireless Chip Designer

Web. http://www.chipdesignmag.com/enewsletters/
Score. 4

eval

Altera Development Kits: PLD's, FPGA's, PCI, DSP, Ethernet and More
Altera and its partners offer a wide range of development kits (shown in Table 1) to support system-on-a-programmable-chip (SOPC) design development. Altera emphasizes complete, high-value kits to simplify design and reduce time-to-market. This page is your gateway to various evaluation kits - ranging in price from several thousand, to a few hundred dollars. A great way to get started with Programmable Logic.

Web. http://www.altera.com/products/devkits/kit-dev_platforms.jsp
Score. 4

hot list

FPGA and other programmable logic ICs
FPGA is an integrated circuit that contains many (64 to over 10,000) identical logic cells that can be viewed as standard components. Each logic cell can independently take on any one of a limited set of personalities. The individual cells are interconnected by a matrix of wires and programmable switches.

Web. http://links.epanorama.net/links/fpga.html
Score. 4

organization

FPGA High Performance Computing Alliance (FHPCA)
The FPGA High Performance Computing Alliance (FHPCA) is developing high-performance computing solutions using Field Programmable Gate Arrays(FPGAs) to deliver new levels of performance into the technical computing market. Hardware and software developed by the FHPCA have been used to build a large-scale demonstrator supercomputer called Maxwell. This is complemented by a campaign to raise industrial awareness and interest and to stimulate...

Web. http://www.fhpca.org/
Score. 4

overview

FGPA FAQ (newsgroup Archives)
This site is a public repository for Frequently Asked Questions (FAQs) for designers of systems using FPGAs. The contributors to this site are typically also participants in the comp.arch.fpga news group. Last updated 7/1/03 - however newsgroup archives are up-to-date, and thus useful.

Web. http://www.fpga-faq.com/
Score. 4

overview

FPGA's vs. ASIC's - What are the Trade Off's (Registration Required)
Designs that were done in ASICs in the past are done by FPGAs today, faster and for less cost. Complex FPGA design is driving new design approaches. ASIC designs are specialized, offer power and flexibility, and accommodate large designs where FPGA falls short. With so much at stake, where should your company's focus lie? Or is it more of a middle area - a place where structured ASIC can fill the gap?

Web. http://www.iec.org/online/iforums/mentor_graphics/choose.asp
Score. 4

overview

What Are CPLDs and FPGAs?
As the title says, this is a quick introduction as to what complex programmable logic devices and field-programmable gate arrays are.

Web. http://www.xess.com/fpgatut.htm
Score. 4

paper

Actel: The New 'Power-Smart' Power Paradigm
The next few years will bring great changes in the way our society views the high-tech community. We're in the early stages of a transition that will result in recognition of the electronics industry as a major contributor to the resolution of the world's global warming problems. To date, companies are talking about power reduction initiatives, but more can be done. From the design of 'power-smart' chips and systems to the development of...

Web. http://www.actel.com/documents/PowerSmart_WP.pdf
Score. 4

paper

ASIC Prototyping with FPGAs
Recently, there is a growing use of FPGAs to prototype ASICs as part of an ASIC verification methodology. With development costs for ASICs approaching $20M, avoiding a respin by prototyping with FPGAs is attractive alternative. This paper explorers the key issues designers should consider when developing and ASIC prototyping methodology.

Web. http://www.mentor.com/products/fpga_pld/techpubs/mentorpaper_33693.cfm
Score. 4

paper

Building A Better DSP Mousetrap: FPGAs, DSP Processors, or a combination of both?
Field Programmable Gate Array (FPGA) technology now offers millions of gates per device and clock rates in the hundreds of MHz range. It has advanced to the point where it provides a substantial resource for demanding, high bandwidth, real-time Digital Signal Processor (DSP) applications.

Web. http://www.traquair.com/articles/mousetrap.pdf
Score. 4

paper

FPGA Resource Management

Producing optimal implementations for designs targeted to today's advanced FPGAs is increasingly dominated by the ability of the user to take advantage of dedicated resources such as block RAMs, multipliers and DSP blocks. What is needed is a way to give expert control to every user, providing early visibility into mapping choices and the ability to easily investigate alternate implementations. While synthesis tools do a good job of properly...

Web. http://www.mentor.com/products/fpga_pld/techpubs/mentorpaper_32284.cfm
Score. 4

paper

FPGA vs. DSP Design Reliability and Maintenance

Digital signal processing (DSP) underpins modern wireless and wireline communications, medical diagnostic equipment, military systems, audio and video equipment, and countless other products, becoming increasingly common in consumers' lives. Due to advances in semiconductor technology, ever more complex DSP algorithms, protocols, and applications are now feasible, which, in turn, increase the complexity of the systems and products....

Web. http://www.altera.com/literature/wp/wp-01023.pdf
Score. 4

paper

Incremental FPGA Synthesis

As FPGA devices have grown larger and more complex, the design process has become more challenging. Designers must now contend with a large number of complex embedded blocks in a single FPGA. This increase in functionality has led to long runtimes and difficulties in achieving timing closure. As a result, designers have turned to incremental design to alleviate this problem; however, the currently available solution requires designers to...

Web. http://www.mentor.com/products/fpga_pld/techpubs/mentorpaper_32628.cfm
Score. 4

paper

Using Hardware Acceleration to Optimize Software-Based Embedded Systems

This document is intended for engineering and product line management executives in companies that develop embedded systems. It highlights the system design considerations associated with implementing algorithms as a combination of hardware and software elements.

Web. http://www.quicklogic.com/images/Optimizing_Embedded_Systems_WP.pdf
Score. 4

personal page

John's VHDL FPGA Page

1. VHDL - References and Tutorials: 2. FPGA Board Vendors: 3. FPGA Prototyping Boards I Use: 3.1 B3-Spartan2+ Board 3.2 Notes on modifying the B3-SRAM module 3.3 B5-X300-Spartan2e Board 3.4 ICST525-01 PLL Clock divider 3.5 Spartan 3 Starter Board 3.6 Spartan 3E Starter Board 3.7 XESS XSA-3S1000 3.8 Memec Design / Avnet

V4FX12LC 4. FPGA Design Tools: 4.1 Xilinx Web Pack ISE: 4.2 Altera Quartus: 5. FPGA Projects for the B3...

Web. http://members.optushome.com.au/jekent/FPGA.htm
Score. 4

personal page

Svenand's Blog / FPGAs from Scratch
have been designing ASICs for more than 15 years. A few years ago I started to realize that there is another player in town and that is the FPGA circuit. With increasing NRE costs and with the long turn-around times, ASIC designs have become high-risk projects. At the same time FPGAs are getting bigger and faster and many companies have therefore decided to only use FPGAs. I also realized that I have to learn how to design using FPGAs, if I...

Web. http://svenand.blogdrive.com/
Score. 4

portal

DSP-FPGA.com
DSP-FPGA.com (formely DSP Engineering magazine) is the engineer's resource for embedded digital signal processing. Our editorial content and product databases focus on DSP and FPGA hardware and software development solutions and their related technologies serving the following industries: Telecommunications, Personal communications, Audio, Video imaging, Automotive systems, Motor and motion control, Broadband, Digital...

Web. http://www.dsp-fpga.com/
Score. 4

portal

FPGAWorld.com
FPGAworld is a news and information site for engineers with a special interest in FPGA design. The site will have a strong focus on FPGA design but will also cover related issues like IP, SOC, ASIC prototyping etc. Also promoting an FPGA World conference in September, 2004.

Web. http://www.fpgaworld.com/
Score. 4

project

BYU JHDL, Open Source FPGA CAD Tools
JHDL is a set of FPGA CAD tools developed at Brigham Young University's Configurable Computing Laboratory that allows the user to design the structure and layout of a circuit, debug the circuit in simulation, netlist and interface for bit-stream synthesis, and so forth. It is an exploratory attempt to identify the key features and functionality of good FPGA tools.

Web. http://www.jhdl.org/
Score. 4

resource

Altera Partner and Eval Kit List
Altera's worldwide partners offer development platforms that speed system design and allow application software development to begin earlier in the design flow. Hardware

designers can use the platforms to verify intellectual property (IP) functionality quickly and effectively. Table 1 lists development platforms from Altera® partners.

Web. http://www.altera.com/products/devkits/kit-dev_platforms_partner.jsp
Score. 4

seminar

ATSF: Portable Applications Workshop

Get to market faster with a real solution for complex and power sensitive embedded systems by attending the newest Arrow Technical Solutions Forum. Learn the latest hardware and software design techniques for maximum power savings with solutions from Altera Corporation, Linear Technology, Arrow Electronics and others.

Web. http://www.arrownac.com/aws/pg_tbGeneralTemplate_5/0,9853,5242,00.html?text=Arrow%20Technical%20Solutions%20Forum%20(ATSF)
Score. 4

seminar

X-Fest: Avnet and Xilinx Design Seminars

Avnet Electronics and Xilinx are pleased to announce X-Fest - a series of technical seminars offering practical, how-to training for FPGA, DSP, and embedded systems designers. Analog Devices, National Semiconductor and Texas Instruments are among the list of sponsors participating in the worldwide technical seminar series. The series kicks off its 90-city global tour in Beijing April 3, 2007 and continues through July 13 in locations...

Web. http://www.em.avnet.com/evs/home/0,1707,RID%253D%2526CID%253D35679%2526CCD%253DUSA%2526SID%253D32214%2526DID%253DDF2%2526LID%253D32233%2526PRT%253D0%2526EFL%253D%2526PVW%253D%2526ASM%253Dl%2526BID%253DDF2%2526CTP%253DEVS,00.html
Score. 4

tutorial

Xilinx Education Home - FPGA, DSP, SOC and More

As a leader in the FPGA space, Xilinx offers a number of courses on how to learn and use its technology. Admittedly, they are by Xilinx, for Xilinx - designed to promote Xilinx technologies. Courses are arranged worldwide, and are on a paid basis only. FPGA Design DSP Design High-Speed Serial Design Embedded Systems Development PCI Design. Also some online training.

Web. http://www.xilinx.com/support/education-home.htm
Score. 4

vendor

DeviceNative.com

Welcome to DeviceNative.com, a discussion about the verification of large Field Programmable Gate Arrays (FPGAs) with the team at GateRocket, Inc. In this blog, we share ideas and observations about FPGA verification and appreciate your comments on the same. If you have followed the market as we have over the past several years, FPGAs have become every bit as advanced as ASIC technologies, but don't suffer from the long, costly and error...

Web. http://www.devicenative.com/
Score. 4

webinar

Secure FPGA Configuration Over Ethernet

Digital consumer and industrial systems inevitably require updates. Systems designed to use reconfigurable logic like FPGA's, or with rewritable non-volatile memory have the potential for upgrades. Many of these systems have some form of network connection and can use the available communications connection to perform system upgrades. But how can updates to these kinds of systems be done securely? This webcast covers an FPGA based embedded...

Web. http://www.latticesemi.com/corporate/webcasts/securefpgaconfigurationov.cfm
Score. 4

eletter

FPGA Journal eLetter

A new online technical magazine and newsletter from techfocus media dedicated to the design and application of programmable logic devices. FPGA and Programmable Logic Journal features in-depth original articles, the latest industry news, and rich technical resources for programmable logic designers, as well as new product, promotion and event announcements from industry-leading companies

Web. http://www.fpgajournal.com/
Score. 5

overview

FPGA-Guide.com

This page offers to you the first (and i think biggest) vendor-independent FPGA-selector-guide for all known FPGA and CPLD-families of the last years. The devices are preselected by gate-complexity and year of introduction. At the first glance you can see max. usable gates, flipflops, speed, RAM, clock-nets, 5V-tolerance, I/Os and many more.

Web. http://www.fpga-guide.com/
Score. 5

portal

Programmable Logic DesignLine

Where can you find real solutionsto tough programable logic design challenges? The Programmable Logic DesignLine is the place. This site provides the practical how-to information needed to program, develop, and implement field programmable gate arrays (FPGAs) and programmable logic devices (PLDs) in wireless, networking, industrial, automotive, and other design applications

Web. http://www.pldesignline.com/
Score. 5

Appendix B: New FPGA-Related Products

Vendors release product-after-product into the competitive FPGA market. Fortunately, ***eg3.com*** *tracks all news releases and new product announcements. Here is an excerpted list from the last six months. For the most recent products, go to* *http://www.eg3.com/fpga.htm*. *Be sure to sign up for e-clips, our news alert service as well.*

APPENDIX B: NEW FPGA-RELATED PRODUCTS

new product

LynuxWorks' Open-source RTOS Supports new Xilinx MicroBlaze Embedded Processor

Continuing its tradition of supporting the latest processors available to embedded developers, LynuxWorks™, Inc., a world leader in embedded software, announced that its BlueCat-ME Linux® fully supports version 7 of the MicroBlaze™ embedded processor launched today by Xilinx, Inc., with the release of its Embedded Development Kit v9.2. The addition of an optional Memory Management Unit (MMU) means the MicroBlaze embedded processor now...

Web. http://www.lynuxworks.com/corporate/press/2007/microblaze.php
Score. 4
Date. 11/23/2007

new product

Actel Libero IDE v8.1 Maximizes Power Efficiency with New Power-Driven Layout and Advanced

Extending the company's industry-leading solutions for saving power at the chip and system levels, Actel Corporation has rolled out its Libero Integrated Design Environment (IDE) with significant new features, such as power-driven layout, that enable designers to further optimize designs to reduce dynamic power consumption by as much as 30 percent for a typical design. With the advanced power analysis capabilities built into Libero's...

Web. http://www.actel.com/company/press/2007/11/19/
Score. 5
Date. 11/23/2007

new product

Atmel Launches Low-Cost Starter Kit for CAP Customizable Microcontroller

Atmel® Corporation has announced the launch of the AT91CAP9A-STK Starter Kit for its CAP Customizable Microcontroller product family. The CAP Starter Kit is the ideal vehicle for low-cost, no-risk evaluation of the customization capabilities of the CAP MCU by mapping application-specific IP blocks into its FPGA that emulates the functionality of the CAP's embedded Metal Programmable (MP) Block. Built on a single PCB including a AT91CAP9S...

Web. http://www.atmel.com/dyn/corporate/view_detail.asp?ref=&FileName=AT91CAP9S_starterkit_11_14.html&SEC_NAME=Product
Score. 4
Date. 11/16/2007

new product

Lauterbach Introduces Real-Time Tracing for Xilinx MicroBlaze v7 Processor

LAUTERBACH, the manufacturer of microprocessor development tools, has launched support for real-time tracing for version 7 of the MicroBlaze processor from Xilinx®. Optimized for embedded applications in Xilinx FPGAs, the MicroBlaze processor is a flexible 32-bit Harvard RISC architecture with a rich instruction set and optional memory management unit (MMU). Lauterbach has supported debuggers for the MicroBlaze processor, starting with...

Web. http://www.lauterbach.com/frames.html?pressroom.html
Score. 4
Date. 11/16/2007

new product

Avnet Electronics Marketing Releases New Virtex-5 Development Kit
Avnet Electronics Marketing Americas, a part of Avnet, Inc., announces the release of the Xilinx(R) Virtex(TM)-5 LXT/SXT Development Kit - a complete development platform for designing and verifying applications based on the Xilinx Virtex-5 LXT and SXT Field Programmable Gate Array (FPGA) families.The new kits support the LX50T, LX110T, SX50T, or SX95T Virtex(TM)-5 devices, and take advantage of the world's first 65nm FPGAs. 'Avnet is...

Web. http://www.avnet.com/prl/home/0,1965,RID%253D0%2526CID%253D43301%2526CAT%253D%2526CCD%253DUSA%2526SID%253D9358%2526DID%253DDF3%2526LID%253D9368%2526PRT%253D%2526PVW%253D%2526intY%253D%2526TYP%253DEM%2526BID%253DDF3%2526CTP%253DPRL,00.html
Score. 4
Date. 11/15/2007

new product

Commercial Availability of First Front Side Bus FPGA High Performance Computing Solution
Xilinx, Inc. (Nasdaq: XLNX), the world's leading supplier of programmable solutions, today announced it has begun commercial licensing of the high-performance computing industry's first FPGA-based acceleration solution to interface with the Intel Front Side Bus (FSB). Enabled by the high-performance 65nm Virtex(TM)-5 platform FPGA and Intel(R) QuickAssist Technology, the Xilinx(R) Accelerated Computing Platform (ACP) M1 licensing package...

Web. http://press.xilinx.com/phoenix.zhtml?c=212763&p=irol-newsArticle&ID=1076021&highlight=
Score. 4
Date. 11/13/2007

new product

Xilinx Launches New Comprehensive Embedded Processing Platform
Xilinx has announced its next generation Embedded Processing Solutions, providing design teams with enhanced system level performance, expanded flexibility and increased design environment productivity covering a broad range of applications. Anchored by an enhanced 32-128 bit Processor Local Bus (PLB), a component of the IBM CoreConnect(TM) bus standard, the platform delivers increased performance and scalability for future performance and...

Web. http://press.xilinx.com/phoenix.zhtml?c=212763&p=irol-newsArticle&ID=1077535&highlight=
Score. 5
Date. 11/13/2007

new product

Spectrum Ships New FPGA Processor Module Offering Higher Performance Processing with Deep Memory
Spectrum Signal Processing by Vecima ('Spectrum') (TSX:VCM), a leading provider of software defined radio (SDR) technology, today announced at the SDR Forum Technical Conference and Product Expo the availability of the flexCommTM XMC-8131 reconfigurable parallel processing engine. The XMC-8131 provides high performance processing that supports the implementation of multi-channel, multi-mode receivers for both narrowband and wideband...

Web. http://cnrp.ccnmatthews.com/client/spectrum/release.jsp?actionFor=788754
Score. 4

Date. 11/9/2007

new product

IDT Introduces High Performance, Lowest Power Serial RapidIO® Switches for the Embedded Market

IDT® (Integrated Device Technology, Inc.; NASDAQ: IDTI), a leading provider of essential mixed-signal semiconductor solutions that enrich the digital media experience, today announced a new family of devices - central packet switches (CPS) that address the interconnect needs of those embedded applications that utilize DSPs, FPGAs or processors. The CPS solutions incorporate in-house third-generation IDT SERDES and serial RapidIO® core...

Web. http://www.idt.com/?id=4600
Score. 5
Date. 11/6/2007

new product

Zuken and Aldec Deliver New Design Solution: CADSTAR FPGA

As a result of the partnership between Zuken and Aldec, a brand new collaborative product for complete FPGA design and verification has been launched. CADSTAR FPGA combines Aldec's Active-HDL Lite verification tool and Zuken's desktop PCB design suite, CADSTAR, allowing engineers to perform mixed language simulation for vendor neutral FPGAs within the CADSTAR environment. Synchronized Design Process

Web. http://www.aldec.com/news/news_10_31_2007.htm
Score. 5
Date. 11/6/2007

new product

Nallatech to Support and Deliver Product for Intel® QuickPath Interconnect

Nallatech, the domain expert in high-performance FPGA computing solutions, today announced that it is the first FPGA system vendor to sign up to deploy product using the Intel® QuickPath interconnect. The Intel QuickPath interconnect is Intel's new high-speed system interconnect for servers and high-end work stations. Nallatech will use the Intel QuickPath interconnect to bring to market the industry's first FPGA-based socket filler...

Web. http://www.nallatech.com/?node_id=1.5.11.1.1&id=157
Score. 4
Date. 10/24/2007

new product

Zuken Makes Free Simulation Kits Available to Users for Xilinx Virtex-5 FPGA

Munich, Germany and Westford, MA, USA Zuken announces the availability of a free simulation design kit for the latest high-performance Virtex-5 FPGA from Xilinx. Born from cooperation between the two companies, this comprehensive design tool keeps pace with advanced technologies, delivering first-class signal integrity for 65nm FPGA designs. The Xilinx® Virtex-5 FPGA simulation kit is for use with Zuken's high-speed design solution,...

Web. http://www.zuken.com/news/press0710-Xilinx.asp
Score. 4
Date. 10/24/2007

new product

Mentor Graphics and Altera announce Catapult C Synthesis Accelerated Libraries for ...
Mentor Graphics Corporation and Altera Corporation announced a design flow that enables users to implement complex DSP algorithms in high-performance FPGAs directly from industry standard ANSI C++. The design flow, based on Altera's Accelerated Libraries for Mentor Graphics' Catapult® C Synthesis tool, delivers 50-80 percent DSP Fmax performance improvements, provides a low-effort path to dedicated DSP...

Web. http://www.altera.com/corporate/news_room/releases/products/nr-catapult_altera_dsp.html
Score. 5
Date. 10/19/2007

new product

ARM Announces the Low Cost Cortex-M1 Development Kit For Altera Cyclone III
ARM announced the ARM® Cortex-M1 Development Kit, a complete ARM design solution optimized for Altera Cyclone® III Field Programmable Gate Arrays (FPGAs). Complementary to the Cortex-M1 processor - the first ARM processor designed specifically for implementation on FPGAs - the ARM Cortex-M1 Development Kit enables the seamless integration of ARM processor technology with the Altera Cyclone III FPGAs using...

Web. http://www.arm.com/news/18447.html
Score. 5
Date. 10/18/2007

new product

Aldec releases Riviera-PRO Targeting ASIC/FPGA Verification Market
Aldec, Inc., a pioneer in mixed-language simulation and advanced design tools for ASIC and FPGA devices, announced today the release of Riviera-PRO 2007.10, with expanded SystemVerilog (Verification) construct support and improved performance of VHDL, Verilog and mixed RTL simulation. This mixed-language design simulation environment supports VHDL, Verilog, SystemVerilog, and SystemC designs. Riviera-PRO supports multi-million gate HDL...

Web. http://www.aldec.com/news/news_10_11_2007.htm
Score. 5
Date. 10/17/2007

new product

Objective Interface Systems Announces Telecommunications Middleware Platform
Objective Interface Systems, Inc. (OIS), provider of the most widely used communications middleware for real-time and embedded systems, has announced the OIS Telecommunications Platform, a standards-based, expandable software communications infrastructure for wireless base stations, routers, switches and network hardware. The OIS Telecommunications Platform features ORBexpress® RT, ORBexpress DSP and ORBexpress FPGA, OIS's high-performance...

Web. http://www.marketwire.com/mw/release.do?id=781373&sourceType=1
Score. 5
Date. 10/17/2007

new product

Tundra Semiconductor Introduces Multi-Standard Serial RapidIO Switch

Tundra Semiconductor Corporation, a leader in System Interconnect, has introduced the Tsi620, an innovative multi-standard Serial RapidIO Switch that lowers 3G baseband costs by bridging RapidIO-based DSP clusters to low cost embedded processors and FPGAs.The Tundra Tsi620 significantly lowers 3G baseband processing costs by directly connecting a switched cluster of RapidIO-enabled DSPs to low cost PCI-enabled microprocessors, in many cases...

Web. http://www.tundra.com/news.aspx?id=2760&bid=687&sid=462
Score. 5
Date. 10/16/2007

new product

Catapult C Synthesis Accelerated Libraries for High-Performance DSP Announced

Mentor Graphics Corporation (Nasdaq: MENT) and Altera (Nasdaq: ALTR) today announced a design flow that enables users to implement complex DSP algorithms in high-performance FPGAs directly from industry standard ANSI C++. The design flow, based on Altera's Accelerated Libraries for Mentor Graphics' Catapult® C Synthesis tool, delivers 50-80 percent DSP Fmax performance improvements, provides a low-effort path to dedicated DSP hardware...

Web. http://www.mentor.com/company/news/alteracatapultcsynthesisacceleratedlibrarieshighperformancedspfpga.cfm
Score. 5
Date. 10/12/2007

new product

Altera Extends Productivity Advantage With Quartus II Software Version 7.2

Delivering unparalleled productivity tools for FPGA users, Altera Corporation announced its Quartus® II software version 7.2. With this new software version, Altera continues to extend its advantage in compile times, a key productivity metric. Designers using Quartus II software version 7.2 can expect their Stratix® III FPGAs compile-time advantage to grow to three times that of competing high-end 65-nm FPGAs. More...

Web. http://www.altera.com/corporate/news_room/releases/products/nr-qii72.html
Score. 4
Date. 10/8/2007

new product

Curtiss-Wright's New Virtex-5 SXT XMC Card Speeds Integration of Embedded Custom FPGA Computing

Curtiss-Wright Controls Embedded Computing, a leading designer and manufacturer of rugged deployed commercial off-the-shelf (COTS) VME, and VPX products, has announced the availability of the XMC-442, its first Xilinx Virtex-5 FPGA-based XMC module (VITA 42) compute engine. The XMC-442 is designed for demanding, high-performance signal and image processing applications including radar, sonar, and signal intelligence. It is Curtiss-Wright's...

Web. http://www.cwcembedded.com/0/62/453.html
Score. 5
Date. 10/1/2007

new product

Xilinx Announces New Low Cost, High Performance DSP Development Platform

Xilinx, Inc., the world's leading provider of programmable solutions, introduced a low-cost development platform for implementing DSP designs using the Spartan(TM)-3A DSP family of low-cost FPGAs. The XtremeDSP(TM) Solutions Starter Platform -- Spartan-3A DSP 1800A FPGA Edition is ideal for engineers developing DSP applications that require the performance and price delivered by Spartan-3A DSP devices. (Photo:...

Web. http://press.xilinx.com/phoenix.zhtml?c=212763&p=irol-newsArticle&ID=1054502&highlight=
Score. 5
Date. 10/1/2007

new product

Nallatech Launches Early Access Program for the Industry's First FSB-FPGA Module

Nallatech, the domain expert in high-performance FPGA computing solutions, has announced at the Intel Developer Forum the launch of the early access program for its 'Slipstream' FSB-FPGA module. Shipments of this innovative product will be made in 4Q07. This high performance computing solution will supply high speed direct access to the Intel® Xeon® 7300 multi-processor server allowing users to significantly accelerate the performance...

Web. http://www.nallatech.com/?node_id=1.5.11.1.1&id=156
Score. 4
Date. 9/28/2007

new product

Actel Addresses Rapidly Expanding Portable Market with Industry's Lowest Power FPGAs

Acknowledging the unique challenges facing today's portable designers, Actel Corporation has detailed its strategy to increase market penetration for the company's ultra low-power IGLOO field-programmable gate arrays (FPGAs) in the rapidly growing portable market. Leveraging the company's leading power-efficient IGLOO FPGAs and ARM Cortex-M1 processor technologies, the company has introduced its new M1-enabled IGLOO FPGAs (see separate...

Web. http://www.actel.com/company/press/2007/9/17/3
Score. 5
Date. 9/28/2007

new product

Atmel CryptoMemories Prevent Product Cloning and Counterfeiting

Atmel® Corporation (NASDAQ:ATML), today announced the world's first family of EEPROMs with a 64-bit embedded hardware encryption engine, four sets of non-readable, 64-bit authentication keys and four sets of non-readable, 64-bit session encryption keys. Called CryptoMemory®, the new devices provide the only low-cost, truly secure means of preventing product counterfeiting and/or piracy. Product counterfeiting is a $600 billion industry....

Web. http://www.atmel.com/dyn/corporate/view_detail.asp?ref=&FileName=CryptoMemoryTBrief_9_28.html&SEC_NAME=Technical%20News%20Brief
Score. 5
Date. 9/28/2007

new product

Impulse C is the Latest Software-to-FPGA Tool to Support the Intel® Front Side Bus

Impulse Accelerated Technologies Inc. today announced that they are the latest software-to-FPGA tools provider to support the Intel front side bus (FSB) architecture. In a related announcement, Impulse has announced that it is in development of a Platform Support Package targeting the Intel QuickAssist Technology Accelerator Abstraction layer for FSB-connected FPGA accelerators. According to David Pellerin, CTO and co-founder of...

Web. http://www.impulsec.com/PR_Impulse_Intel_Release_FSB.pdf
Score. 4
Date. 9/26/2007

new product

Connect Tech Inc. Incorporates Xilinx's Virtex-5 in its Next Generation, Reconfigurable FPGA Product

Connect Tech, Inc. has been designing and manufacturing rugged communications solutions for the embedded and industrial PC markets for over 20 years. Today they are pleased to announce the next generation in reconfigurable FPGA products: FreeForm/PCI-104. FreeForm/PCI-104 provides high speed data communications, signal integrity and a powerful, versatile platform for design flexibility. "We understand that an efficient balance of FPGA...

Web. http://www.connecttech.com/sub/News/FPGA_FreeForm_PCI_104_press_release.asp
Score. 5
Date. 9/26/2007

new product

AKA Launches High Performance PRISM200 with Huge Processing Power and Massive Bandwidth Capabilities

Advanced Knowledge Associates (AKA) - the leader in Prepackaged Reconfigurable Integrated System-on-Module (PRISM) technology - today launched the PRISM200, its latest high-performance, and hardware reconfigurable, highly integrated system on a module, designed to enable and accelerate advanced embedded system design. Packaged in a 656 pin PGA with a footprint of just 3.0x3.0in, the PRISM200 features the Xilinx Virtex-4FX platform FPGA...

Web. http://www.a-k-a.net/pr6.shtml
Score. 4
Date. 9/25/2007

new product

Denali Software and Tokyo Electron Device Unveil New DFI Compatible DDR2 SDRAM PHY for Xilinx FPGA

Tokyo Electron Device, Ltd. (TED), an electronics technology and trading company focused on semiconductor products, and Denali Software, a world-leading provider of electronic design automation (EDA) software and intellectual property (IP), today announced the co-development and release of a DDR2 SDRAM PHY Design running on Virtex-5, the largest and fastest FPGA in the world, produced by Xilinx, Inc., compatible with DDR PHY Interface (DFI),...

Web. http://www.denali.com/news_pr20070920.html
Score. 4
Date. 9/24/2007

new product

Mentor Graphics Announces Precision RTL Plus for FPGA Synthesis - Vendor-Independent Solution

Mentor Graphics Corporation (Nasdaq: MENT) today announced a new product, Precision® RTL Plus Synthesis, which provides a significantly improved way of designing field-programmable gate arrays (FPGAs) and dramatically increases designer productivity. The new tool provides several industry-first capabilities that enable every designer, regardless of level of expertise, to reach timing closure faster, minimize the impact of late cycle...

Web. http://www.mentor.com/company/news/precisionrtlplusfpgasynthesisvendorindeendentsolutionproductivity.cfm
Score. 5
Date. 9/24/2007

new product

Xilinx Enhances Wireless Infrastructure Solutions W/ New Virtex-5 FPGA IP for CPRI & OBSAI Standards

Xilinx, Inc., the world's leading supplier of programmable solutions, has announced immediate availability of two high performance wireless connectivity LogiCORETM solutions optimized for Xilinx(R) 65nm Virtex(TM)-5 LXT and SXT FPGAs, compliant with CPRI v2.1 and OBSAI RP3 & RP3-01 v4.0 connectivity standards. The new LogiCORE solutions enable wireless OEMs to leverage these industry-leading connectivity standards to drive down wireless base...

Web. http://press.xilinx.com/phoenix.zhtml?c=212763&p=irol-newsArticle&ID=1051932&highlight=
Score. 4
Date. 9/21/2007

new product

Xilinx Teams W/ Industry Leaders to Accelerate Time-to-Market With Virtex-5 LXT FPGA...

Xilinx, Inc., the world's leading supplier of programmable logic solutions, has announced a vast array of solutions for the PCI Express(R) protocol based on Xilinx(R) Virtex(TM)-5 LXT FPGAs. The solutions include software/driver development kits, reference designs, and IP from a growing list of companies that make up an ecosystem of independent design service and IP vendors. The solutions offer proven compatible technology providing users a...

Web. http://press.xilinx.com/phoenix.zhtml?c=212763&p=irol-newsArticle&ID=1053170&highlight=
Score. 4
Date. 9/21/2007

new product

Mentor Graphics Accelerates FPGA / PCB Design Collaboration with New I/O Designer Product

Mentor Graphics Corporation, (NASDAQ: MENT), the market and technology leader in printed circuit board (PCB) design solutions, today announced the availability of the PADS I/O Designer product specifically targeted at its PADS® product user community. For designers implementing complex field-programmable gate arrays (FPGAs) on their PCBs, the I/O Designer™ product has a proven track record of decreasing design cycle time, improving...

Web. http://www.mentor.com/company/news/fpga_pcb_collaboration_iod.cfm
Score. 5
Date. 9/21/2007

new product

Lattice Delivers Industry's Lowest Power, Smallest Footprint Programmable Bridge Solution

Lattice Semiconductor Corporation, announced the industry's lowest power XAUI/ HiGig/HiGig+ to SPI4.2 programmable Fabric Interface Chip (FIC) solution implemented in its award-winning LatticeSCM FPGAs. The solution, which utilizes the LatticeSCM device's System Packet Interface Level 4 Phase 2 (SPI4.2) hard IP capability, and includes Lattice's 10Gigabit Ethernet Media Access Controller (MAC) soft IP core and the XAUI/HiGig/HiGig+ to SPI4.2...

Web. http://www.latticesemi.com/corporate/newscenter/productnews/2007/r070910deliversindustryss.cfm
Score. 4
Date. 9/20/2007

new product

Avnet Electronics Marketing Launches SpeedWay Design Workshop Series Featuring High-Speed ...

Avnet Electronics Marketing, a division of Avnet, Inc., and Lattice Semiconductor Corporation announce a new workshop series featuring high-speed interfaces for Lattice's latest series of FPGAs. Designers, developers and engineers interested in leveraging the latest high-speed interface technologies with FPGAs can get hands-on experience by attending the Avnet Lattice High Speed Interface SpeedWay Design Workshops,...

Web. http://www.avnet.com/prl/home/0,1965,RID%253D0%2526CID%253D41934%2526CAT%253D%2526CCD%253DUSA%2526SID%253D9358%2526DID%253DDF3%2526LID%253D9368%2526PRT%253D%2526PVW%253DN%2526intY%253D%2526TYP%253DEM%2526BID%253DDF3%2526CTP%253DPRL,00.html
Score. 5
Date. 9/13/2007

new product

ProASIC3 FPGA Development Card Comes with MRAM and On-Board Programmer

Domain Technologies announces the availability of its FPGA development card for Actel ProASIC3 FPGAs that includes 512 Kbytes of 35 ns non-volatile magneto resistive random access memory (MRAM) and an on-board device programmer. Measuring only 2.4 x 1.0 and priced at only $750.00 each, the standard A3P-MRAM development card comes with an Actel A3P1000 in an FGG256 package, allowing for speedy development of some of the most sophisticated...

Web. http://www.domaintec.com/press_a3pmram.html
Score. 4
Date. 8/31/2007

new product

Xilinx DSP Development Tools Deliver Up to 38 Percent Higher DSP Performance

Xilinx, Inc. (Nasdaq: XLNX) today announced that its DSP development tools now deliver up to a 38 percent faster Fmax performance for multi-rate DSP designs and improved ease of use. With the release of version 9.2 of the AccelDSP(TM) synthesis tool and System Generator for DSP, the development tool component of the Xilinx(R) XtremeDSP(TM) solution, provides higher-levels of performance as well as a tighter integration between the two tools...

Web. http://press.xilinx.com/phoenix.zhtml?c=212763&p=irol-newsArticle&ID=1042470&highlight=
Score. 4
Date. 8/27/2007

new product

Cypress's PSoC Express Design Tool Now Offers Real-Time Debugging And Tuning ...

Cypress Semiconductor Corp. introduced Version 3.0 of PSoC Express, the breakthrough visual embedded system design tool for PSoC® mixed-signal arrays that dramatically simplifies embedded design. The new release delivers real-time monitoring and tuning of designs, allowing designers to observe and improve the performance of designs with Cypress's CapSense touch sensing and EZ-Color High-Brightness LED (HB-LED) control...

Web. http://www.cypress.com/portal/server.pt?space=CommunityPage&control=SetCommunity&CommunityID=208&PageID=218&DirectoryID=1021287
Score. 4
Date. 8/20/2007

new product

QuickLogic Announces Availability of Ultra-Secure, Digital Rights Management...

QuickLogic® Corporation, the leader in lowest power programmable solutions, announced it has added a suite of digital rights management (DRM) security functions, including AES encryption, to the library of IP available for its programmable connectivity platforms. The technology greatly enhances time to market and time in market for handheld electronics products. It allows developers to extend the capability of their...

Web. http://www.quicklogic.com/images/082007.pdf
Score. 4
Date. 8/20/2007

new product

Actel Delivers Power-Efficient System Management Solution Starting ...

Enabling a broader range of markets to design more cost- and energy-efficient end systems, Actel Corporation announced a new reference design that enables intelligent system and power management implementations starting at $1.20. The design combines the award-winning, mixed-signal Fusion Programmable System Chip (PSC) with the optimized, configurable CoreABC microcontroller to provide a complete system management...

Web. http://www.actel.com/company/press/2007/8/6/1
Score. 4
Date. 8/7/2007

new product

Altera Delivers PCI-SIG Compliant x1 and x4 PCI Express Solution Supporting Arria GX FPGAs

Altera Corporation announced that its low-cost ArriaTM GX FPGA Development Kit has passed PCI-SIG's compliance tests on its first submission. Altera® Arria GX FPGAs, combined with Altera's PCI Express x4 MegaCore® intellectual property (IP) function, are an integral part of the lowest-cost, PCI-SIG-compliant development kit in the industry. The kit provides designers with an ideal platform for developing PCI Express...

Web. http://www.altera.com/corporate/news_room/releases/products/nr-arriagx_devkit_pcisigcert.html
Score. 4
Date. 8/7/2007

new product

PrismTech Innovation Facilitates FPGA Programming and Integration
PrismTech, an acknowledged leader in the provision of state-of-the-art middleware and development tools, has announced an innovative solution that reduces the complexity of programming and integrating FPGAs in embedded systems. PrismTech's Integrated Circuit ORB (ICO) is an IP core that provides standards-based CORBA® protocol messaging for FPGA logic blocks. The patent application for this breakthrough technology has recently been...

Web. http://www.prismtechnologies.com/section-item.asp?id=722&sid=29&sid2=14
Score. 5
Date. 8/7/2007

new product

PrismTech Innovation Facilitates FPGA Programming and Integration
PrismTech, an acknowledged leader in the provision of state-of-the-art middleware and development tools, has announced an innovative solution that reduces the complexity of programming and integrating FPGAs in embedded systems. PrismTech's Integrated Circuit ORB (ICO) is an IP core that provides standards-based CORBA® protocol messaging for FPGA logic blocks. The patent application for this breakthrough technology has recently been...

Web. http://www.prismtech.com/section-item.asp?id=722&sid=29&sid2=14
Score. 4
Date. 8/3/2007

new product

Altera Delivers First FPGA-Based IP Support for Key Industrial Ethernet Protocols
Altera Corporation announced FPGA-based support for Ethernet communications protocols used in industrial automation applications, including ProfiNet, Ethernet/IP, Modbus-IDA, EtherCAT, SERCOS III Interface, and Ethernet Powerlink. Intellectual property (IP) cores for these key communications protocols can now be implemented on Altera's low-cost Cyclone® series FPGAs. The Industrial Ethernet IP cores enable designers

Web. http://www.altera.com/corporate/news_room/releases/products/nr-multiprotocol.html
Score. 4
Date. 7/24/2007

new product

FPGA Module, Virtex-4 SX35-12; ZBT-SRAM ; SLB Interface; SHB Interface
The SMT368A provides a 'Base' module for a range of applications and functions. The Virtex4 SX has the highest amount of DSP blocks in the Virtex4 range, and the FPGA also has direct access to 8MBytes of ZBTRAM. This will provide storage for the majority of applications. The addition of a Xilinx configuration PROM enables the module to be used 'Stand-Alone'. Alternatively, FPGA configuration can be made from a connected DSP module.

Web. http://www.sundance.com/web/files/productpage.asp?STRFilter=SMT368A
Score. 4
Date. 7/23/2007

new product

Altera and eCosCentric Announce eCosPro Support for Nios II Embedded Processor

Altera Corporation and eCosCentric Limited announced the availability of the eCosPro® real-time operating system (RTOS) for Altera's Nios® II embedded processor, the world's most versatile soft-core processor. The combination of the Nios II embedded processor and the eCosPro RTOS meets the needs of a wide range of applications, including industrial automation, consumer appliances, telematics, communications, networking...

Web. http://www.altera.com/corporate/news_room/releases/products/nr-niosiiecos.html
Score. 4
Date. 7/13/2007

new product

Xilinx Delivers Ise Webpack 9.2i Offering Expanded Support For Latest 65nm Virtex-5 Fpgas

Xilinx, Inc. announced immediate availability of Integrated Software Environment (ISE) WebPACK 9.2i- the latest version of the company's free downloadable programmable logic design suite. The 9.2i version includes all the features and enhancements of Xilinx ISE Foundation 9.2i software with full support for optional embedded, digital signal processing (DSP) and real-time debug design flows. ISE WebPACK 9.2i software...

Web. http://www.xilinx.com/prs_rls/2007/software/0789_webpack9.2i.htm
Score. 4
Date. 7/12/2007

new product

A New Generation VXS DSP Card blends Dual Core PowerPC MPC8641D & Dual Virtex-5 FPGAs

VMETRO today announced the Phoenix VPF2, a rugged COTS DSP processing card which integrates a Freescale MPC8641D processor, two Xilinx® VirtexTM-5 FPGAs and a VXS based high-speed serial inter-connect fabric. The VPF2 tackles both high-bandwidth pre-processing and sophisticated back-end processing in one 6U VME64/VITA 41 (VXS) product for demanding DSP applications such as real-time video processing, surveillance, radar and other...

Web. http://www.vmetro.com/article4134-304.html
Score. 4
Date. 7/10/2007

new product

Altera and eCosCentric Announce eCosPro Support for Nios II Embedded Processor

Altera Corporation (NASDAQ: ALTR) and eCosCentric Limited, today announced the availability of the eCosPro® real-time operating system (RTOS) for Altera's Nios® II embedded processor, the world's most widely used configurable soft-core processor. The combination of Nios II and eCosPro meet the needs of a wide range of embedded applications including industrial automation, consumer appliances, telematics, communications, networking and...

Web. http://www.ecoscentric.com/news/press-070709.shtml

Score. 4
Date. 7/10/2007

new product

Embedded Systems Design, Inc. Unveils StreamBlade FPGA PCI Board

Embedded Systems Design, Inc. (ESD), an embedded engineering services and products company delivering high-performance, real-time, embedded processing systems, today announced its release of the StreamBlade SOE-4. This short form PCI card is a FPGA-based processing board designed specifically to process real-time streaming data. The SOE-4 is ideally suited to streaming applications such as telecommunications protocol processing,...

Web. http://www.embedded-sys.com/062607.php
Score. 4
Date. 7/10/2007

new product

Lattice Announces Extensive Ip Portfolio For New 90nm Flash

Lattice Semiconductor Corporation announced the immediate availability of 45 ispLeverCORE Intellectual Property (IP) and third-party vendor IP cores for its new 90 nanometer embedded FLASH LatticeXP2 FPGA family. Lattice and its ispLeverCORE Connection partners CAST, ANAGRAM Technologies, DCD, Eureka Technology and WDC -- have already ported a wide range of cores addressing automotive, communications, consumer,...

Web. http://www.latticesemi.com/corporate/newscenter/productnews/2007/r070627announcesextensive.cfm
Score. 4
Date. 7/10/2007

new product

Aldec releases STARC based Linting Tool

Aldec, Inc., a pioneer in mixed-language simulation and advanced design tools for ASIC and FPGA devices, announced today the release of new advanced Verilog linting engine - ALINT that complies with the second edition of the STARC 'RTL Design Style Guide'. ALINT supports rules that cover various levels of RTL design cycle: from simple coding style rules and use of language constructs to complex constraints in synthesis and DFT areas. The new...

Web. http://www.aldec.com/news/news_06_11_2007.htm
Score. 4
Date. 7/9/2007

new product

Lattice Delivers Industry's Fastest Memory And Hypertransport Technology I/o

Lattice Semiconductor Corporation (NASDAQ: LSCC) today announced industry-leading FPGA support and performance for HyperTransport technology and three popular memory interfaces. The LatticeSC and LatticeSCM FPGA families (collectively, the LatticeSC/M families) now support HyperTransport technology at rates up to 1600Mbps, QDRII+ rates up to 750Mbps, RLDRAM® II rates of 800Mbps and DDR2 interface speeds of 667Mbps. HyperTransport...

Web. http://www.latticesemi.com/corporate/newscenter/productnews/2007/r070604deliversindustrysf.cfm
Score. 4
Date. 7/9/2007

new product

Lattice Semiconductor Announces µitron Rtos Support For Latticemico32 Microprocessor

Lattice Semiconductor Corporation (NASDAQ: LSCC) today announced that it has validated the operation of the TOPPERS open source implementation of the uITRON 4.0 Real Time Operating System (RTOS) with its LatticeMico32 32-Bit soft microprocessor. This announcement expands the RTOS options available to users of the LatticeMico32 microprocessor, and is particularly significant because uITRON represents the de facto RTOS for embedded...

Web. http://www.latticesemi.com/corporate/newscenter/productnews/2007/r070618announcesultronrto.cfm
Score. 4
Date. 7/9/2007

new product

TQM Hxx-IBA FPGA Development Tool

The TQM HydraXC family is the smallest, most flexible and uni-versal hardware platform on the market for reconfigurable computing. The core component of every TQM HydraXC mod-ule is an innovative Xilinx-FPGA which provides the highest level of computing flexibility with the smallest footprint.

Web. http://www.tqc.de/uploads/media/TQM_Hxx-Iba_eng_02.pdf
Score. 4
Date. 7/9/2007

new product

Xilinx Delivers Ise 9.2i With Lower Memory Requirements And New Operating System Support

Xilinx, Inc. announced immediate availability of the ISE 9.2i (Integrated Software Environment) design tools, the latest release of its widely-used design solution. Improvements in the ISE 9.2i release reduce memory requirements by an average of 27 percent while providing expanded support for Microsoft Windows Vista, Microsoft Windows XP x64, and Red Hat Enterprise WS 5.0 32-bit and 64-bit operating systems. To...

Web. http://www.xilinx.com/prs_rls/2007/software/0786_ise92i.htm
Score. 4
Date. 7/9/2007

new product

Altera Ships Production-Qualified Arria GX FPGAs

Altera Corporation shipped its first production-qualified ArriaTM GX FPGAs. The EP1AGX50 device with 50K logic elements (LEs) and EP1AGX60 device with 60K LEs are now shipping to customers. The Arria GX family of low-cost, transceiver-based FPGAs is optimized to support PCI Express (x1 and x4), Gigabit Ethernet and Serial RapidIOTM standards at speeds up to 2.5 Gbps. The Arria GX family is comprised of five devices...

Web. http://www.altera.com/corporate/news_room/releases/products/nr-arriagxprodship.html
Score. 5
Date. 7/9/2007

new product

TQM Hxx-IBA "FPGA Development Tool" Released

The HydraXC family is the smallest, most flexible and universal hardware platform on the market for reconfigurable computing. The core component of every HydraXC module is an innovative Xilinx-FPGA which provides the highest level of computing flexibility with the smallest footprint. The TQM Hxx-IBA "FPGA Development Tool" is available for the HydraXC modules. With the aid of the TQM Hxx-IBA, you can immediately start to develop and test...

Web. http://www.tqc.de/uploads/media/TQM_Hxx-Iba_eng.pdf
Score. 4
Date. 6/8/2007

new product

E-16 Released - World's First Virtext-5 FPGA in ExpressCard/34 Form Factor
Pico Computing, Inc., has announced the release of the E-16, the industry's first Virtex-5 FPGA in the ExpressCard / 34 Form factor. The ROHS compliant E-16 is available with the Virtext-5 LX50 and incorporates the PLX PEX8311 that provides a x1 PCI Express Lane.

Web. http://www.picocomputing.com/press/E-16%20Press%20Release.pdf
Score. 5
Date. 6/5/2007

new product

GateRocket Introduces RocketDrive - Device Native Verification for FPGAs
GateRocket Inc. today announced availability of the industry's first Device Native verification product that gives Field Programmable Gate Array (FPGA) designers the power to validate designs with one to two orders of magnitude faster simulation, and realize actual device behavior early in the design process. RocketDrive is a hardware and software solution that adds significant value to existing design verification environments without a...

Web. http://www.devicenative.com/2007/04/23/gaterocket-introduces-rocketdrive-device-native-verification-for-fpgas/
Score. 5
Date. 6/1/2007

Appendix C: FPGA Vendors

Vendors who actually make FPGAs are, of course, the center of the FPGA marketplace. This Appendix identifies the primary FPGA vendors with links to their websites for more information. Note: Rating information is a very rough indication of company size, frequency of news updates, and relevance to practical embedded systems designers.

APPENDIX C: FPGA VENDORS

Actel Corporation

As the leader in single-chip FPGAs, Actel Corporation offers Flash- and antifuse-based solutions that are live at power-up, low power, and highly secure. Actel also provides IP cores, including CoreMP7, its soft ARM7 core; design suites; programming tools; and design services. [Cores: 8051, ARM, CORTEX-M1, SPARC]

Web. http://www.actel.com/
Score. 5

Altera

Altera is the world's pioneer in system-on-a-programmable-chip (SOPC) solutions. As a leading supplier of FPGAs, CPLDs, structured ASICs and embedded processors, Altera combines programmable logic technology with design software, IP, and design services to offer designers high-value programmable solutions. Central to Altera's embedded solutions is the Nios II processor, a user-configurable, general-purpose RISC embedded processor, and...

Web. http://www.altera.com/
Score. 5

Lattice Semiconductor Corporation

Lattice Semiconductor Corporation provides the industry's broadest range of Programmable Logic Devices (PLD), including Field Programmable Gate Arrays (FPGA), Complex Programmable Logic Devices (CPLD), Mixed-Signal Power Management and Clock Generation Devices, and industry-leading SERDES products. [FPSC, ispGDX, ispPAC, mixed-signal, power management, clock generation, non-volatile]

Web. http://www.latticesemi.com/
Score. 5

MathStar

MathStar is a fabless semiconductor company addressing the reconfigurable logic markets with a new class of platform chips we call "Field Programmable Object Arrays" or FPOAS. MathStar's FPOAs are high-performance, reconfigurable chips based on MathStar's proprietary Silicon Object technology. MathStar is designing its chips to be programmed with customer-specific functionality [FPGA] . . .

Web. http://www.mathstar.com/
Score. 5

QuickLogic Corporation

Provider of the lowest power programmable logic solutions for the portable electronics, industrial, communications and military markets. Our latest products, PolarPro, Eclipse II and QuickPCI are being used to implement bridge and control solutions in embedded systems requiring Wi-Fi, DVB_H and IDE or CE-ATA-based disk drives. QuickLogic's proprietary ViaLink® technology offers significant benefits, for programmable logic [FPGA]...

Web. http://www.quicklogic.com/
Score. 4

Xilinx

Supplier of complete programmable logic solutions, including advanced integrated circuits, software design tools, predefined system functions delivered as cores, and unparalleled field engineering support. [FPGA, PLD, Programmable Logic]

Web. http://www.xilinx.com/
Score. 5

Appendix D: FPGA Tool & IP Vendors

FPGA design is not easy, and so there are many companies that provide design tools and IP ("intellectual property") to ease your design. This Appendix identifies the primary FPGA vendors with links to their websites for more information. Note: Rating information is a very rough indication of company size, frequency of news updates, and relevance to practical embedded systems designers.

APPENDIX D: FPGA TOOL & IP VENDORS

Adveda

Adveda enables both SW- and HW- developers to close the SoC verification gap by offering fast and fully integrated simulation and debugging tools. With these tools both the software and hardware of a System-On-Chip or complex FPGA can be verified within one environment. Automatic embedded OS support, One tool for SW and HW development.

Web. http://www.adveda.com/
Score. 2

Aldec Inc.

Aldec is currently delivering high performance, mixed HDL-based design entry and verification software to support the development and verification of IC designs. The products also support Co-Simulation of C/C++ and Matlab/Simulink for verification of both software algorithms and HDL based descriptions from one environment. [FPGA, ASIC, SystemVerilog, SystemC, VHDL, Verilog, FPGA/CPLD]

Web. http://www.aldec.com/
Score. 4

Altium

Altium Designer provides electronic designers and engineers with a single, unified application that incorporates all the technologies and capabilities necessary for a complete electronic product development. Altium Designer integrates board- and FPGA-level system design, embedded software development, and PCB layout, editing and manufacturing within a single design environment.

Web. http://www.altium.com/
Score. 5

Amontec

Amontec is ASIC / FPGA Designers who use HDL Design approaches to solve engineering challenges and understand the benefits of applying EDA tools to these design issues. Amontec has experience of the design and functional verification of HDL based designs ranging from FPGAs to complex SoC devices. [JTAG]

Web. http://www.amontec.com/
Score. 2

AutoESL Design Technologies

AutoESL Design Technologies (AutoESL), Inc. provides platform-based communication-centric Electronic System Level (ESL) synthesis tools in the field of Electronic Design Automation (EDA) for integrated circuits and systems. The AutoPilot tool from AutoESL provides novel platform- based, communication-centric ESL synthesis flow synthesis flow that automatically generates high-quality RTL code...[ASIC, structured ASIC, FPGA]

Web. http://www.autoesl.com/
Score. 2

Binachip

BINACHIP develops and markets software products and services that enable embedded systems developers to design and implement high-performance applications such as HD video CODEC, within their price/performance and time-to-market constraints. It also enables seamless migration of software from older generation, general-purpose embedded processors into newer hardware, and mixed hardware/software platforms of the future. [FPGA]

Web. http://www.binachip.com/
Score. 3

Blue Pearl Software, Inc.

Innovative, high performance tools that generate accurate timing exception constraints automatically, before synthesis, validate existing timing exceptions and find functional problems in RTL code. Cobalt Timing Constraint Generation enables faster timing closure for complex chips. [ASIC, FPGA, EDA, RTL, Verilog, Timing, Linting]

Web. http://www.bluepearlsoftware.com/
Score. 2

Bluespec Inc.

Bluespec manufactures EDA toolsets that unify modeling, software prototyping, verification and implementation within a single environment. The only general purpose ESL Synthesis platform, Bluespec's silicon-proven SystemVerilog and SystemC toolsets significantly raise the level of abstraction while they retain the ability to automatically synthesize high quality, readable RTL, without compromising speed, power or area. [SystemC, SystemVerilog,]

Web. http://www.bluespec.com/
Score. 2

Cambridge Consultants

Cambridge Consultants is a leading technology and innovation company, renowned for its ability to solve technical problems and provide creative, practical solutions to business issues. They offer an extensive library of analogue, digital, mixed-signal and wireless IP cores together with embedded software development tools, protocol stacks and design platforms for ASIC and FPGA. Our IP cores are portable and flexible, and can be... [Bluetooth]

Web. http://www.cambridgeconsultants.com/
Score. 2

CAST, Inc.

CAST develops and supports over 100 different popular and standards-based IP cores, including 8051s, H.264, PCI Express, AES, and even complete platforms for ARM-based SoCs (see menu to the left). With thirteen years of experience and hundreds of successful customers, we know how to deliver IP that works. Our complete, high-quality cores are ready for implementation in custom or structured ASICs or in FPGAs, and our world-wide team with a...

Web. http://www.cast-inc.com/
Score. 4

CebaTech Inc.

CebaTech Inc. develops tools and intellectual property modules that accelerate the development and realization of software algorithms and complex communication protocols into silicon. CebaTech's products include high-value 10G TCP/IP cores for networking, storage, and communication systems and servers as well as ESL technology that transforms ASIC/ FPGA development into a top-down design process, alleviating existing verification/ simulation...

Web. http://www.cebatech.com/
Score. 2

Celoxica Inc.

Celoxica is the technology leader for Software-Compiled System Design, a process that accelerates design productivity by using high-level languages to directly drive design verification and implementation. Celoxica provides tools and services that support the co-design, verification and implementation of hardware and software through a platform-based design methodology. [Keywords: C synthesis, FPGA, Handel-C, SystemC, ESL]

Web. http://www.celoxica.com/
Score. 3

Cortus

Our cores are unique in being extremely small and power efficient as well as supporting out of order instruction completion. The cpu itself is no bigger than the 8 bit cpu core in a 8051 or a 6811 micro-controller. Hence it is also perfectly adapted for the high volume, low cost micro-controller market as well as for embedding on low cost FPGA's such as the Xilinx Spartan 3 XC3S200 or XC3S250E.

Web. http://www.cortus.com/
Score. 2

CriticalBlue

CriticalBlue delivers Cascade, an embedded system design tool that synthesizes optimized programmable coprocessors to accelerate embedded software within FPGAs, structured ASICs and platform SoCs. Cascade analyzes executable software code to identify functions to be offloaded from the main processor onto a coprocessor.

Web. http://www.criticalblue.com/
Score. 3

Derivation Systems, Inc.

Derivation Systems, Inc. (DSI), founded in 1993, is a leading developer of formal verification systems for high assurance hardware/software applications and embedded systems products. The company's corporate mission is to develop innovative technologies for safety-critical systems through advanced research in formal methods. Our goal is to develop computer-aided design tools and provide... [PC/104-PLUS FPGA, Xilinx Virtex-II Platform FPGAs]

Web. http://www.derivation.com/
Score. 2

DSPlogic, Inc.

DSPlogic is a leading provider of programming tools and services for hybrid FPGA computing systems, including both embedded systems and high-performance computing platforms. We specialize in FPGA-based Software Acceleration, High Performance Reconfigurable Computing (HPRC) and Digital Signal Processing (DSP) tools, algorithms and implementations for applications such as bioinformatics, wireless communications, financial modeling, image...

Web. http://www.dsplogic.com/
Score. 2

Dynalith Systems Co., Ltd.

Dynalith Systems provides innovative verification solutions that include functional & behavioral level verification, cost-effective HW accelerator, and virtual prototyping: iNTUITION for prototyping and acceleration, iPROVE for acceleration and virtual prototyping, and iTUTOR and iNCITE for education/training. WIth these solutions, design in FPGA can be run along with HDL simulator, high-level language (C/C++, SystemC, Matlab, Simulink)...

Web. http://www.dynalith.com/
Score. 3

e8051 Cores

The low-cost e8051 is the fastest available 8051/8052 embedded microcontroller core for ASICs and FPGAs, achieving peak processing speeds of over 300 Mips in ASICs and over 150 Mips in FPGAs (equivalent to 3.6 GHz/1.8 GHz clock rates in a conventional 8051!) The e8051 core has the following features: 100% instruction set compatible with standard 8051 and 8052 microcontrollers, Low gate count/cell count , low power consumption, etc.

Web. http://www.e8051.com/
Score. 2

Eureka Technology Inc.

Eureka Technology is a leading intellectual property (IP) provider for ASIC and FPGA and SoC designs. The company offers a wide range of fully synthesizable, silicon-proven system core logic functions and peripheral functions to support different bus standards and CPU interfaces, including PCI, PCI-X, PCI Express, Cardbus, PowerPC, ARM, MIPS, ARC, SH2/3/4, SDRAM, DDR/DDR2 SDRAM, NAND Flash, Flash/SRAM/EEPROM, SD memory, SDIO, CompactFlash...

Web. http://www.eurekatech.com/
Score. 2

Evatronix S.A.

Evatronix develops electronic virtual components (IP cores) and offers VHDL & Verilog model development services as well as FPGA design services (Altera & Xilinx) and development of hardware & software for embeded systems. Products range from microcontroller cores based on legacy instruction set architectures like Z80, 68000, 80186 with best selling 8051 compliant microcontroller cores family, through serial bus interfaces (USB, I2C, Firewire...

Web. http://www.evatronix.pl/
Score. 2

EVE (Emulation & Verification Engineering)

EVE offers ZeBu, a high-performance verification platform for ASIC, FPGA, IP, and Embedded Systems. Designed around a pioneering hardware-assisted architecture to debug hardware and validate software of SoC designs of 1 to 100 millions ASIC gates, ZeBu supports interactive read/write internal access to the design without compiling internal probes, co-verification with a HDL/C/C++ test benches at signal and transaction level up to 12MHz. . .

Web. http://www.eve-team.com/
Score. 2

Expressive Systems Limited

Expressive Systems is dedicated to the provision of quality tools for the ASIC/FPGA design community. Our mission is to develop new and novel forms of design data visualization - Expressive-IV, a tool dedicated to the conception, visualization and maintenance of the design hierarchy. Expressive-IV provides improved functionality over previous releases and is now available at new low price allowing a one-per-engineer tool strategy.

Web. http://www.expressivesystems.com/
Score.

FishTail Design Automation

Fishtail offers a suite of products for timing exception generation, timing exception verification and constraint management. FishTail's timing exception generation product Focus takes RTL/netlist and design constraints as input and synthesizes false and multi-cycle paths for a chip. FishTail allows engineers to verify user-specified false and multi-cycle paths with its Confirm product that takes RTL and design constraints [ASIC, FPGA]...

Web. http://www.fishtail-da.com/
Score. 2

Forte Design Systems

Forte Design Systems is a leading provider of software products that enable design at a higher level of abstraction. Forte's industry leading behavioral synthesis technology allows design teams creating complex electronic systems from algorithmic designs using ASICs, FPGAs, and SoCs to significantly reduce their overall design and verification time. [SystemC, ANSI-C, ANSI-C++, ESL, synthesis]

Web. http://www.forteds.com/
Score. 3

Gaisler Research

Gaisler Research is a privately owned company providing IP cores and supporting development tools for embedded processors based on the SPARC architecture. The key product is the LEON synthesizable processor model together with a full development environment and a library of IP cores (GRLIB). Our personnel have extended design

experience, and have been involved in establishing European standards for ASIC and FPGA development. [VHDL]

Web. http://www.gaisler.com/
Score. 2

GateRocket, Inc.

GateRocket offers the industry's first Device Native verification solution for Field Programmable Gate Arrays (FPGAs). This product can cut in half the time it takes to develop the electronic products that enrich our lives every day. As FPGAs become larger and ever more complex, electronic design engineers face a crisis in their inability to adequately verify and test these advanced designs. GateRocket provides a new, Device Native...

Web. http://www.gaterocket.com/
Score. 3

GDA Technologies Inc.

GDA Technologies Inc. is a leading Electronic Design Services (EDS) and Silicon Intellectual Property (SIP) having extensive experience with Freescale PowerQUICC, PowerPC, and i.MX architectures for the embedded, networking, and consumer electronics markets. GDA specializes in designing ASICs, FPGAs, IPs, boards, SoCs, software and complete systems from concept to product. GDA is part of the L&T Infotech Product Engineering Services (PES)...

Web. http://www.gdatech.com/
Score. 3

HDL Works

HDL Works develops and markets high-performance, intuitive front-end design tools for complex HDL design across a wide spectrum of applications. The software products focus on 'Graphical HDL Design Entry', 'Design Exploration' and 'Design Navigation'. All tools available on UNIX, Linux and Windows. HDL Works currently holds EASE, HDL Companion, and Scriptum...[FPGA, ASIC, VHDL, Verilog]

Web. http://www.hdlworks.com/
Score. 2

HyWire

HyWire provides high-performance, low-cost solutions for switching and routing equipment. Its products include: Search Engines, Event Monitor / Accumulator, Event Monitor / Accumulator, Evaluation and Tester Boards, and Software Tools and Drivers. Their solutions are offered as soft macros, either stand-alone to be embedded in a customer's SoC/FPGA or as a standard product EGA/ASIC [FPGA IP-core]

Web. http://www.hywire.com/
Score. 2

Impulse Accelerated Technologies, Inc.

Impulse C and CoDeveloper - Create applications using ANSI C and compile to FPGA-based platforms. Create hardware accelerators for key algorithms and perform iterative,

interactive optimizations for increased performance. Identify bottlenecks and partition code between FPGA hardware and software. Automatically generate interfaces for popular FPGA embedded processors. Outputs are compatible with Xilinx, Altera or Synplicity tools. From $2,700/yr.

Web. http://www.impulsec.com/
Score. 2

M2000

FlexEOS Configurable IP Cores from M2000 bring unique flexibility to SoC design by combining the advantages of both ASIC and FPGA technology into a single device. M2000 supplies the FlexEOS range of embedded FPGA (e-FPGA) macros. Each of these advanced technology products comprises an e-FPGA hard macro plus automatic software to generate the bitstream file which configures the e-FPGA with a specific application.

Web. http://www.m2000.fr/
Score. 2

Magillem Design Services

Magillem IDE is a IP-XACT tool suite providing to systems designers an integrated development environment to create and configure platforms. MDS helps its clients to audit their own design process, to customize the Magillem software and to adapt it to their flow requirements. MDS' clients are semiconductors manufacturers (Asics, Assps), system integrators and information technology companies engaged in the research... [EDA, FPGA, ESL and RTL]

Web. http://www.magillem.com/
Score. 2

Mentor Graphics Corporation

Mentor Graphics® is a technology leader in electronic design automation (EDA), providing software and hardware design solutions that enable companies to develop better electronic products faster and more cost-effectively. The company offers innovative products and solutions that help engineers overcome the design challenges they face in the increasingly complex worlds of board and chip design. [FPGA, ASIC, Embedded]

Web. http://www.mentor.com/
Score. 5

Mirabilis Design

VisualSim enables quick performance analysis, power evaluation and architecture exploration for the design of electronics and real-time software. VisualSim is used for designing Large Complex Systems, ICs, Processors, FPGA, Real-Time Software and Network Systems. VisualSim is a graphical modeling and simulation environment. Models of the proposed system are constructed by engineers in VisualSim using parameterized modeling library and...

Web. http://www.mirabilisdesign.com/
Score. 3

Modelware

Modelware is a leading provider of semiconductor intellectual property (SIP) cores for telecom and networking ASIC and FPGA applications. Its highly scalable products provide semiconductor and system OEM customers a compelling value and enable them to bring standards-compliant products to market faster. Modelware also offers standard-bridging products that provide interoperability solutions between different interface standards. [ATM, Ethernet]

Web. http://www.modelware.com/
Score. 2

nSys

Leverages a large portfolio of Verification IPs it has developed, to provide products and services that Accelerate Designs for ASIC, FPGA or IP. Developers using the nVS family of Verification IPs benefit from proven BFMs, Monitors, Checkers and Test Suites by quickly verifying their designs while lowering costs as well as risks. The nVS are available in SystemVerilog and Verilog for standard interfaces. [ARM, Ethernet, Intellectual Property]

Web. http://www.nsysinc.com/
Score. 2

Orange Tree Technologies Ltd

Orange Tree Technologies are leaders in hardware and software products and design services for the high performance embedded computing markets. We are specialists in high speed digital design including the use of programmable logic (FPGAs and CPLDs) for digital signal processing. [VHDL, Verilog, Xilinx, PCI, PMC and USB]

Web. http://www.orangetreetech.com/
Score. 2

PLDA

PLDA, the largest provider of IP cores for the logical and transport layers of PCI, PCI-X and PCI Express (The Linley Group, Apr 2006), designs and sells a wide range of ASIC, structured ASIC and FPGA interfacing solutions for the PCI Express, PCI, PCI-X, and derivative protocols. The company offers complete solutions, including IP cores, hardware, software, and comprehensive technical support provided directly by the IP designers.

Web. http://www.plda.com/
Score. 3

Poseidon Design Systems, Inc

Poseidon Design Systems provides innovative Electronic System Level (ESL) solutions for embedded system design. Poseidon offers breakthrough technologies in hardware/software analysis, co-simulation, and hardware synthesis to help reduce the complexity and cost of designing Systems on Chips (SoCs) and Systems on FPGA's.

Web. http://www.poseidon-systems.com/
Score. 2

PrismTech

Optimized real-time & embedded CORBA middleware technologies to sectors including software defined radio, military, aerospace & telecommunications. PrismTech's OpenFusion product suite provides embedded & real-time ORBs & CORBA Services with wide language (C, C++, Java, Ada) & platform support. The small size & optimized architecture of the OpenFusion e*ORB SDR products . . . [FPGA]

Web. http://www.prismtechnologies.com/
Score. 2

RF Engines Ltd (RFEL)

Electronics design and IP (Intellectual Property) company specialising in the development of high performance digital signal processing (DSP) techniques and the development of new products. Provide individual IP Cores and System-Level Cores for Xilinx and Altera FPGAs, intended for use in high performance radio systems, and other signal processing based designs. The company also provides products and complementary System Design and... [RF]

Web. http://www.rfel.com/
Score. 3

Samplify Systems

Samplify's high-speed FPGA-based compression dramatically improves system performance, reduces design complexity, and lowers system cost. Samplify's portfolio of patented algorithms compress and decompress signals in real time with lossless, fixed-rate, and fixed-quality options. Samplify breaks data transfer and storage bottlenecks across a wide-range of embedded applications including COTS, military, medical imaging, homeland security,...

Web. http://www.samplify.com/
Score.

Synplicity, Inc.

Innovative synthesis, verification, and physical implementation software solutions for designers of programmable logic, ASICs, Structured / Platform ASICs, and SoCs. The industry's most widely used FPGA synthesis solution, Synplify Pro uses a true timing-driven approach to synthesis. All products support industry-standard design languages (VHDL and Verilog) and run on most popular computing platforms.

Web. http://www.synplicity.com/
Score. 5

Systemyde International Corporation

Develops Intellectual Property (IP), in the form of synthesizable Verilog HDL models. They specialize in Z80 and Z180-compatible microprocessors and peripheral controllers, although we have a broad range of design experience. Their Verilog HDL models can be used in FPGA, ASIC or full custom implementations.

Web. http://www.systemyde.com/
Score.

Tektronix, Inc.

Tektronix, Inc. is a test, measurement and monitoring company providing measurement solutions to the telecommunications, computer and semiconductor industries worldwide. Tektronix enables its customers to design, build, deploy and manage next-generation global communications networks and Internet technologies. [oscilloscopes, probes, logic analyzers, mobile protocol analyzers, spectrum analyzers. FPGA test and debug]

Web. http://www.tektronix.com/
Score. 4

Temento Systems S.A.

Temento Systems S.A.is an innovative provider of Test, Debug and Verify Solutions for FPGA, System On Chip (SoC), Boards and Hardware Platforms. Temento Systems products are used by different functional teams (Development, Industrialization, Manufacturing, Maintenance) and in major companies from various industrial sectors worldwide : Semi-conductor, Telecommunications, Consumer Electronics, Computer, Automotive, Aerospace.

Web. http://www.temento.com/
Score. 3

Terasic

Terasic Technologies is the leading provider in high-performance hardware and software solutions for FPGA/ASIC prototyping, multimedia and image processing markets. Terasic has created many FPGA boards for Altera including DE2, DE1, Cyclone® II Starter Kit, and the new Cyclone® III Starter Kit. Headquartered in Taiwan, Terasic Technologies is committed to serve global customers well and provide highly optimized FPGA systems for the highest...

Web. http://www.terasic.com.tw/
Score. 3

TransEDA

TransEDA is a leading provider of integrated verification solutions for SoC, ASIC and FPGA designs. TransEDA Solution is an integrated design verification and verification measurement environment with tools that perform code & assertion coverage analysis, coverability analysis, static property checking, test suite optimisation and configurable HDL checking. In addition TransEDA provide verification IP and transistor abstraction tools.

Web. http://www.transeda.com/
Score. 2

True Circuits, Inc.

True Circuits offers a complete family of standardized clock generator, deskew, low-bandwidth, spread-spectrum adn high resolution PLLs and DDR DLLs that spans nearly all performance points and features typically requested by ASIC, FPGA and SoC designers. These hgih-quality, low-jitter, silicon-proven timing hard macros are availabel for immediate delivery in a range of frequencies, multiplication factors, sizes adn functions in TSMC, UMC...

Web. http://www.truecircuits.com/

Score. 2

Ultimodule, Inc.

Ultimodule offers embedded building blocks, for prototyping to volume production, with hardware, software, and pre-configured IPMix designs. Smart Controller Modules are complete systems with FPGA, CPU, memory, peripheral control and OS. IP blocks are packaged in different IPMix designs, and downloading a selected IPMix design into an FPGA creates a system that is optimized to fit a specific application.

Web. http://www.ultimodule.com/
Score. 2

Verific Design Automation Inc.

Verific Design Automation Inc. develops and sells source code (C++) Verilog, SystemVerilog, and VHDL front-ends (parsers, analyzers, elaborators) as well as a generic hierarchical netlist database for EDA applications. Applications include FPGA synthesis, Model Checking, Functional Verification, Hardware Acceleration, RTL Debug, Logic Equivalence Checking, RTL Floorplanning, HDL Entry, and Design for Test

Web. http://www.verific.com/
Score. 2

3L

3L provides development tools for multiprocessor systems built from combinations of DSP and FPGA modules. Diamond DSP and Diamond FPGA (RTOS) are 3L's main products, simplifying application development on TI C6000 processors and Xilinx FPGAs.

Web. http://www.3l.com/
Score. 2

APPENDIX E: FPGA BOARD VENDORS

Appendix E: FPGA Board Vendors

FPGAs are frequently employed directly in boards. Sometimes these are deployable boards, and other times they are used for ASIC prototyping. This Appendix identifies FPGA board vendors with links to their websites for more information. Note: Rating information is a very rough indication of company size, frequency of news updates, and relevance to practical embedded systems designers.

Acromag, Inc.

Acromag provides embedded I/O solutions for measurement and control applications. Bus boards are available for VME, PCI, CompactPCI, Industry Pack, and PMC module formats. Functions include re-configurable FPGA computing, analog I/O, digital I/O, counter/timers, and serial communication. Signal conditioners and fieldbus I/O provide Ethernet, Modbus, Profibus, and 4-20mA interfacing.

Web. http://www.acromag.com/
Score. 4

ACT/Technico

ACT/Technico is a leading supplier of integrated real-time and embedded systems using CompactPCI, VMEbus, mezzanine form factora and other platforms. We support several RTOS, Linux and Windows. ACT/Technico is also a manufacturer and reseller of real-time and embedded hardware and software such as PMC modules, CompactPCI Adapters and Mass Storage modules. [FPGA, I/O Solutions, rugged]

Web. http://www.acttechnico.com/
Score. 3

Alpha Data

Alpha Data is at the forefront of the new wave of reconfigurable computing, providing leading-edge hardware and software solutions. Industry-standard products harness the power of the latest Xilinx Virtex-II and Virtex-II Pro FPGAs to provide flexible solutions for computer-intensive applications. Leading edge products are available for PCI, PCI-X, PMC, CompactPCI and VME under WindowsNT/2000/XP, VxWorks and Linux. [Xilinx Virtex-5 support]

Web. http://www.alpha-data.com/
Score.

AMIRIX

AMIRIX is a leading provider of PCI and PCI/e Platform FPGA Development Boards, as well as standard and custom deriviative reference designs, for researchers and OEMs looking to develop embedded FPGA System-on-a-Chip (SoC) solutions using Xilinx's most advanced programmable logic devices. AMIRIX also provides custom electronic design services for the embedded industry to help companies develop new products and enhance existing ones.

Web. http://www.amirix.com/
Score. 2

Annapolis Micro Systems, Inc.

World leader in COTS FPGA-based High Performance Processing Products for radar, sonar, SIGINT, ELINT, Digital Signal Processing, FFTs, communications, software radio, encryption, image processing, prototyping, text processing and other processing intensive applications. We have COTS hardware and software solutions for VME, PCI, CompactPCI, PMC, PMCIA and CardBus, with a large, growing list of I/O options. [Xilinx Solutions, rugged]

Web. http://www.annapmicro.com/

Score. 2

BittWare, Inc.

From Digital Signal Processing, to I/O interfaces, to IP cores and software tools, at BittWare you'll find the building blocks you need for your signal processing applications. Whether your application is in the defense, communications, life sciences, or instrumentation sectors, BittWare has the expertise and experience you need [DSP, FPGA, TigerSharc, Analog Devices, AMC, PMC, PCI, CompactPCI, and VME]

Web. http://www.bittware.com/
Score. 4

CorEdge Networks

CorEdge Networks is a leading supplier of ATCA/MicroTCA/AMC/IPMI compliant infrastructure products including the industry's first MicroTCA Carrier Hub (MCH), 10GbE MCH, MicroTCA Power Module, PicoTCA development platform, 10Gbps and 20Gbps FPGA-based AMCs and full ATCA Cutaway Carrier. CorEdge Networks customers include a number of leading telecom, military and embedded systems companies. [AdvancedTCA, MicroTCA, AMC]

Web. http://www.coredgenetworks.com/
Score. 2

Dini Group

The Dini Group brings extensive knowledge and expertise to the following areas: ASIC and FPGA Designs; Design Cost Reduction; Embedded systems hardware and software design; Hardware Description Languages: AHDL, VHDL and Verilog; High Speed digital, analog, and integrated circuit design; Performance Improvement; Real time operating system software design; Windows 3.x, 95, and NT, DOS, and other O/S software and driver design [Xilinx, Altera, FPGA]

Web. http://www.dinigroup.com/
Score. 2

DLP Design

Add USB to your next project - it's easier than you might think. This company focuses on easy-to-use tools for designing in USB. Products include: USB adaptors, USB Security Dongles, deveopment boards, USB to RS232 and USB to Serial (TTL Level) Cables, Modules and Adapters, Temperature Humidity Sensor, Microcontroller FLASH Programmer, Prototyping Board, USB to RS232 Converter Module, RFID products, RF Transceivers, FPGA products,...

Web. http://www.dlpdesign.com/
Score. 2

EnTegra

EnTegra provides hardware and software products and services for real time implementation of systems from DSP through to RF. Development tools include the SystemView simulation environment, providing a powerful RF and DSP development platform for embedded signal processing design. The wide range of integrated COTS hardware for I/O and DSP on ISA, PCI, cPCI, and single board formats...[FPGA, training]

Web. http://www.entegra.co.uk/
Score. 3

Eridon Corp.

Eridon is defining the emerging field of Embedded Computing Objects where self-integrating subsystems consisting of circuit designs, supporting electronic logic, and software drivers become simple units that are easily and automatically assembled into production-ready designs. Eridon's UnifiedLogic framework dramatically reduces time-to-market and development risk through its ... [FPGA, PCB, Board Design]

Web. http://www.eridon.com/
Score. 3

Gidel

Family of FPGA-based systems for algorithm development and debug and for embedded algorithm acceleration. The FPGA boards and a family of user configurable, multiple-board FPGA systems are used for high-speed SoC verification. GiDEL software tools and memory IPs enable rapid implementation and debugging of C/C++ or model-based algorithms or HDL-based chip designs in the reconfigurable hardware. [ASIC, emulation, prototyping]

Web. http://www.gidel.com/
Score. 3

Hunt Engineering

FPGA and DSP Hardware for Programmable Real-Time Systems from Hunt Engineering. Modular systems for PCI/cPCI/USB based and embedded use, high performance and designed for real-time. Systems are programmable and reconfigurable, using common APIs to provide compatibility and complete flexibility. Configure your custom system using modules with Xilinx Virtex-II or Virtex-4 FPGA (some with SDRAM), TMS320C6000 DSP and powerful I/O in any combination.

Web. http://www.hunt-dsp.com/
Score. 3

Innovative Integration

Innovative Integration provides state-of-the-art, applied, data acquisition and digital signal processing solutions to a wide spectrum of industries. Products cover the full spectrum of real-time systems: PC-based real-time data acquisition, DSP-based signal processing and hardware-assisted (FPGA) signal processing. Custom designs are offered to OEM seeking an optimum price/performance balance. Platforms supported: PCI, CPCI, PXI [C++]

Web. http://www.innovative-dsp.com/
Score. 2

Kane Computing Ltd

Kane Computing Ltd (KCL) supply and support: * Audio: Development Systems, Compression Algorithms/Boards, Vocoders. * Broadcast: MPEG-4 AVC/H.264 Video Encoding, Off-Line Encoders, PCI Encoder Boards, Chip Sets and SoC Solutions. *

DSP/FPGA: Emulators, DSKs, EVMs, Application Boards, Development Systems, Software, Daughter Cards. * Telecomms: Echo Cancellation, Telephony. * Video Security: Compression Libraries/Boards, DVR/DVS, Reference Design

Web. http://www.kanecomputing.co.uk/
Score. 3

Lyrtech Inc.

Lyrtech has more than 20 years of experience in the delivery of advanced digital signal processing solutions to companies worldwide. Serving clients across the Americas, Asia, and Europe, Lyrtech offers a full range of DSP-FPGA development platforms, as well as design, prototyping, and manufacturing of electronic products. The company works in partnership with industry leaders such as Texas Instruments, The MathWorks, and Xilinx....

Web. http://www.lyrtech.com/
Score. 4

Mango DSP, Ltd.

Mango DSP is a leading provider of high-performance embedded multiprocessing system solutions for Automated Optical Inspection (AOI), Video, Medical Imaging, Defense and other OEM cutting-edge systems. Combining the latest in DSP and FPGA technologies, Mango DSP offers its customers complete solutions, introducing a new level of customer service in the embedded systems market.

Web. http://www.mangodsp.com/
Score. 4

Mercury Computer Systems, Inc.

Commercial and rugged VME, PCI and cPCI systems provide high-density computation using PowerPC microprocessors, FPGAs, RACEway Interlink, the new standard RapidIO switch fabric architecture, and a complete software development environment. Multicomputers process real-time radar, sonar, and signals intelligence data in military reconnaissance and surveillance platforms; and data in medical diagnostic imaging and semiconductor imaging applications.

Web. http://www.mc.com/
Score. 3

Micro Memory Inc.

CoSine - Bridging two high speed interfaces (Serial RapidIO, PCI-X, or PCI-Express) through a multi-port DDR controller, CoSine is a fully integrated System-On-Chip for FPGA processing. Othello Vme Carriers - Othello carriers include two high speed mezzanine sites (PMC or XMC) and optional connectivity to backplane switch fabrics such as StarFabric, RACE++, and Serial RapidIO.

Web. http://www.micromemory.com/
Score. 3

Minford Technology

Minford Technology is an electronics company specializing in designing of embedded systems, FPGA and CPLD application. We provide leading embedded sytem development tools, development board. and experience that are needed when developing complex functions in resource-constrained embedded systems.

Web. http://www.minford.ca/
Score. 2

Nallatech

Nallatech is a technology leader in FPGA technology and high performance reconfigurable computers. Building on the worldwide success of its award-winning modular standard, DIME, Nallatech's product line allow users to harness the full capability of advanced FPGAs for DSP, Real-Time Imaging, Scientific Computing, Simulation and Modelling, and Aerospace and Defence applications.

Web. http://www.nallatech.com/
Score. 3

National Instruments

National Instruments builds on industry-standard technology to create real-time, embedded solutions. NI customers can deterministically acquire data and then analyze and present their results across their enterprise or across the Internet using the networked measurement capabilities of NI LabVIEW, a leading graphical programming environment for measurement and automation applications. [data acquisition, test and measurement, FPGA]

Web. http://www.ni.com/
Score. 5

NitAl

NitAl offer rich technology experience through consulting & innovative products in the areas of IEEE 1394A/B, USB2.0 and PCI Express™ technology. Products are evolved from an in-depth understanding of technology, customer interaction & market needs and converting those into high quality products. NitAl's Bus Analyzer, Exercisers and Emulators are used world-wide. PCI Express Design Kit based on Xilinx FPGA is offered for rapid prototyping.

Web. http://www.nital.com/
Score. 2

Opal Kelly Incorporated

Opal Kelly Incorporated, located in Hillsboro, Oregon produces hardware modules for engineers and OEMs with a strong concentration on providing rich software support for their products. The focus on a full software and hardware solution allows Opal Kelly customers to quickly and seamless integrate their products into custom solutions. With extensive expertise in FPGA technology, hardware design, software programming, and embedded systems,...

Web. http://www.opalkelly.com/
Score. 2

Orange Tree Technologies Ltd

Orange Tree Technologies are leaders in hardware and software products and design services for the high performance embedded computing markets. We are specialists in high speed digital design including the use of programmable logic (FPGAs and CPLDs) for digital signal processing. [VHDL, Verilog, Xilinx, PCI, PMC and USB]

Web. http://www.orangetreetech.com/
Score. 2

Pender Electronic Design

Specialised in digital hardware design and board development, VHDL coding and FPGA development hardware. In cooperation with GAISLER RESEARCH in Gothenburg Sweden, our emphasis is on the continuing development, promotion and support for LEON microprocessor designs. Our products include FPGA Development boards designed for large capacity Xilinx FPGA's in both Compact PCI and 'Classic' PCI form factors

Web. http://www.pender.ch/
Score. 2

Pentek

Powerful VME, PMC, XMC, PCI and cPCI boards and development system platforms for data acquisition, software radio and DSP featuring the C6000 DSP, G4 PowerPC and Xilinx FPGAs. Data acquisition line is extensive and includes A/D's, D/A's, digital receivers and upconverters, digital I/O and more. Pentek equips products with high-speed interfaces including Serial Rapid IO, VXS and FPDP and offers strong software development tools. . .

Web. http://www.pentek.com/
Score. 5

Pico Computing, Inc.

Pico Computing designs and manufactures deployable development FPGA solutions in small form factor (Compact Flash, CardBus, ExpressCard). Products are based on the Virtex-4 series of FPGA's and can be used as an embedded device or stand alone. Applications: Cryptography, Embedded Processor, DSP, Software-Defined Radio (SDR), size and weight constrained environments, Encryption/Decryption. Pico also provides consulting engineering services.

Web. http://www.picocomputing.com/
Score. 3

ProDesign

ProDesign is the specialist in high speed hardware assisted design verification and validation for SoC, ASIC and algorithm development. CHIPit describes scalable products for software, firmware and hardware design verification and validation to reduce design time significantly. IMAGEit products, based on Field Programmable Gate Arrays (FPGA) technology, offer tremendous processing capabilities.

Web. http://www.prodesign-usa.com/
Score. 3

Rapid Technology

Rapid Technology specializes in engineering productivity through design services, IP, and development platforms. These products and services provide accelerated time to market. Products offered include: PMC Stratix Board, Stratix High Speed Development Board, ACEX 1K Development Board, Download Cables. Our expertise in FPGA, DSP, and processor architectures, capabilities, and development tools results in the best match of hardware and...

Web. http://www.rapid-technology.com/
Score. 3

Red Rapids (formerly Red River)

Red Rapids supplies products and services to the high performance signal processing and data communication markets. The company specializes in wireless applications with product offerings in FPGAs, RF converters, digital transceivers, signal recorders, and software defined radio components for embedded, desktop and notebook computers. These products are available in VME, CPCI, PCI, PMC, and CardBus formats.

Web. http://www.redrapids.com/
Score. 3

Signalogic, Inc.

Signalogic designs, develops, manufactures, and markets OEM and off-the-shelf embedded systems for voice, video, wireless, control system, audio/acoustic, automation, and data acquisition applications. Products include hardware (board level), software, logic, and real-time algorithms. Many of the company's products involve in some way DSP and FPGA software and hardware, for example Texas Instruments VoIP, video, and wireless chipsets and...

Web. http://www.signalogic.com/
Score. 3

Silicon Turnkey Express (STx)

Division of RPC Electronics, Inc. in order to provide support and design services to semiconductor suppliers for their new microprocessor development systems as well as offering our own branded Original Design Manufacturer (ODM) production ready embedded reference board and software. A[Reference designs, FPGA / ASIC Prototyping Boards]

Web. http://www.silicontkx.com/
Score. 2

Soft dB

Soft dB supplies innovative DSP+FPGA boards based on 55x and 54x TI DSP. Our Signal Ranger DSP boards are cost effective, designed for small production volume, ideal for OEM, development and educational applications. All the development phases: design, prototyping and deployment are performed on the Signal Ranger boards. The USB connexion and the LABVIEW driver provided with the boards facilitate the deployment and the interface with a computer.

Web. http://www.softdb.com/

Score. 2

Sundance Digital Signal Processing Inc.

Sundance leads the world in the design and manufacture of mixed COTS digital signal processing (DSP) and FPGA architectures. Sundance modular and customisable COTS hardware and software systems are easy to reconfigure to suit all high-speed I/O and signal processing applications, enabling the rapid prototyping and development of embedded systems. Designers and manufacturers of wireless infrastructures, satellite communications, industrial...

Web. http://www.sundance.com/
Score. 3

System Level Solutions

Provides solutions for products in enterprise, industrial, automotive and embedded system markets. SLS has an extensive product portfolio of Embedded Operating System, Embedded software, ASIC (Application Specific Integrated Circuit) and PCB (Printed Circuit Board) Solutions. FPGA Development Boards.

Web. http://www.slscorp.com/
Score. 2

Technologic Systems

Technologic Systems produces rugged PC/104 Single Board Computers, based on ARM and x86 processors, and PC104 Peripheral Boards. Our products enable a wide range of embedded applications, including real-time,2 Wi-Fi, CAN bus, GSM & CDMA modems, and DAQ. Our Linux FPGA embedded platform enables hardware/software co-design and custom core development. We support the open-source vision with full documentation, and our software solution...

Web. http://www.embeddedarm.com/
Score. 4

TEK Microsystems, Inc.

Advanced high-performance boards and systems for embedded real-time computing systems. Product line includes advanced carrier boards based on widely adopted industry standards and more than 30 PMC/XMC cards. TEK Microsystems develops, markets and sells high performance PMC I/O modules, I/O carriers, A/D and D/A interfaces, FPGA processors and complete signal processing and data acquisition systems solutions.

Web. http://www.tekmicro.com/
Score. 3

Trenz Electronic

Trenz Electronic supplies Xilinx FPGA and ARM MCU development boards and modules as well as components for industrial control and automation. While focussing on embedded systems in industrial environments and PC based control and measurement systems, the products are accompanied by comprehensive design-in support and engineering design services. Trenz Electronic helps companies to benefit from FPGA technology.

Web. http://www.trenz-electronic.de/
Score. 2

Varisys Ltd

Varisys design and manufacture high performance embedded computer systems along with novel solutions to high performance I/O and routing of analogue and digital data including audio and video. Varisys specialize in applications that require solutions optimized for space, performance, power, and reliability. Military, public transportation, automotive, telecommunications and avionic applications. [FPGA]

Web. http://www.varisys.co.uk/
Score. 2

VMETRO, Inc.

VMETRO provides integrators of high-end embedded computer systems with products and services from development through deployment, at the highest levels of performance, innovation and reliability. Our products range from PowerPC, FPGA and TigerSHARC Digital Signal Processing, FPGA Input and Output Modules, sFPDP IP Core, Data Recorders and Bus Analyzers for PCI, PCI Express, PCI-X, VME, CompactPCI, and PMC.

Web. http://www.vmetro.com/
Score. 4

Appendix F: FPGA / DSP Vendors

One of the most common application areas for FPGAs is DSP. This Appendix identifies vendors that concentrate in FPGAs in the DSP area with links to their websites for more information. Note: Rating information is a very rough indication of company size, frequency of news updates, and relevance to practical embedded systems designers.

APPENDIX F: FPGA / DSP VENDORS

Annapolis Micro Systems, Inc.

World leader in COTS FPGA-based High Performance Processing Products for radar, sonar, SIGINT, ELINT, Digital Signal Processing, FFTs, communications, software radio, encryption, image processing, prototyping, text processing and other processing intensive applications. We have COTS hardware and software solutions for VME, PCI, CompactPCI, PMC, PMCIA and CardBus, with a large, growing list of I/O options. [Xilinx Solutions, rugged]

Web. http://www.annapmicro.com/
Score. 2

Berkeley Design Technology, Inc. (BDTI)

BDTI helps companies create, select, and use DSP technology to achieve key business objectives. BDTI provides assistance with DSP technology: benchmarks; reports on technologies including DSPs, microprocessors, and FPGAs; analysis of architectures including TMS320, SHARC, ARM, and SH; consulting on product roadmaps, technology selection, and competition; and, technical marketing.

Web. http://www.BDTI.com/
Score. 5

Dexcel

Dexcel is in the business of design, development & innovation of embedded software & hardware products for global customers. Our services span system level architecture design & implementation to module level design, verification, validation and testing. Our specialised group that optimises algorithms on various DSP platforms and also creates RTL code of the same for FPGAs or ASICs, provides us the cutting edge in addressing media...

Web. http://www.dexceldesigns.com/
Score. 3

EnTegra

EnTegra provides hardware and software products and services for real time implementation of systems from DSP through to RF. Development tools include the SystemView simulation environment, providing a powerful RF and DSP development platform for embedded signal processing design. The wide range of integrated COTS hardware for I/O and DSP on ISA, PCI, cPCI, and single board formats...[FPGA, training]

Web. http://www.entegra.co.uk/
Score. 3

Hunt Engineering

FPGA and DSP Hardware for Programmable Real-Time Systems from Hunt Engineering. Modular systems for PCI/cPCI/USB based and embedded use, high performance and designed for real-time. Systems are programmable and reconfigurable, using common APIs to provide compatibility and complete flexibility. Configure your custom system using modules with Xilinx Virtex-II or Virtex-4 FPGA (some with SDRAM), TMS320C6000 DSP and powerful I/O in any combination.

Web. http://www.hunt-dsp.com/

Score. 3

Innovative Integration

Innovative Integration provides state-of-the-art, applied, data acquisition and digital signal processing solutions to a wide spectrum of industries. Products cover the full spectrum of real-time systems: PC-based real-time data acquisition, DSP-based signal processing and hardware-assisted (FPGA) signal processing. Custom designs are offered to OEM seeking an optimum price/performance balance. Platforms supported: PCI, CPCI, PXI [C++]

Web. http://www.innovative-dsp.com/
Score. 2

Kane Computing Ltd

Kane Computing Ltd (KCL) supply and support: * Audio: Development Systems, Compression Algorithms/Boards, Vocoders. * Broadcast: MPEG-4 AVC/H.264 Video Encoding, Off-Line Encoders, PCI Encoder Boards, Chip Sets and SoC Solutions. * DSP/FPGA: Emulators, DSKs, EVMs, Application Boards, Development Systems, Software, Daughter Cards. * Telecomms: Echo Cancellation, Telephony. * Video Security: Compression Libraries/Boards, DVR/DVS, Reference Design

Web. http://www.kanecomputing.co.uk/
Score. 3

Lyrtech Inc.

Lyrtech has more than 20 years of experience in the delivery of advanced digital signal processing solutions to companies worldwide. Serving clients across the Americas, Asia, and Europe, Lyrtech offers a full range of DSP-FPGA development platforms, as well as design, prototyping, and manufacturing of electronic products. The company works in partnership with industry leaders such as Texas Instruments, The MathWorks, and Xilinx....

Web. http://www.lyrtech.com/
Score. 4

Mango DSP, Ltd.

Mango DSP is a leading provider of high-performance embedded multiprocessing system solutions for Automated Optical Inspection (AOI), Video, Medical Imaging, Defense and other OEM cutting-edge systems. Combining the latest in DSP and FPGA technologies, Mango DSP offers its customers complete solutions, introducing a new level of customer service in the embedded systems market.

Web. http://www.mangodsp.com/
Score. 4

Pentek

Powerful VME, PMC, XMC, PCI and cPCI boards and development system platforms for data acquisition, software radio and DSP featuring the C6000 DSP, G4 PowerPC and Xilinx FPGAs. Data acquisition line is extensive and includes A/D's, D/A's, digital receivers and upconverters, digital I/O and more. Pentek equips products with high-

speed interfaces including Serial Rapid IO, VXS and FPDP and offers strong software development tools. . .

Web. http://www.pentek.com/
Score. 5

Rincon Research Corporation

At Rincon Research Corporation, our primary business is innovating, developing, and fielding digital signal processing (DSP) products and services for the United States Defense and Intelligence communities in defense of national security. We serve our customers with a range of technologies: * Signals collection, analysis, and processing * DSP systems development * DSP infrastructure development * High-performance electronics... [FPGA based, RF]

Web. http://www.rincon.com/
Score. 3

Signalogic, Inc.

Signalogic designs, develops, manufactures, and markets OEM and off-the-shelf embedded systems for voice, video, wireless, control system, audio/acoustic, automation, and data acquisition applications. Products include hardware (board level), software, logic, and real-time algorithms. Many of the company's products involve in some way DSP and FPGA software and hardware, for example Texas Instruments VoIP, video, and wireless chipsets and...

Web. http://www.signalogic.com/
Score. 3

Soft dB

Soft dB supplies innovative DSP+FPGA boards based on 55x and 54x TI DSP. Our Signal Ranger DSP boards are cost effective, designed for small production volume, ideal for OEM, development and educational applications. All the development phases: design, prototyping and deployment are performed on the Signal Ranger boards. The USB connexion and the LABVIEW driver provided with the boards facilitate the deployment and the interface with a computer.

Web. http://www.softdb.com/
Score. 2

Sundance Digital Signal Processing Inc.

Sundance leads the world in the design and manufacture of mixed COTS digital signal processing (DSP) and FPGA architectures. Sundance modular and customisable COTS hardware and software systems are easy to reconfigure to suit all high-speed I/O and signal processing applications, enabling the rapid prototyping and development of embedded systems. Designers and manufacturers of wireless infrastructures, satellite communications, industrial...

Web. http://www.sundance.com/
Score. 3

Valley Technologies Inc.

Valley Technologies, Inc., (VTI) specializes in the design and development of advanced 'DSP' and 'reconfigurable' hardware and software systems for critical space, airborne and terrestrial applications. VTI excels in porting complex DoD and Communication algorithms to standard and custom FPGA and FPOA arrays providing 'ASIC' like performance at a fraction of the time and at low cost. This compact PCI development system is being integrated...

Web. http://www.valleytech.com/
Score.

3L

3L provides development tools for multiprocessor systems built from combinations of DSP and FPGA modules. Diamond DSP and Diamond FPGA (RTOS) are 3L's main products, simplifying application development on TI C6000 processors and Xilinx FPGAs.

Web. http://www.3l.com/
Score. 2

4DSP

4DSP is a supplier of Digital Signal Processing solutions. 4DSP offers a comprehensive portfolio of data acquisition, DSP, FPGA systems and boards for CompactPCI, PXI, VME, PCI and stand alone platforms. Their FPGA IP cores and DSP libraries are aimed to boost software radio and digital recorder system performances. 4DSP operates as a hardware/software design company, a retailer of COTS products and a service provider.

Web. http://www.4dsp.com/
Score. 3

Appendix G: FPGA Misc. & Services Vendors

Some companies research the FPGA marketplace, while others provide unusual products or services. This Appendix identifies miscellaneous vendors of importance to FPGAs with links to their websites for more information. Note: Rating information is a very rough indication of company size, frequency of news updates, and relevance to practical embedded systems designers.

APPENDIX G: FPGA MISC. & SERVICES VENDORS

Baykal Technology Inc.

Baykal Technology, Inc. is 'The Board Level Design Company' specializing in error free large pin count FPGA / ASIC based complex circuit boards. Our services include: Schematic design , FPGA design and ASIC Verification , PCB design, Software drivers and Board bring up cover all necessary stages of your board level design.

Web. http://www.baykal.com/
Score. 2

Berkeley Design Technology, Inc. (BDTI)

BDTI helps companies create, select, and use DSP technology to achieve key business objectives. BDTI provides assistance with DSP technology: benchmarks; reports on technologies including DSPs, microprocessors, and FPGAs; analysis of architectures including TMS320, SHARC, ARM, and SH; consulting on product roadmaps, technology selection, and competition; and, technical marketing.

Web. http://www.BDTI.com/
Score. 5

Bluewater Systems

Bluewater Systems provides product design services, hardware and software development and project management services. Bluewater Systems has the latest tools for FPGA design, PCB design and layout, software development and debugger and hardware analysis and offers a highly competent and competitve service. Bluewater Systems has a diverse client base. As a centre of ARM expertise we have completed projects for ARM PLC and a number of ARM partners.

Web. http://www.bluewatersys.com/
Score. 3

California Software Labs

California Software Labs (CSWL) is focused on providing specialized software engineering services to technology firms around the globe. Be it Board and System Design, ASIC & FPGA Design, developing device drivers or embedded software for your devices or software applications or management interfaces, CSWL engineers have experience working with technology clients in various vertical and horizontal industry segments. [BIOS]

Web. http://www.cswl.com/
Score.

Capitol Automation, Inc.

Capitol Automation provides designers, OEMs and IT professionals with embedded, wired, network and wireless connectivity solutions. Software and hardware development tools for 8, 16, 32 bit and ARM. [Moxa, FPGA support]

Web. http://www.capitolautomation.com/
Score.

CG-CoreEl Programmable Solutions

CG-CoreEl offers design services in the area of FPGA design, Embedded Design, PCB Design & ASIC design with emphasis on quality deliverables. Our offerings are designed to function with minimal customer involvement, and the process ensures flawless and timely delivery be it designs starting from specifications or point services.

Web. http://www.coreel.com/
Score. 3

Comit Systems, Inc.

Founded in 1992, and a pioneer in the area of Contract Engineering, Comit Systems works closely with Fortune 500 companies and start-ups alike, helping realize specs to products. Comit provides a comprehensive range of electronic engineering services, including all FPGA and deep sub-micron SoC/ASIC design services from specs to GDS-II, High-speed complex board designs, Embedded software including protocol stacks and device drivers, and...

Web. http://www.comit.com/
Score. 3

Dallas Logic

Dallas Logic is located in Plano, Texas, USA. Serves the Dallas/Fort-worth area and the internet community at large with electronic design and prototype delivery services. Dallas Logic is a relatively new company that operates with a 'lean and expedient' operating philosophy. We utilize efficient development strategies which translates to lower development costs for you. [FPGA, VHDL, Verilog]

Web. http://www.dallaslogic.com/
Score. 3

DSPlogic, Inc.

DSPlogic is a leading provider of programming tools and services for hybrid FPGA computing systems, including both embedded systems and high-performance computing platforms. We specialize in FPGA-based Software Acceleration, High Performance Reconfigurable Computing (HPRC) and Digital Signal Processing (DSP) tools, algorithms and implementations for applications such as bioinformatics, wireless communications, financial modeling, image...

Web. http://www.dsplogic.com/
Score. 2

DSR Management Inc.

DSRM Embedded Solutions Group provides hardware and software design services relating to PIC, AVR, ARM and NIOS processors. Microchip consultants with extensive experience in communication IP, sensors, interfacing, precision analog circuit, high speed digital circuit, PCB Design, FPGA, PIC control, FFT, signal integrity analysis, DFMEA, EMC compliance and testing.

Web. http://www.dsrminc.com/
Score.

Embedded Wireless Labs

Research and development laboratory with the financial, entrepreneurial and management expertise to develop innovative products for the telecommunications and wireless markets. EWL develops products from concept to commercialization. It integrates cross-disciplinary engineering capabilities in software and hardware. EWL's cross-disciplinary development teams possess multiple capabilities in digital hardware design, RF design, ASIC/FPGA...

Web. http://www.embeddedwireless.com/
Score. 2

Emulation Technology

ET offers a range of products including BGA socket systems, QFN/MLF test sockets, MICTOR test accessories, spring-probe test clips, programming adapters, prototyping adapters, ASIC and FPGA development systems, wireless products, high speed board to board interconnects as well as soldering iron systems and other lab and rework accessories.

Web. http://www.emulation.com/
Score. 3

EnTegra

EnTegra provides hardware and software products and services for real time implementation of systems from DSP through to RF. Development tools include the SystemView simulation environment, providing a powerful RF and DSP development platform for embedded signal processing design. The wide range of integrated COTS hardware for I/O and DSP on ISA, PCI, cPCI, and single board formats...[FPGA, training]

Web. http://www.entegra.co.uk/
Score. 3

Evatronix S.A.

Evatronix develops electronic virtual components (IP cores) and offers VHDL & Verilog model development services as well as FPGA design services (Altera & Xilinx) and development of hardware & software for embeded systems. Products range from microcontroller cores based on legacy instruction set architectures like Z80, 68000, 80186 with best selling 8051 compliant microcontroller cores family, through serial bus interfaces (USB, I2C, Firewire...

Web. http://www.evatronix.pl/
Score. 2

GDA Technologies Inc.

GDA Technologies Inc. is a leading Electronic Design Services (EDS) and Silicon Intellectual Property (SIP) having extensive experience with Freescale PowerQUICC, PowerPC, and i.MX architectures for the embedded, networking, and consumer electronics markets. GDA specializes in designing ASICs, FPGAs, IPs, boards, SoCs, software and complete systems from concept to product. GDA is part of the L&T Infotech Product Engineering Services (PES)...

Web. http://www.gdatech.com/
Score. 3

Inicore Inc.

INICORE is a system design house providing FPGA and ASIC design services using state of the art technologies, tools and methodology. Our expertise is system-on-chip design, from concept to fully tested silicon. It is INICORE's primary objective to provide our customers with competitive advantages by using IP for a fast and reliable product development and by delivering first-time-right silicon. Some IP samples: CAN, CPU, SPI, UART, VME, DSP

Web. http://www.inicore.com/
Score. 2

Intrinsix

Intrinsix is an IP-Enabled Electronics Design Solutions company. We architect, design and verify high integration devices and systems using digital, analog, mixed-signal and RF ASIC, System-on-Chip (SoC) and FPGA technologies while leveraging our cutting edge IP.

Web. http://www.intrinsix.com/
Score. 2

iWave Systems Technologies

iWave Systems Technologies is an embedded hardware and software turnkey design services company, focused on providing integrated solutions for developing innovative products and systems in the areas of data communication, consumer electronics, and multimedia. i Offer comprehensive design solutions in areas of ASIC, FPGA and HDL as well as RTOS/Kernel, DSP Algorithms, Firmware, Bus based HW platforms.

Web. http://www.iwavesystems.com/
Score. 3

Kawasaki Microelectronics America, Inc.

K-Micro is in advanced yet affordable ASIC technology. The company's innovative technologies and world-class design support are used in the consumer electronics, computer, office-automation, networking and storage markets. Offer Broad IP portfolio, including ARM, MIPS, Ceva DSPs, StarCore DSPs, Sonics, SafeNet, Embedded TCAM, SPI4.2; as well as Low-power design techniques, including voltage islands and clock gating. [FPGA conversion, ASSP]

Web. http://www.k-micro.us/
Score. 2

Logic Product Development

Logic is a consulting service and Embedded Product Solutions (EPS) provider capable of propelling your ideas to successful, market-defining products. The EPS line of products includes development kits; product-ready single-board computers, based on Sharp and Renesas 32-bit RISC processors; and board support packages for Windows CE and Linux. Also offer FPGA/DSP and PCB design and layout. [ARM, ColdFire, PowerQICC, SuperH, x86, xScale]

Web. http://www.logicpd.com/
Score. 3

Microtronix

Embedded hardware and software engineering company that provides products and services around programmable logic, intellectual property, embedded operating systems and Development tools. Today, we continue to lead the industry with innovations like AMATPS, X.25/TCP Gateway and SMDI/SIP solutions. Provides a turnkey design-development service, with proven expertise in taking products from initial concept through to production. [FPGA]

Web. http://www.microtronix.com/
Score. 3

Millogic Ltd

Experience encompasses all phases of the development and delivery of high-speed logic designs, the implementation of 16/32/64 bit microprocessors, the design of high performance FPGAs, ASICs, DSPs, PCI and SCSI interfaces, complete board layout services, Linux, native software development on proprietary hardware, and varied targets such as TI dsp and 405gp ppccode development, VMEbus, and custom drivers. [microcode, Unix, VME interface, PCI-X]

Web. http://www.millogic.com/
Score. 2

Multi Video Designs (MVD)

MVD develops image processing applications and other electronic circuit boards. These include both PCI boards and boards for fast ASIC prototyping using Xilinx FPGAs. In addition, MVD offers expert services and industry recognised trainings for Xilinx FPGA development, PowerPC IBM and FREESCALE processors, digital buses and Wind River embedded software. Public training courses are given in French language only.

Web. http://www.mvd-fpga.com/
Score. 2

North Pole Engineering, Inc.

North Pole Engineering provides businesses with software and hardware consulting services and products. NPE manufactures embedded controllers, programmers, demo platforms, and IP cores. And NPE provides consulting services for ASIC, FPGA, software, and embedded design. Our programming staff has a wide range of experience in Linux, Microsoft Windows applications and device driver design, and in embedded microprocessor-based design using...

Web. http://www.npe-inc.com/
Score.

NovTech, Inc.

NovTech offers a wide range of products, services, and expertise. We have a 'can do' attitude, and we complete your work quickly to shorten your development cycle. Our services run the gamut from a single PAL design to the entire development cycle for a complete hardware/software product.Areas of expertise include: Embedded computing, Microcontrollers, PC motherboards, PC peripherals, Logic design (FPGA, CPLD), Telephony Networking

Web. http://www.novtech.com/
Score. 2

Nuvation

Nuvation was founded in 1997 in San Jose, CA. From its inception, Nuvation's expansion to a multi-million dollar engineering consultancy was accomplished without benefit of outside financing. We provide project-based design services including: * Board Design * Signal Integrity Consulting * FPGA and Structured ASIC Design * Firmware for DSP, MCU, NPU, and GPU devices * RTOS, Device Drivers, and APIs * Turnkey Product Realization

Web. http://www.nuvation.com/
Score.

RealFast

RealFast combines consulting services and education within the field of electronics together with product development and buisiness support. Our experienced designers will provide complete PCB designs starting from an idea to a tested product. We also have many years of experience in the areas VHDL, Verilog, FPGA, PLD, ASIC design and test or verification. Also offers IP components (UDP, SDRAM-contoller). [XILINX]

Web. http://www.realfast.se/
Score. 2

Siconix Inc.

Siconix Inc. provides professional electronic design services that specialize in new product and prototype development. Siconix provides experience in all facets of product development whether it is specialized RF, digital signal processing, real-time embedded systems or simply re-design, cost reduction and manufacturing optimization needs. We provide complete FPGA VHDL development and simulation using Altera and Xilinx development tools....

Web. http://www.siconix.com/
Score. 3

Silicon Logic Engineering, Inc. (SLE)

Silicon Logic Engineering, Inc. (SLE) , a wholly owned division of Tundra Semiconductor Corporation, specializes in high-end, right-first-time design services that address all aspects of digital ASIC, FPGA, and semiconductor system design services. SLE also offers product development consulting services for teams that need assistance with thier complex IC project and high-end semiconductor intellectual property.

Web. http://www.siliconlogic.com/
Score. 3

SoftJin

Electronic Design Automation (EDA) software services company developing customized EDA tools for specific requirements of semiconductor and EDA product companies across geographies. SoftJin offers high end, platform FPGA design and implementation services for the purposes of FPGA based system design and SoC/ASIC prototyping. SoftJin has

expertise and experience in developing tools that span the entire design spectrum including System design...

Web. http://www.softjin.com/
Score. 2

Technically-Speaking Inc.

Welcome to Technically-Speaking Inc., the premier training organization for VHDL Verilog, Xilinx & related EDA tools. Training provider for VHDL, Verilog, and FPGA design language learning. Technically Speaking offers multimedia HDL courses, course development and on-site delivery of training for digital designers. [FPGA Training]

Web. http://www.technically-speaking.com/
Score.

Tekmos

Tekmos is a semiconductor company that designs and manufactures replacements for older microprocessors, ASICs, FPGAs, and memories. Using our merged design technology, along with a modular processor implementation and our own 0.35u gate arrays with analog features allows us to replace most chips with exact package and code compatibility.

Web. http://www.tekmos.com/
Score. 3