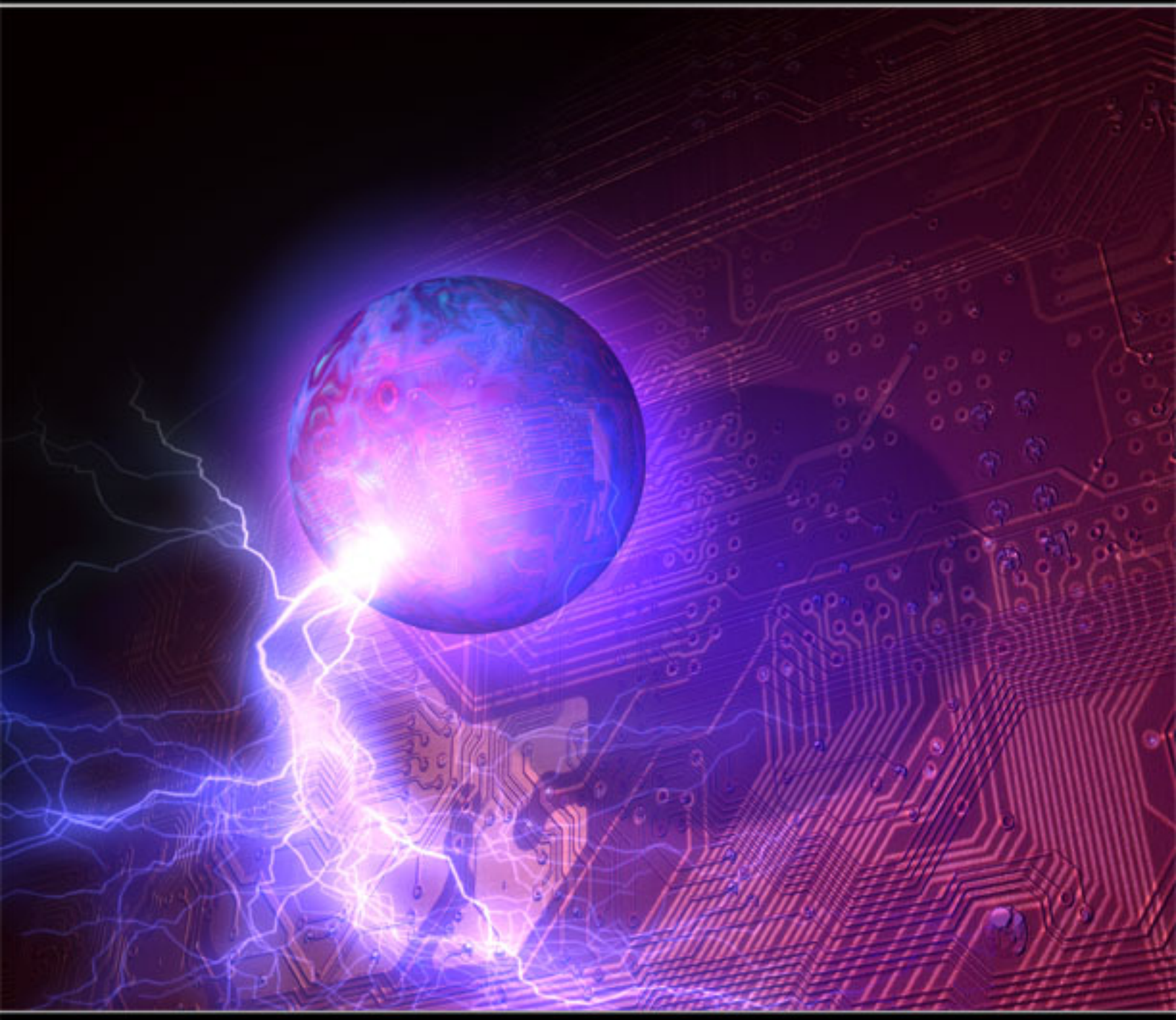
INSIDERS' GUIDE:

FPGAs, Tools, and Boards



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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
- FPGA Design Services

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." (http://www.humorsphere.com/movie_quotes/woody-allen.htm, 16 October 2008). 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 get your design started.

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 wrestling with many of the issues common to FPGA newcomers. We shall call the first group "experts" and the second group, "newbies."
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> **Insider Group #2**: the *vendors* of FPGA technologies. Companies like **Xilinx, Altera, Lattice;** software vendors like **Aldec, Altium**, or **Mentor Graphics;** board makers like **National Instruments, Bittware, Vmetro,** 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

In addition, this year we have a special focus on "design services" for FPGAs. There are more and more design service companies, eager to help you with your FPGA-based design, and we hope both to identify the universe of possible design partners as well as help you think through the pro's and con's of "outsourcing" all or part of yoru FPGA design.

Finally, the members of the FPGA vendor community will surely 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 and managers 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* (http://www.google.com/search?hl=en&q=FPGA) returns over 10,100,000 results. The #4 result is an outdated site at the University of Idaho, and the #2 result is *fpga4fun.com*, a useful but basic hobbyist site (10 September 2008).

> **Google** provides a sheet quantitative breadth of information, but with little organization. This guide, in contrast, seeks to approach the topic of FPGAs in an organized way, and help orient you to understand the FPGA ecosystem and the actors within it as well as the available sources of design information.

To use a real world example - 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 (http://www.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.

(http://www.altera.com/technology/embedded/fpgas/emb-why-use.html, 10 September 2008).

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

(http://www.xilinx.com/esp/, 10 September 2008).

Our survey (see below) confirms that these are 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, area, and cost requirements of today's portable electronics. Based on the Actel nonvolatile flash technology and single-chip ProASIC3 FPGA architecture, the 1.2 V to 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 620 user I/Os. (http://www.actel.com/products/igloo/, 10 September 2008).

In fact, don't miss their July, 2007, white paper, "The New 'Power-Smart' Power Paradigm at http://www.actel.com/documents/PowerSmart_WP.pdf.

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 *Hawaii Vacations / Maui*). 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.

Best 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** (http://www.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 - http://www.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** (http://www.dsp-fpga.com/) - online magazine from **Open Systems Publishing**, focusing most on FPGA boards and DSP issues.

(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.

- **Xilinx** (http://www.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.

Another vendor targeting the FPGA market with a "non-FPGA" out-of-the-box product is **Cypress Semiconductor** (http://www.cypress.com). "Cypress' PSoC(R) Mixed-Signal Arrays are programmable systems-on-chips 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 with a microcontroller, saving customers design time, board space, power consumption, and from 5 cents to as much as $10 in system costs" (http://www.cypress.com/products/?gid=13&fid=24&GoGatewayCategoryID=PSoC&, 12 September 2008).

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	http://www.actel.com/products/software/.
Altera	http://www.altera.com/products/software/sfw-index.jsp
Lattice	http://www.latticesemi.com/products/designsoftware/index.cfm
Xilinx	http://www.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** (http://www.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. (http://www.eg3.com/shorturl/fpga1.htm 12 September 2008)

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 http://www.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** (http://www.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** (http://www.mentor.com/) - Mentor Graphics is a technology leader in electronic design automation (EDA), providing software and hardware design solutio ns 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

(http://www.mentor.com/products/fpga_pld/fpga_advantage/index.cfm 12 September 2008)

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 the more prominent vendors.

Agility Design Solutions Inc. (http://www.agilityds.com/) - Agility speeds the development of signal processing algorithms offering complete solutions for algorithm acceleration, prototyping and implementation in both software and hardware. The solutions include Agility's unique software technologies for MATLAB to C and C to FPGA synthesis and a rich portfolio of synthesizable algorithmic functions and FPGA hardware platforms. Agility completes the solutions with services delivered by a team of...

Aldec, Inc. (http://www.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.

CriticalBlue (http://www.criticalblue.com/) - 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.

Dynalith Systems Co., Ltd. (http://www.dynalith.com/) - 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)...

EVE (Emulation & Verification Engineering) (http://www.eve-team.com/) - 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. . .

GateRocket, Inc. (http://www.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...

Mirabilis Design (http://www.mirabilisdesign.com/) - 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...

Synplicity, Inc. / Synopsys (http://www.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.

Temento Systems S.A. (http://www.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.

Consult *Appendix D* for a full list of FPGA tool vendors).

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** (http://www.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** (http://www.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** (http://www.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** (http://www.ChipEstimate.com/) - Now owned by **Cadence**, 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 http://www.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	http://www.actel.com/products/ip/default.aspx
Altera	http://www.altera.com/products/ip/ipm-index.html
Lattice Semiconductor	http://www.latticesemi.com/products/intellectualproperty/index.cfm
Xilinx	http://www.xilinx.com/ipcenter/

Each vendor attempts to catalog available IP and provide a quasi-"store front" at which the developer can identify useful IP. Both **Xilinx** and **Altera** have invested heavily in their own IP cores: *Microblaze* (http://www.xilinx.com/products/design_resources/proc_central/microblaze.htm) for the former, and *Nios/Nios II* (http://www.altera.com/products/ip/processors/nios2/ni2-index.html) for the latter. **Actel** has taken a different approach, forming a partnership with **ARM** to provide the 32-bit ARM Cortex-M1 "free" with **Actel**-based design:

> Developed by ARM in collaboration with Actel, the 32-bit ARM Cortex™-M1 processor is the first ARM processor designed for FPGA implementation. With a balance between size and speed, the free Cortex-M1 processor operates at up to 68 MHz and can be implemented in as few as 4,410 tiles. A streamlined three-stage pipeline solution, the Cortex-M1 processor runs a subset of the classic Thumb®-2 instruction set so existing Thumb code can be utilized without change.

More details are at http://www.actel.com/products/mpu/CortexM1/ (12 September 2008). 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

> For leading-edge DSP and data communications, VMETRO provides a range of FPGA hardware solutions based on Xilinx's Virtex-II Pro, Virtex-4 and Virtex-5 FPGA devices. The functionality of Virtex-5 LXT and SXT members now include features such as embedded Ethernet EMACS, PCI Express support alongside RocketIO/GTP high-speed serial communications for highly integrated solutions. Board formats for FPGA solutions that VMETRO can provide range from XMC/PMC mezzanine cards to 6U VME/VXS and VPX.
>
> (http://www.vmetro.com/category3949.html 12 September 2008)

Vmetro was very assertive this past year in promoting the new "FMC" standard from VITA (http://www.vita.com/). On 23 April 2008, they announced their *ADC510*, the industry's first FPGA Mezzanine Card (FMC/VITA 57) module. "The introduction of the first FMC module marks a new generation in I/O aimed at FPGAs – developers continue to benefit from high-bandwidth, low-latency coupling between an FPGA and I/O with a new level of industry standard flexibility," commented Thomas Nygaard, Chief Technology Officer of VMETRO. "FMC modules such as the ADC510 can be integrated with baseboards such as VMETRO's FPE650 (a 6U VPX board with four Xilinx® Virtex®-5 FPGAs and two FMC sites) to create very powerful solutions" ((http://www.vmetro.com/article4602-3759.html).

A final interesting FPGA deployment approach comes from **National Instruments** (http://www.ni.com/). The innovative Austin-based company launched their *CompactRIO* product a few years back. Their whole philosophy is really to focus less on the FPGAs and more on the application, and hopefully to enable a whole group of "domain experts" to harness FPGAs via *CompactRIO* and **NI**'s *LabView* software. According to the product information:

> The National Instruments CompactRIO programmable automation controller is an advanced embedded control and data acquisition system designed for applications that require high performance and reliability. With the system's open, embedded architecture, small size, extreme ruggedness, and flexibility, engineers and embedded developers can use COTS hardware to quickly build custom embedded systems. NI CompactRIO is powered by National Instruments LabVIEW FPGA and LabVIEW Real-Time technologies, giving engineers the ability to design, program, and customize the CompactRIO embedded system with easy-to-use graphical programming tools. (http://www.ni.com/compactrio/whatis.htm 12 September 2008)

The positive value in *CompactRIO* is that it is easy to learn and quick to deploy, while the negative is that it is expensive (especially on a per unit basis) and has a "lock in" to **NI** technology, although they do allow you to port your code to processors such as **Analog Devices**' *BlackFin*. Check out the *CompactRIO* home page at http://www.ni.com/compactrio/. A world away, **Altium** (http://www.altium.com/) has come up with a rather similar concept with their *Innovation Station*. You can ready the flashy marketing literature on it at http://www.altium.com/AltiumInnovationStation/.

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 http://www.xilinx.com/products/design_resources/dsp_central/grouping/index.htm.

Among board vendors, many concentrate on FPGA boards for DSP-intensive applications. **BittWare, Inc.** (http://www.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. **Pentek** (http://www.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.
>
> (http://www.pentek.com/tutorials/16_1/XMC.cfm 12 September 2008)

One of the major application areas for FPGA-based boards is "software radio." Again, **Pentek** has published a niece overview to the topic, *FPGAs for Software Radio* (http://www.pentek.com/deliver/TechDoc.cfm/FPGAsfwrad.pdf?Filename=FPGAsfwrad.pdf 12 September 2008).

Other vendors active in the FPGA/DSP space include **Innovative Integration** (http://www.innovative-dsp.com/), **Lyrtech Inc.** (http://www.lyrtech.com/), **Vmetro** (http://www.vmetro.com), **Hunt Engineering** (http://www.hunt-dsp.com/) and **Mango DSP, Ltd.** (http://www.mangodsp.com/) among others.

FPGA Design Services

Ultimately, your company is in business to get a product out the door, quickly and under budget, with all the cool new features that will excite your customers and generate product sales. Management may therefore want to consider seriously what part of your design process to keep "in house" vs. what part to "outsource," whether outsourcing is bringing in temporary engineering talent to outsourcing to consultants in your home country to outsourcing to full design companies half a world away.

Outsourcing has clearly hit the FPGA field, especially (but not only) where FPGAs intersect with ASICs, and so for the first time we have a special Appendix I on "FPGA Design Services." You can use this as a quick index to companies that offer design services.

As a project manager, therefore, you might want to think about what parts of your design is your "special competency" and what parts are less relevant. If some of these other parts are more common to many designs, these may be excellent candidates to "outsource." Why reinvent the wheel? Why struggle on certain aspects of FPGA design, in which others may already excel and already have done it many times?

> **Take Away**. Design service outsourcing is ultimately all about a "division of labor" between you and the outside design company or consultant. What do you do best? What is not your "core competency" that might be done more effectively by a specialized outsider?

Finding Design Partners

There are a few great ways to locate FPGA design partners. First and foremost, **eg3.com** has spent much of the past year working on our own design partner database, released now in beta form as **"eg3.com connect"** (http://www.eg3.com/connect). Click on "search services" and enter keywords like "FPGA PCI Express" to browse for service partners that offer both.

In addition, **Xilinx, Altera**, and other FPGA vendors often have partner programs and online catalogs wherein you can search for FPGA design partners.

Here are links:

- **Actel Partner Program** - http://www.actel.com/products/partners/default.aspx
- **Altera Partner Program** - http://www.altera.com/corporate/partners/prt-index.html
- **Xilinx Partner Program** - http://www.xilinx.com/ise/embedded/epartners/listing.htm

Another good resource for locating consultants is the *IEEE Consultants Database* at http://www.ieeeusa.org/business/consultants/cgi-bin/consultant.cgi?task=display_page/page=home.html/sid=/id=101244720. You can enter search terms like FPGA as well as specify locations and other variables to help identify knowledgeable third parties for your FPGA project.

Evaluation a Potential Design Partner

All the issues involved in working with outside parties are beyond the scope of this guide. Suffice it to point out that common sense tells you -

- Evaluate skillsets - ask for past projects, examples of past expertise.
- Check references - ask for and follow up with references from previous clients.
- Look for skill examples - use their websites and portfolios to look for projects that they have done that are similar to your needs, check white papers, presentations, technical conferences, etc., to validate skills.
- Start small - do a small project first and see how they work out.

A good example of online technical presentations that establish credibility for FPGA designs comes from **Octera** at http://www.octera.com/technology/. They also have a decent overview to the whole "choosing a design partner" issue.

For a nice general overview to design service outsourcing, check out the white paper from **SSI Embedded** at http://www.ssiembedded.com/Consult_White_Paper.pdf. It's not specific to FPGAs but it covers many of the basic issues involved in design outsourcing. Finally, check out Appendix I for design service companies, and spend some time surfing to and researching websites before you decide whom to contact. Then send out queries and set up brief email or phone interviews for your "short list."