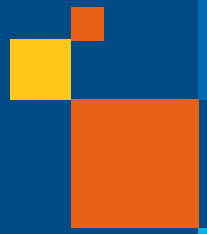
Read Me First!



intel®

Using this Document

New to Intel® FPGAs? This guide will help you with:

Getting Started: Get your **My Intel** account for access to information and support

Preparation: Download the Intel Quartus® software and get software licensing setup

Software Developers: Resources for embedded and software application developers focusing on a C / C++ flow

Hardware Developers: Resources for FPGA developers focusing on system level, HDL, and schematic design entry

Using this Document (cont.)

New to Intel® FPGAs? This guide will help you with:

Research: See design examples, solutions, literature, or intellectual property (IP) for your project

Support: Learn about the varieties of websites and training material to keep you productive on your design

Design Resources: Successfully complete and optimize your design

But First....

Intel® FPGA Support Resources

- https://www.intel.com/content/www/us/en/support/programmable/support-resources/overview.html

Agenda


Getting Started


Preparation

Software Developers


Hardware Developers

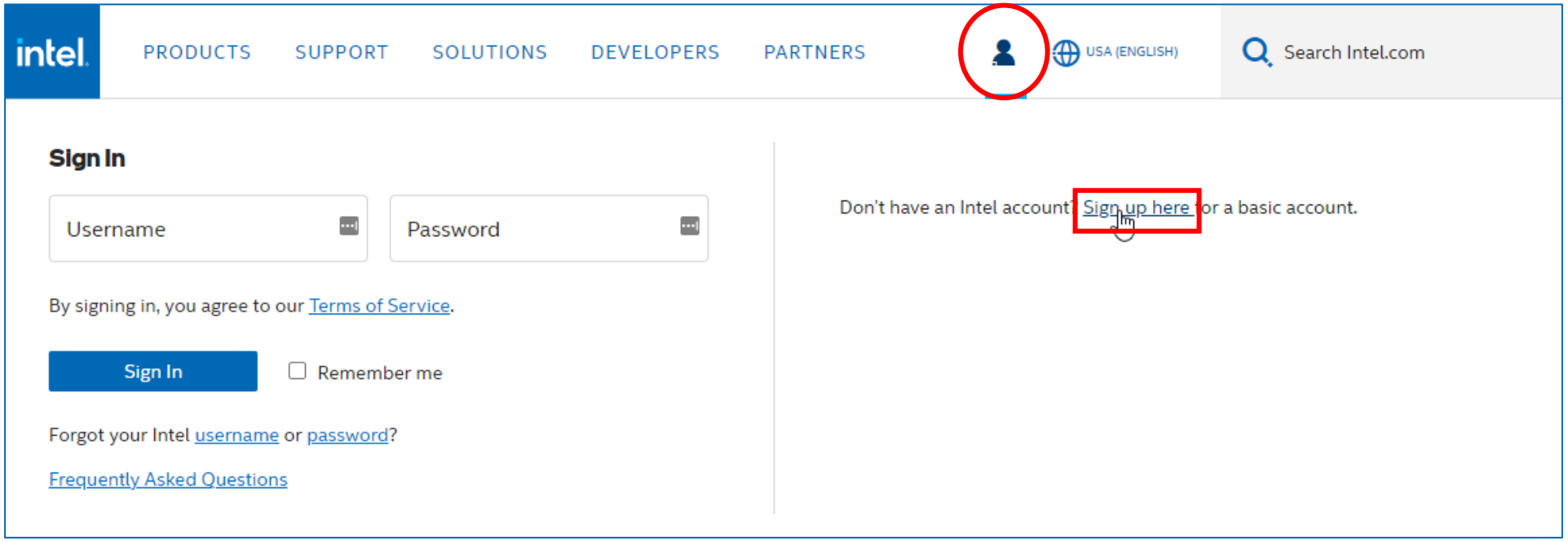

Research


Support


Design Resources

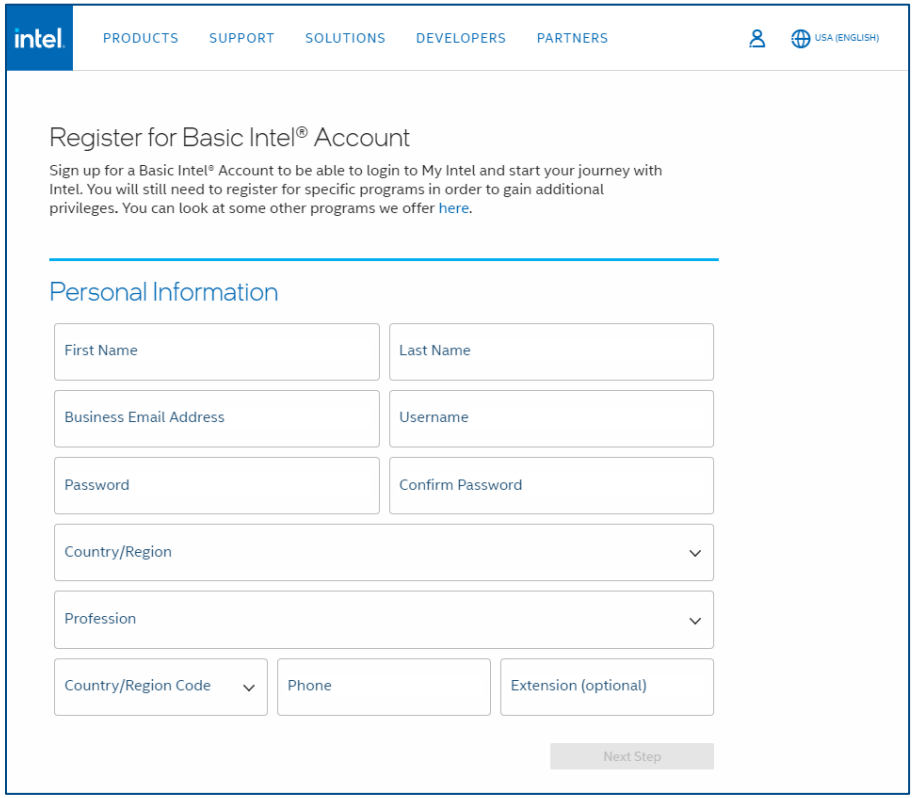
How to Create a My Intel Account

- From Intel® home page
- Click Sign up here



Account Registration

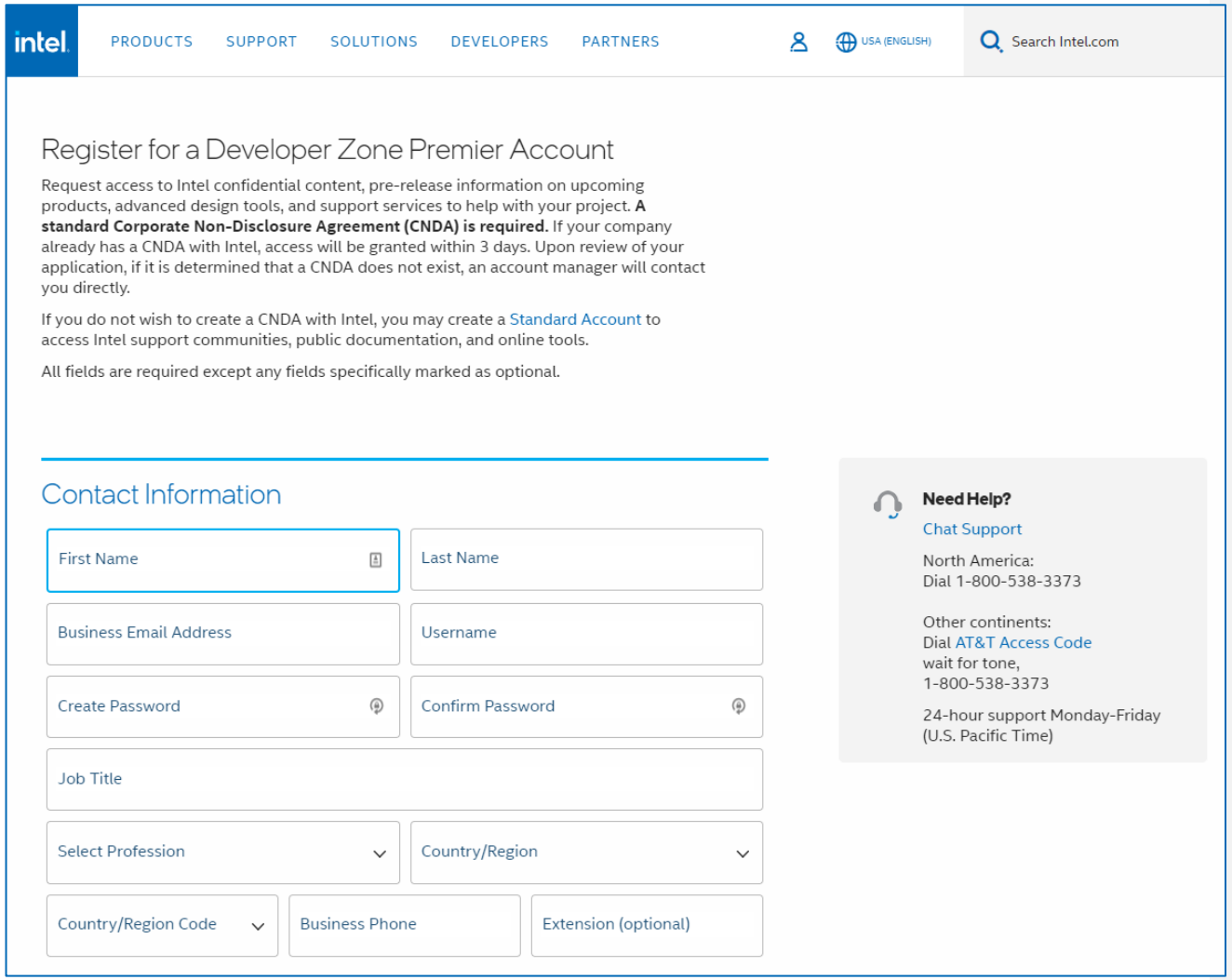
- Basic account registration
- Provide registration information
- Registration complete!



- https://www.intel.com/content/www/us/en/forms/basic-intel-registration.html

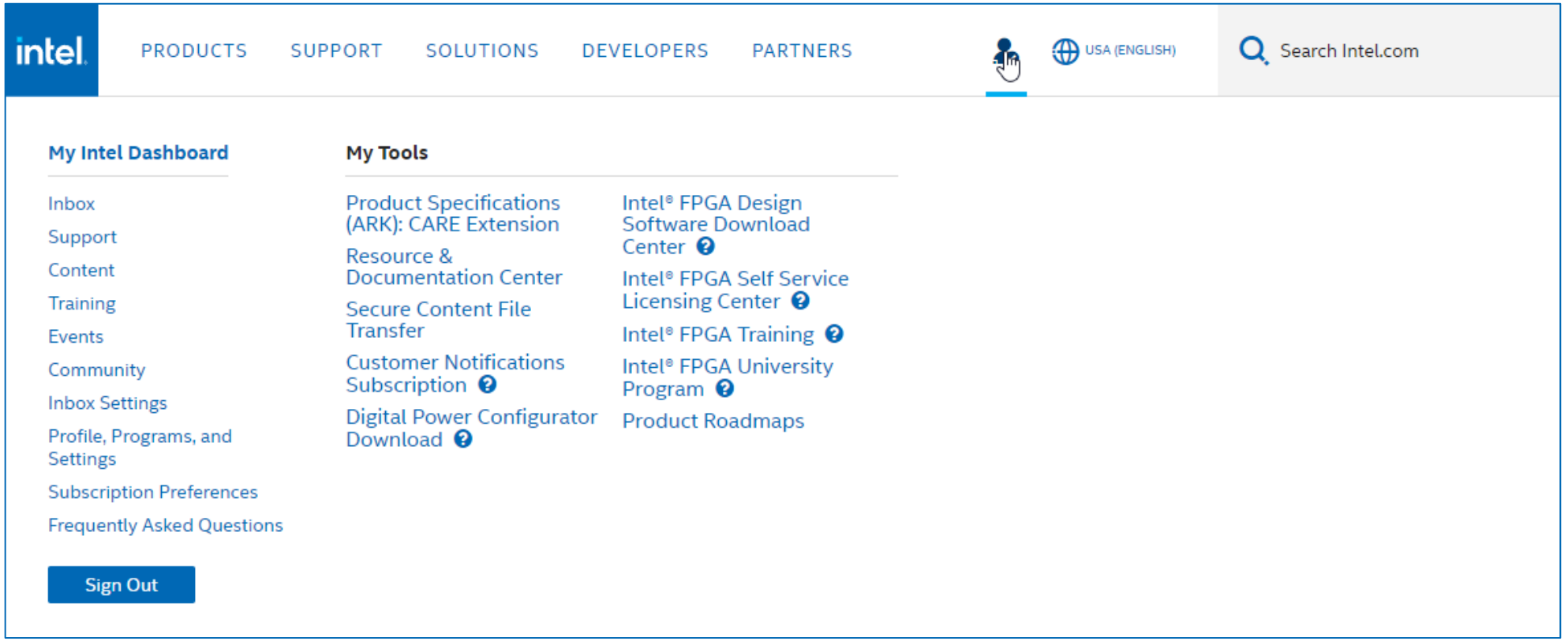
Premier Account

- https://www.intel.com/content/www/us/en/forms/developer/premier-registration.html



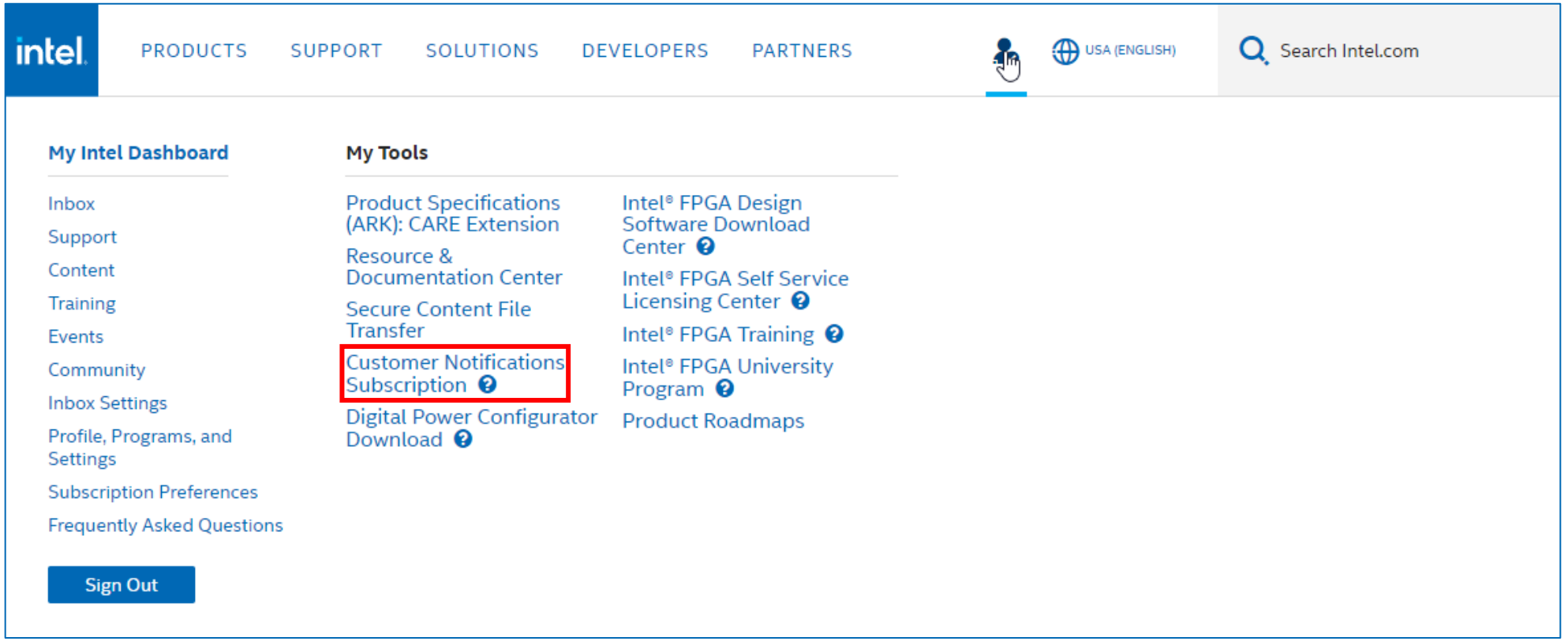
What You Get with Registration

You get access to the following



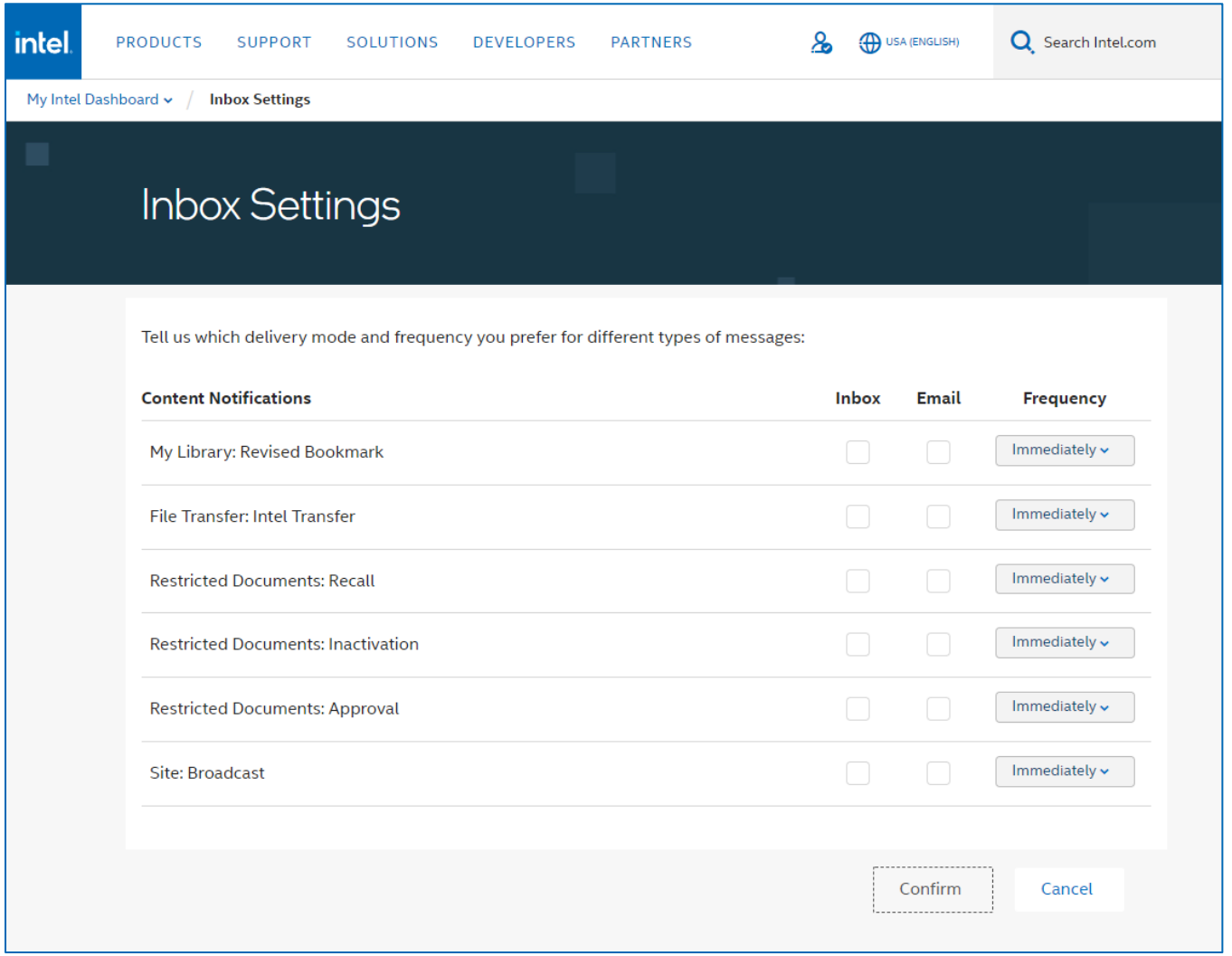
Subscription Preferences

- Click on the Customer Notifications Subscription



Subscription Preferences

- Select
  - Document type
  - Frequency
  - Delivery location



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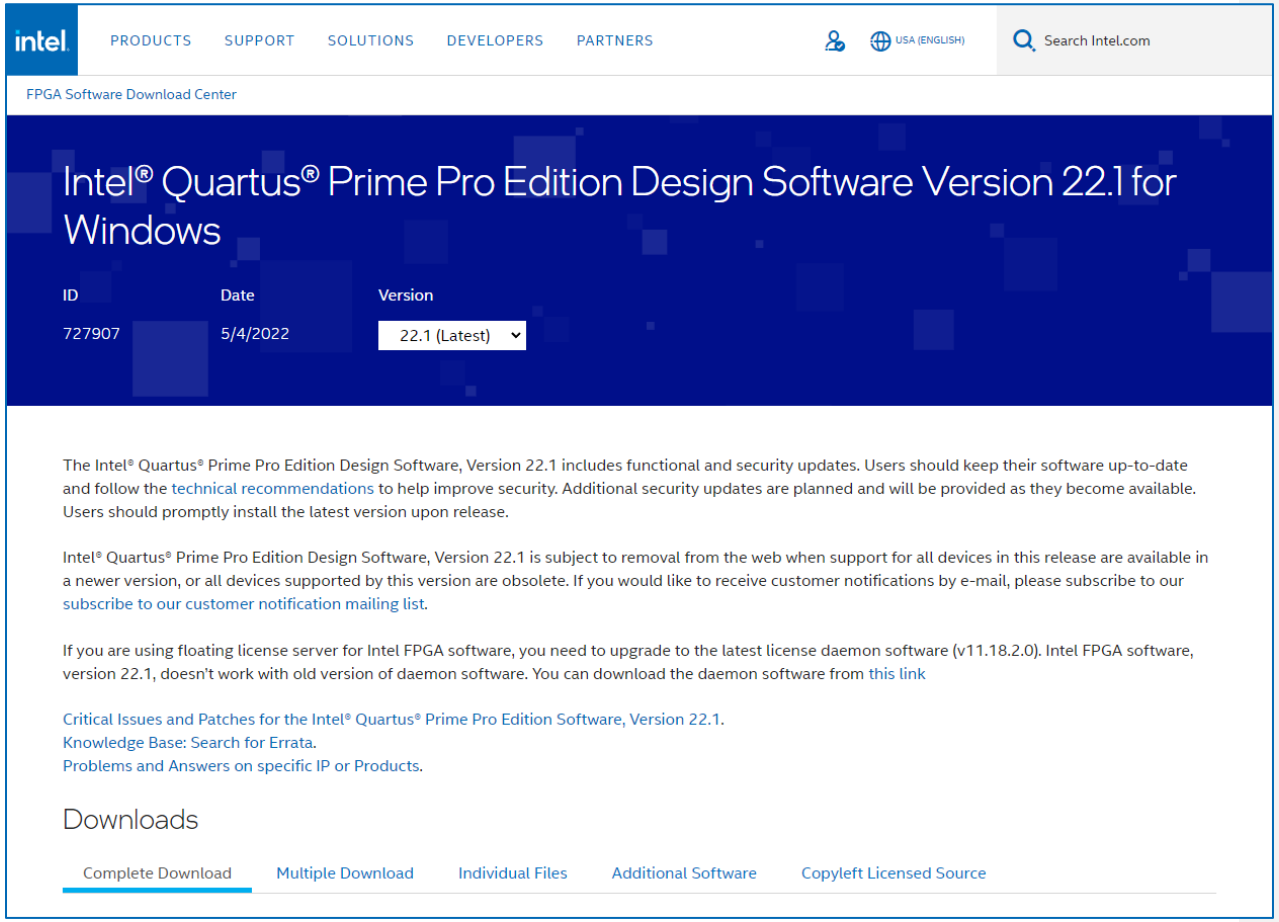
- Software download
- Getting a license

Download Software

Download the latest design software and tools at the Download Center

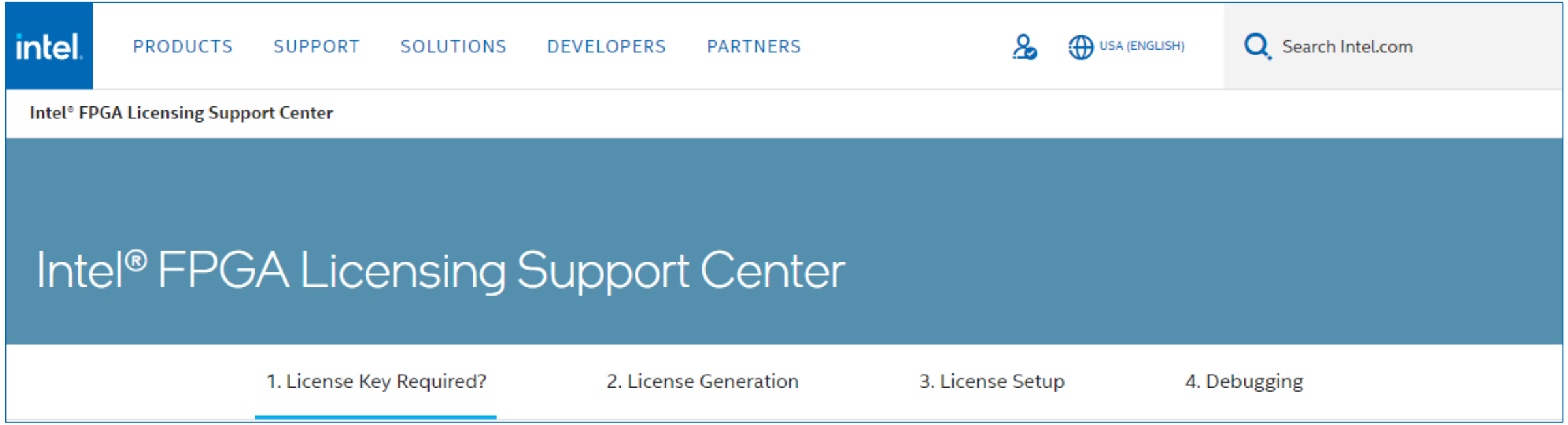
- https://www.intel.com/content/www/us/en/collections/products/fpga/software/downloads.html



Get a License

Visit the Intel® FPGA Licensing Support Center

- https://www.intel.com/content/www/us/en/support/programmable/licensing/support-center.html



Licensing Support Center Tasks

1. Which software needs a license key
2. Generate the license
3. License setup
4. Debugging license issues

1. License Key Required?

1. License Key Required?

The following table details the license requirements for various Intel® FPGA software tools and IP cores.

Software / IP	License Key Required?	License Fee Required?
Intel® Quartus® Prime Pro Edition	Yes	Yes Note: Intel Quartus Prime Pro Edition software seat licenses include licenses for the Intel Quartus Prime Standard Edition software. Compare between Editions
Intel Quartus Prime Standard Edition	Yes	Yes
Intel Quartus Prime Lite Edition	No	Beginning with version 8.1, a license file is no longer required for this or future versions of the Intel® Quartus® II Web Edition or Intel Quartus Prime Lite Edition software. There is no charge for this version of the software.

2. License Generation

2. License Generation

How to Activate and Generate the License File?

License	How to Activate and Generate the License File?
Intel Quartus Prime Pro Edition	Intel® FPGA Self Service Licensing Center
Intel Quartus Prime Standard Edition	Intel® FPGA Self Service Licensing Center
Intel Quartus Prime Lite Edition or Intel Quartus II Web Edition Licensing	Get a license for previous versions (prior to version 8.1) of the Intel Quartus II Web Edition software. Beginning with version 8.1, a license file is no longer required for this or future versions of the Intel Quartus II Web Edition or Intel Quartus Prime Lite Edition software.
ModelSim*-Intel® FPGA Edition	Intel® FPGA Self Service Licensing Center

3. License Setup

3. License Setup

Intel Quartus Prime Standard and Pro Edition

- Setting Up Fixed Node License (HTML | PDF)
- Setting Up Floating Licenses (HTML | PDF)
- Online Training: Setting up floating licenses.

ModelSim*-Intel® FPGA Edition

- Specifying the License for the ModelSim*-Intel® FPGA Edition Software (HTML | PDF)

DSP Builder for Intel® FPGAs

- Setting Up the DSP Builder for Intel® FPGAs License (HTML | PDF)

ARM* Development Studio 5* (DS-5*) Intel SoC FPGA Edition

- Activating the Arm Development Studio license (HTML | PDF)

MAX+PLUS II (Legacy)

- Setting up MAX+PLUS II licensing ›
- Setting up MAX+PLUS II licensing for version 9.1 and higher ›

4. Debugging

4. Debugging

Frequently Asked Questions

- Intel Quartus Prime design software licensing ›
- MAX+PLUS II software licensing ›
- IP base suite ›
- DSP builder for Intel® FPGAs installation and licensing ›
- Intel® FPGA software installation ›

Troubleshooter

- This troubleshooter helps you to solve licensing problems relate

Knowledge Base Solution

- Why my OpenCL license is not detected in 17.0 when my mainte

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Getting Started


Preparation

Software Developers


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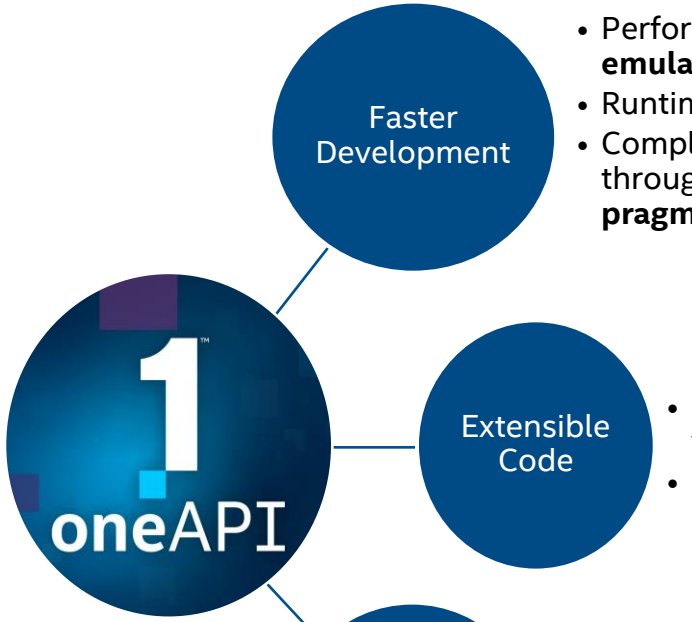
Design Resources

Software Developers

Tools and environment familiar to software engineers

- Leverage the inherent parallel processing nature of Intel FPGAs as accelerators
  - Intel® oneAPI
  - Intel Open FPGA Stack (Intel OFS)
- System on a Chip (SoC) embedded process development
  - Embedded Arm* Cortex* hard processor and Nios® V soft processor
  - RTOS support

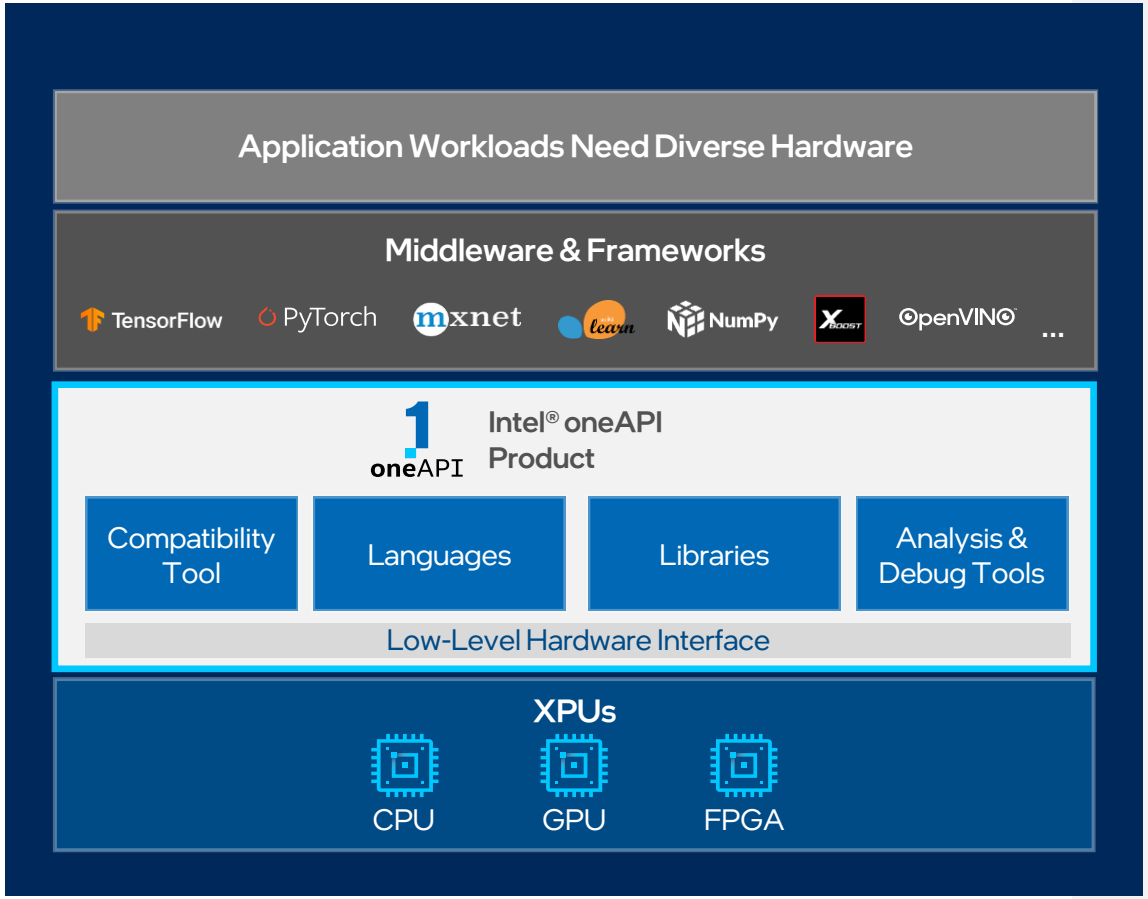
Intel® oneAPI Product



- Performance tuning and timing closure through **emulation** and **reports**.
- Runtime analysis via **VTune™ Profiler**
- Complex hardware patterns implemented through built-in language features: **macros**, **pragmas**, **headers**

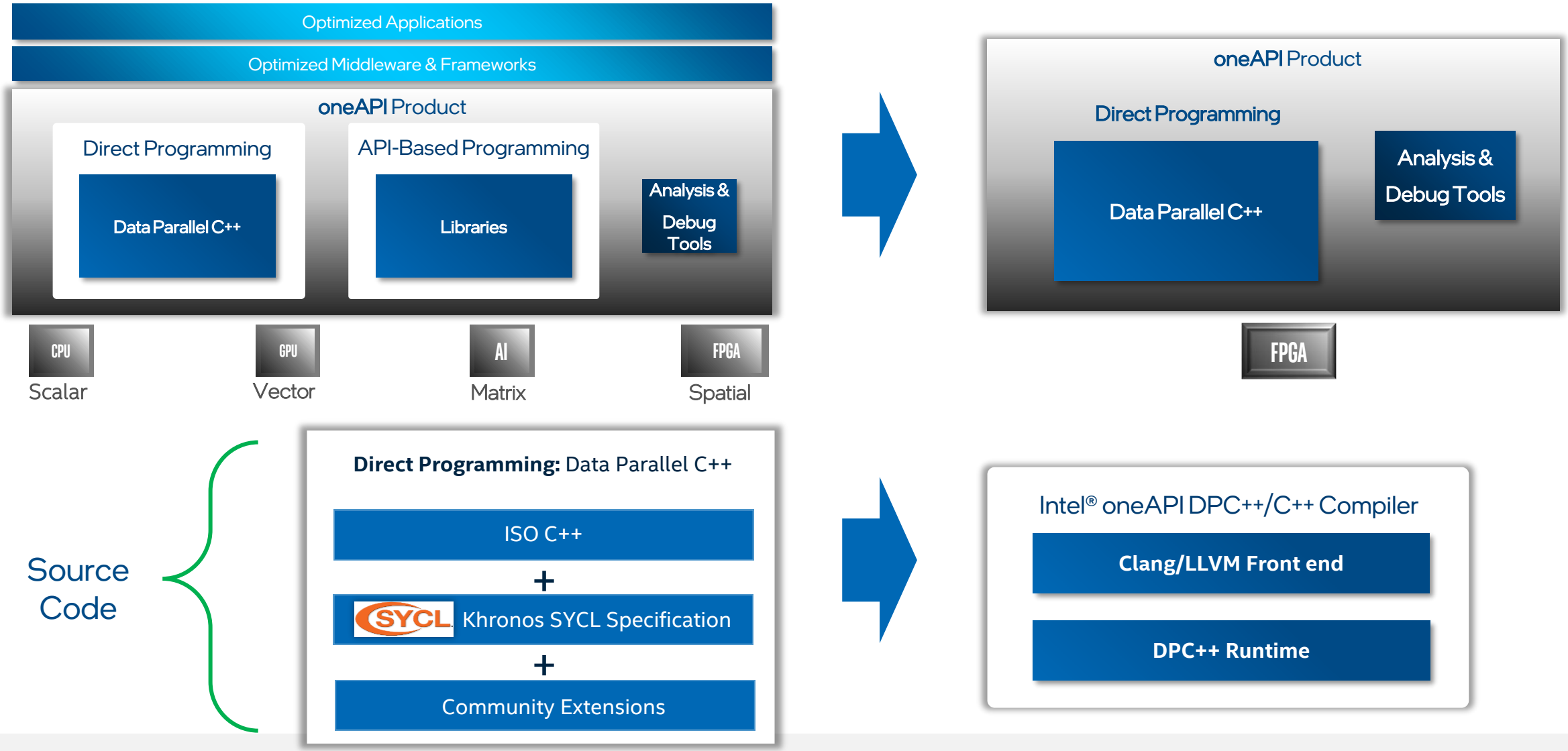
- **Code re-use** across architectures and vendors**.**
- Compatible with existing high-performance languages.

- Leverage familiar sequential programming languages: improved **ramp-up** and **debug** time.
- IDE Integration: **Eclipse, VS, VS Code**

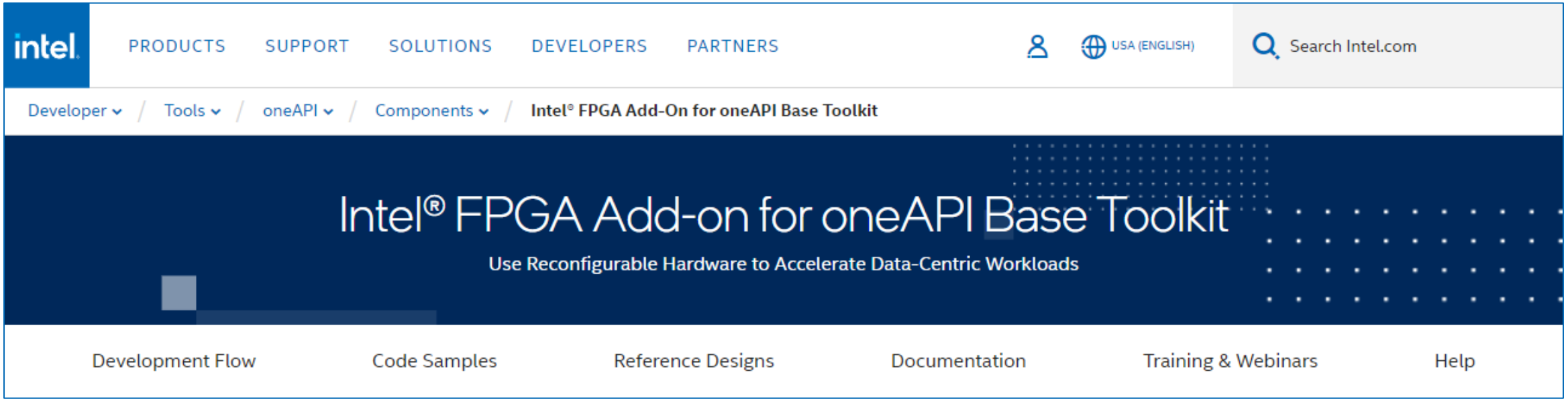


Available Now

Intel® oneAPI Base Toolkit for FPGAs



Intel® oneAPI Base Toolkit for FPGAs More Information

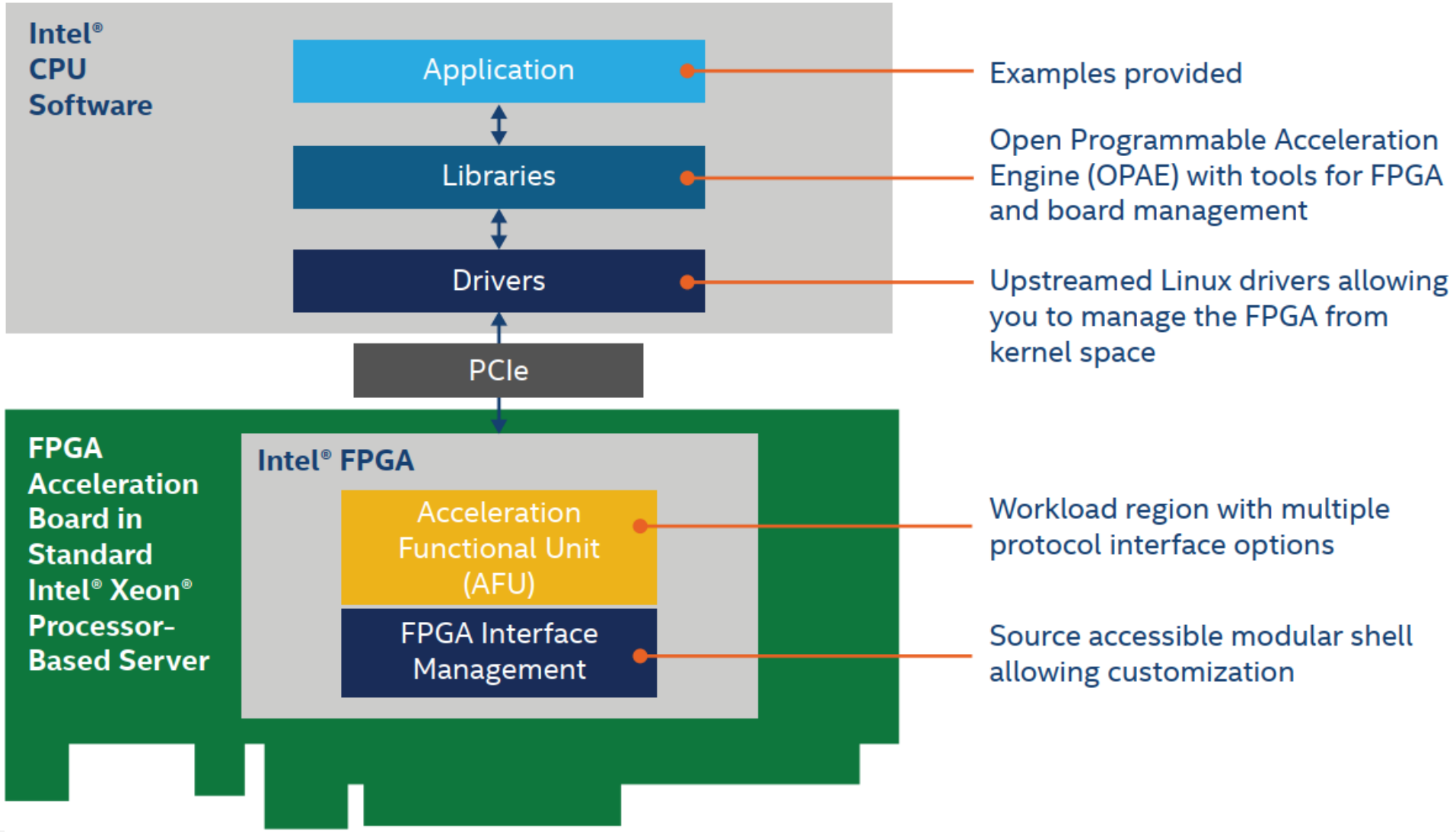


- https://www.intel.com/content/www/us/en/developer/tools/oneapi/fpga.html

Intel® Open FPGA Stack

- Standardization
- Utilize the Acceleration Functional Unit
- Leverage the Ecosystem
- Ease of Deployment
- Customizations
- Wide-Range of Solutions

Intel® Open FPGA Stack Block diagram



Embedded Software

Arm* Cortex* processors and Nios® soft processors

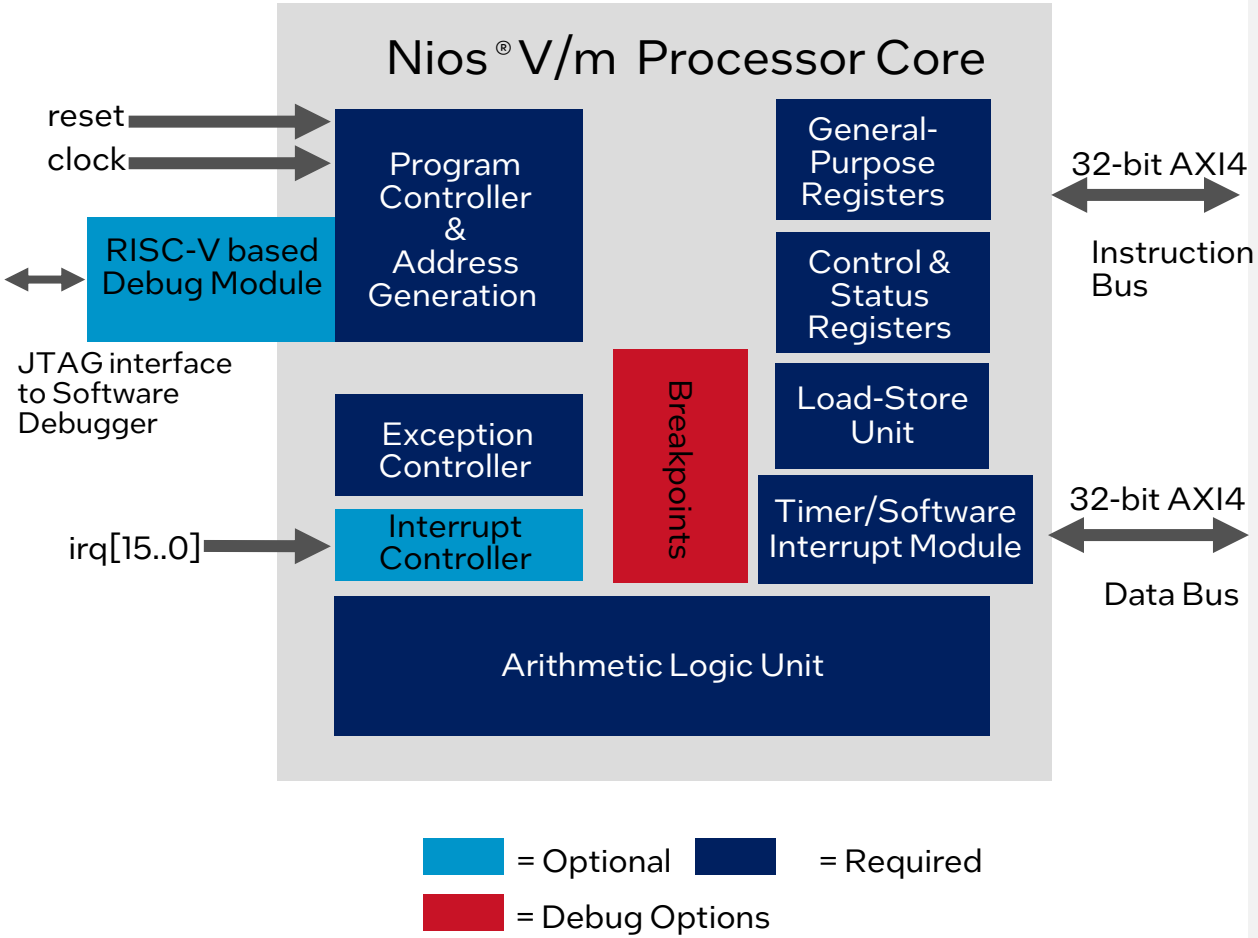
- Multicore embedded Arm Cortex processors
- Nios soft processors
- Embedded software ecosystem
- RTOS support

The Processors

- Intel® FPGA SoC devices contain Arm* Cortex* processors
  - Intel Agilex™ & Intel Stratix® 10, quad-core 64 bit Arm Cortex-A53 Hard Processor System (HPS) up to 1.5 GHz
  - Intel Arria® 10, dual-core ARM Cortex-A9 MPCore* HPS up to 1.5 GHz
  - Arria V, dual-core ARM Cortex-A9 MPCore HPS up to 1.05 GHz
  - Cyclone® V dual-core ARM Cortex-A9 MPCore HPS up to 925 MHz
  - https://www.intel.com/content/www/us/en/products/details/fpga.html
- Soft processors
  - Intel Quartus® Standard and Intel Quartus Pro software Nios® II soft processor
  - Intel Quartus Pro software RISC-V based Nios V soft processor
  - https://www.intel.com/content/www/us/en/products/details/fpga/nios-processor.html

Nios® V/m Soft Processor

- 32-bit microcontroller based on RISC-V RV32IA
- Initial support on Intel® Agilex, Intel Stratix® 10, Intel Arria® 10, and Intel Cyclone® 10 GX devices
- 5 stage pipeline
- Standard interfaces
- Intel® HAL, uC/OS-II*



Easy Debug

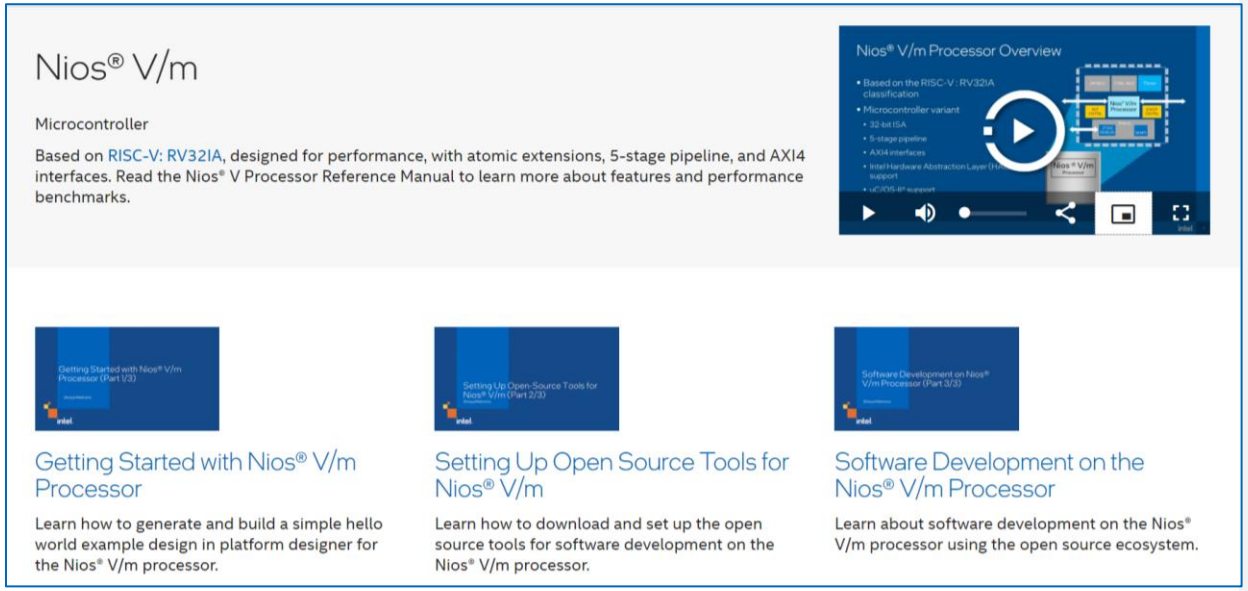
Initial Development: Open-Source Ecosystem*

- Eclipse CDT (C/C++ Development Tooling) 10.1.0
- Debug using supported Eclipse-based openOCD
- RISC-V toolchain

*Eclipse CDT, CMake, RISC-V Toolchain is not included in the Intel® Quartus® Prime Software. Instructions to download and setup are provided

Nios® V Resources

- Documentation
  - Nios V Processor Quick Start Guide
  - Nios V Processor Reference Manual
- Quick Videos available
  - Part 1: Getting Started with Nios V/m Processor
  - Part 2: Setting Up Open-Source Tools for Nios V/m Processor
  - Part 3: Software Development on the Nios V/m Processor
- Separate $0 license for each core available in the self-service licensing center



Intel® SoC FPGA Embedded Design Suite

- Comprehensive software / firmware development environment
- FPGA-adaptive software debugging capabilities
  - Arm* Development Studio for Intel® SoC FPGA edition toolkit
- Hardware / software handoff tools
- Linux* OS application development
  - Yocto Linux* OS build environment
  - Pre-built binaries for Linux* OS / U-Boot
- Work in conjunction with the Community Portal
- Bare-metal application development
  - SoC Hardware Libraries
  - Bare-metal compiler tools
- Design examples

Arm* Development Studio for Intel® SoC FPGA

- Code
- Build
- Debug
  - FPGA-Adaptive Debug
  - Program Trace
- Optimize
  - Program Trace
  - Application Performance Analysis

Intel® SoC FPGA Embedded Design Suite

For more information:

- Embedded Software and Tools for Intel SoC FPGA
  - https://www.intel.com/content/www/us/en/software/programmable/soc-eds/overview.html
- Documentation and Support:
  - https://www.intel.com/content/www/us/en/support/programmable/support-resources/support-centers/fpga-soc-eds-support.html?s=Newest

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Getting Started


Preparation

Software Developers


Hardware Developers


Research


Support


Design Resources

Hardware Developers

FPGA development tools

- Intel® Quartus® software
- Intellectual Property
- DSP Builder for Intel FPGAs
- Intel HLS (high-level synthesis) Compiler

Intel® Quartus® Software – Three Editions

- Intel Quartus Prime Lite Edition
  - http://fpgasoftware.intel.com/?edition=lite
- Intel Quartus Prime Standard Edition
  - http://fpgasoftware.intel.com/?edition=standard
- Intel Quartus Prime Pro Edition
  - http://fpgasoftware.intel.com/?edition=pro

- Feature comparison
  - https://www.intel.com/content/www/us/en/software/programmable/quartus-prime/download.html

Intel® Quartus® Software

- Fully-integrated development tool
  - Multiple design entry methods
  - Logic synthesis
  - Place & route
  - Device programming
- Simulation
  - Supports standard HDL simulation tools
  - Includes Questa*-Intel FPGA Starter Edition tool
    - Optional upgrade to Questa-Intel FPGA Edition tool
  - See comparison
    - https://www.intel.com/content/www/us/en/software/programmable/quartus-prime/questa-edition.html

Intel® Quartus® Software

- For more information
  - https://www.intel.com/content/www/us/en/software/programmable/quartus-prime/overview.html

Intellectual Property (IP)

IP cores optimized for Intel® FPGA devices

- Available from Intel FPGA and our partners
  - https://www.intel.com/content/www/us/en/products/programmable/intellectual-property.html
- IP cores included in the **IP Base Suite** are free with an active Intel Quartus® subscription
  - https://www.intel.com/content/www/us/en/products/programmable/intellectual-property/ip-base-suite.html
  - Suite license can be purchased for use with the Intel Quartus Lite Edition

Intellectual Property (IP) (cont.)

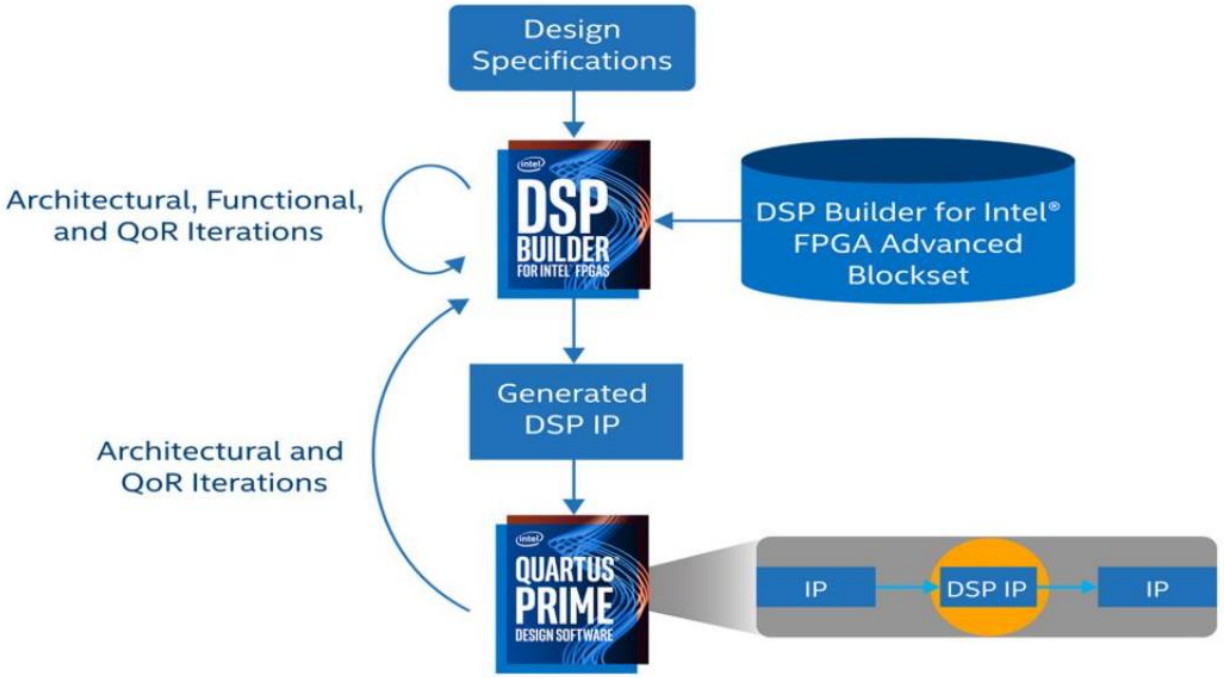
Evaluate Intel® FPGA IP cores and partner IP cores

- Intel Quartus® Prime Pro
  - IP evaluation automatic until purchase of IP license
    - https://www.intel.com/content/www/us/en/docs/programmable/683416/19-4/ip-evalmode.html
- Intel Quartus Prime Standard
  - Refer to AN320
    - https://www.intel.com/content/www/us/en/docs/programmable/683502/17-1/an-320-using.html

DSP Builder for Intel® FPGAs

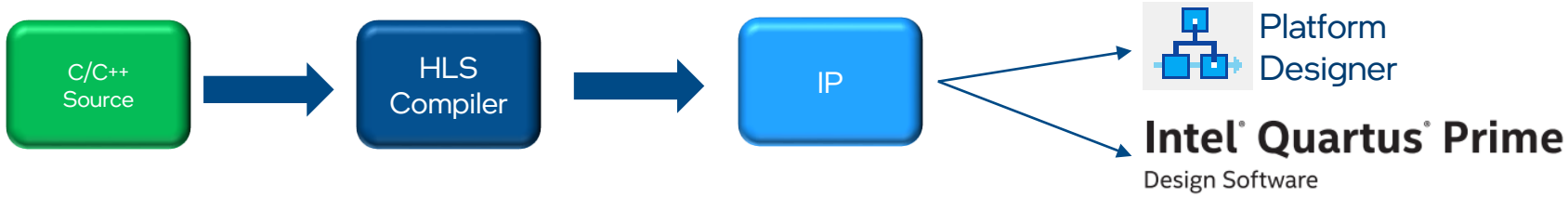
Generate HDL from MathWorks Simulink* environment

- Intel® FPGA optimized
- High level design exploration
- HW-in-the-loop verification
- IP generation for Intel Quartus® software and Platform Designer
- For more information
  - https://www.intel.com/content/www/us/en/software/programmable/quartus-prime/dsp-builder.html



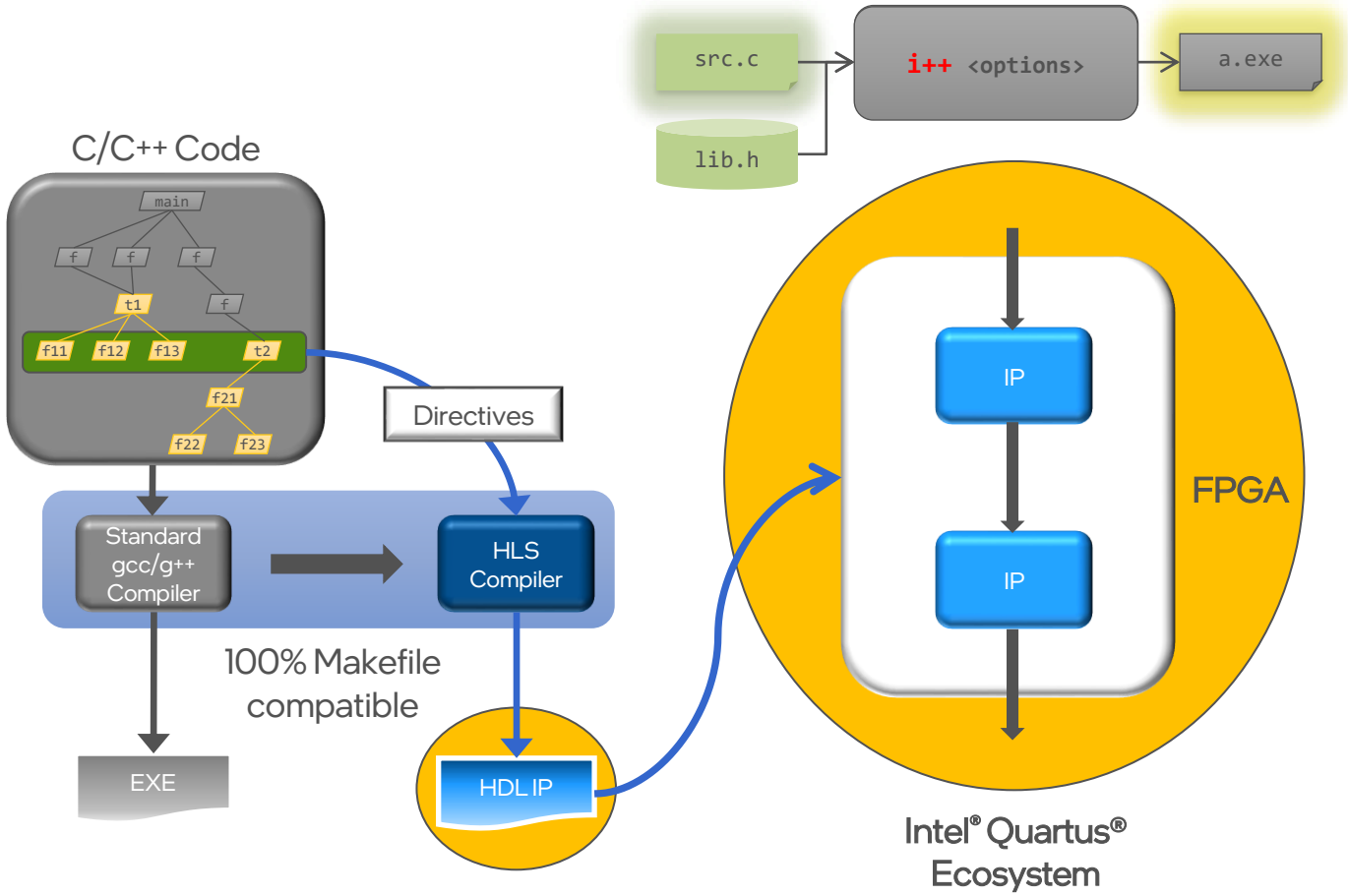
Intel® HLS (high-level synthesis) Compiler

- Targets Intel FPGAs
- Command-line executable: `i++`
- Builds an IP block
  - Integrate into Intel Quartus® software or Platform Designer



- Leverages standard C/C++ development environment

HLS Use Model



Intel® HLS Compiler

- For more information
  - https://www.intel.com/content/www/us/en/software/programmable/quartus-prime/hls-compiler.html

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Design Resources

Research

- Design Examples
- Development Kits
- Design Store
- Devices
- Technology Center
- Documentation

Design Examples

Many building blocks are available to help you better understand and easily use Intel® FPGA products, implement various functions, and address basic design needs.

- https://www.intel.com/content/www/us/en/support/programmable/support-resources/design-examples/design-examples-overview.html
- HDL code samples included to help you get started using Intel FPGA products
- Design entry/tool examples highlight the design entry process
  - Instantiating basic logic blocks
  - Scripting
  - Gate-level timing simulation tools
  - Debugging
- Search by keyword(s) or product descriptions

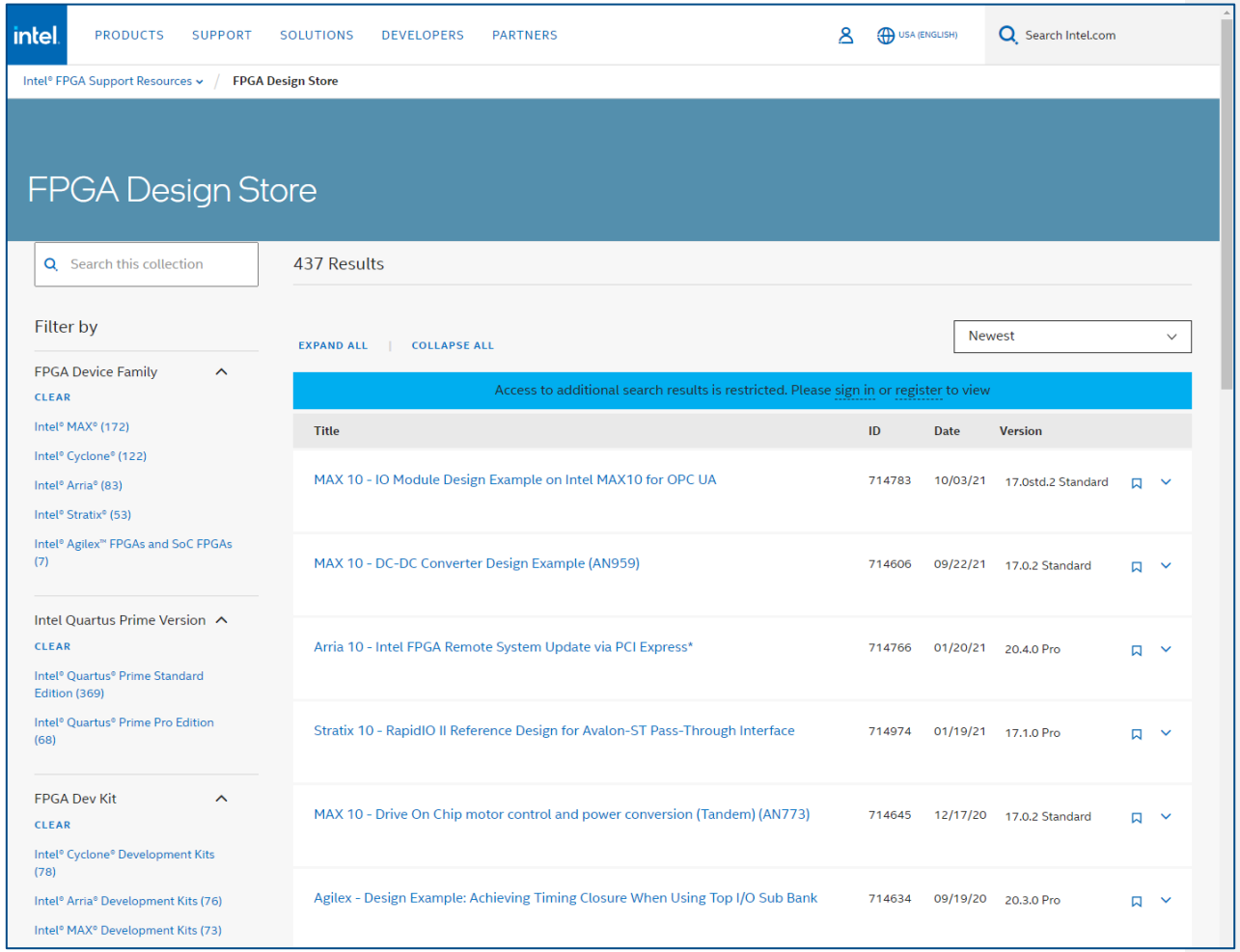
Development Kits

There is a wide range of development kits available with everything you need to create, implement, and evaluate

- All kits include software, reference designs, cables, and programming hardware
  - https://www.intel.com/content/www/us/en/products/details/fpga/development-kits.html
- For Intel® FPGA development kit technical support
  - https://www.intel.com/content/www/us/en/support/programmable/support-resources/overview.html
- Intel FPGA's partners offer development platforms that address a wide range of applications
  - https://www.intel.com/content/www/us/en/products/details/fpga/find-fpga-boards.html

Design Store

- Download complete design project templates
  - https://www.intel.com/content/www/us/en/support/programmable/support-resources/design-examples/design-store.html
- Find templates by:
  - Device family
  - Intel® Quartus® software version
  - Development kit
  - IP core
- Templates integrate directly into the Intel Quartus software



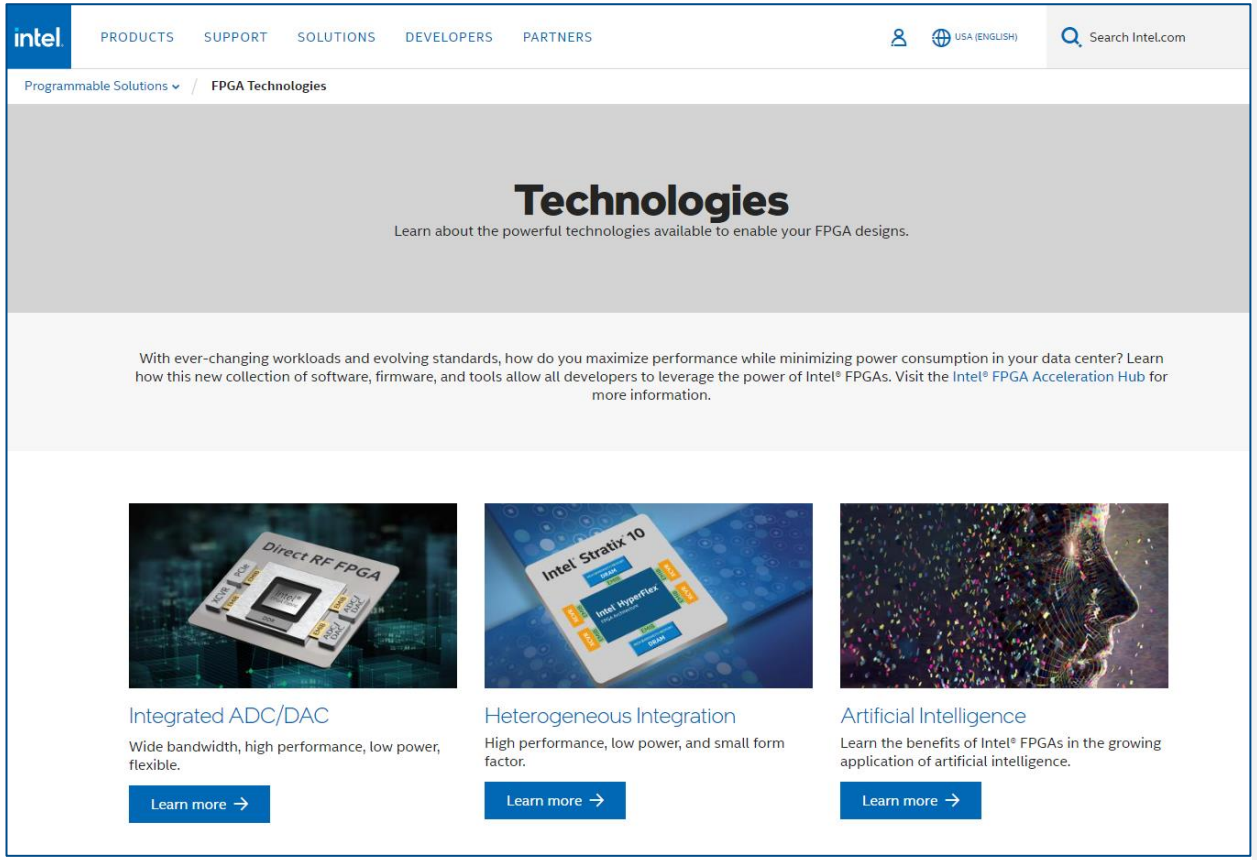
Devices

- Wide range of device series and variants available
  - https://www.intel.com/content/www/us/en/products/details/fpga.html
- Device and Product Selector tool
  - https://ark.intel.com/content/www/us/en/ark.html#@Intel%C2%AEFPGAs
  - Find and compare Intel® FPGA devices
  - Filter down to specific products based on search specifications
  - Compare products side-by-side by filtering the criteria you choose for analysis

FPGA Technologies

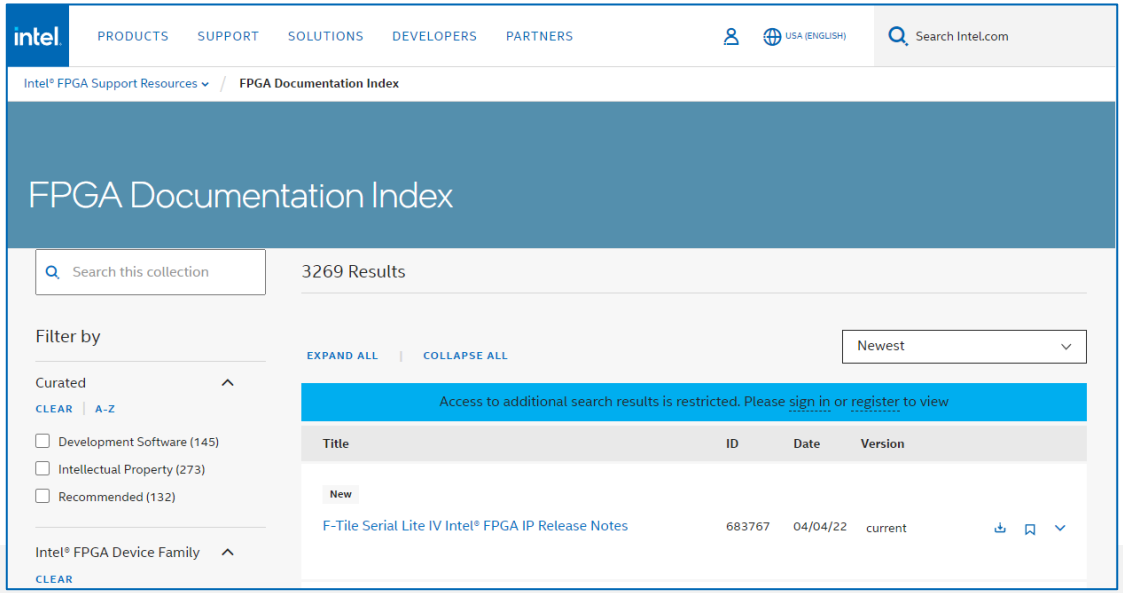
Access to solutions for many common applications

- https://www.intel.com/content/www/us/en/products/programmable/technologies.html



Documentation

- Find detailed documentation on all Intel® FPGA devices, IP, and software
  - https://www.intel.com/content/www/us/en/support/programmable/support-resources/fpga-documentation-index.html
- Can be viewed online as HTML or downloaded as a PDF



Documentation: User Guides and White Papers

- **User Guides** provide additional help for:
  - Devices
  - Using IP
  - Development kits
  - https://www.intel.com/content/www/us/en/support/programmable/support-resources/design-software/user-guides.html
- **White Papers** written by Intel® FPGA experts to explain:
  - How a technology was developed
  - How a technology is used
  - Product operation for an application, market, or technology
  - https://www.intel.com/content/www/us/en/programmable/documentation/lit-wp.html

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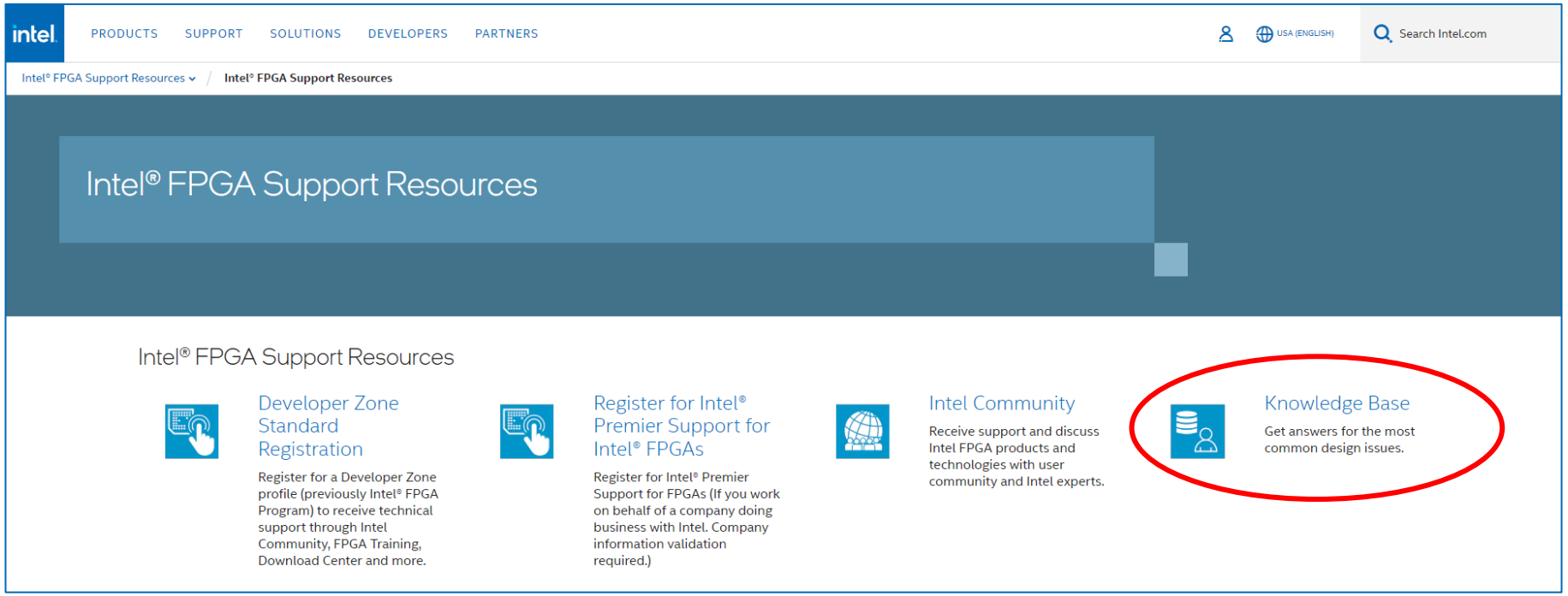
Support

- Knowledge Base
  - https://www.intel.com/content/www/us/en/support/programmable/kdb-filter.html
- Intel® Community
  - https://community.intel.com/t5/FPGA/ct-p/fpga
- RocketBoards.org
- Support
- Training

Knowledge Base

Your questions are answered in the Knowledge Base

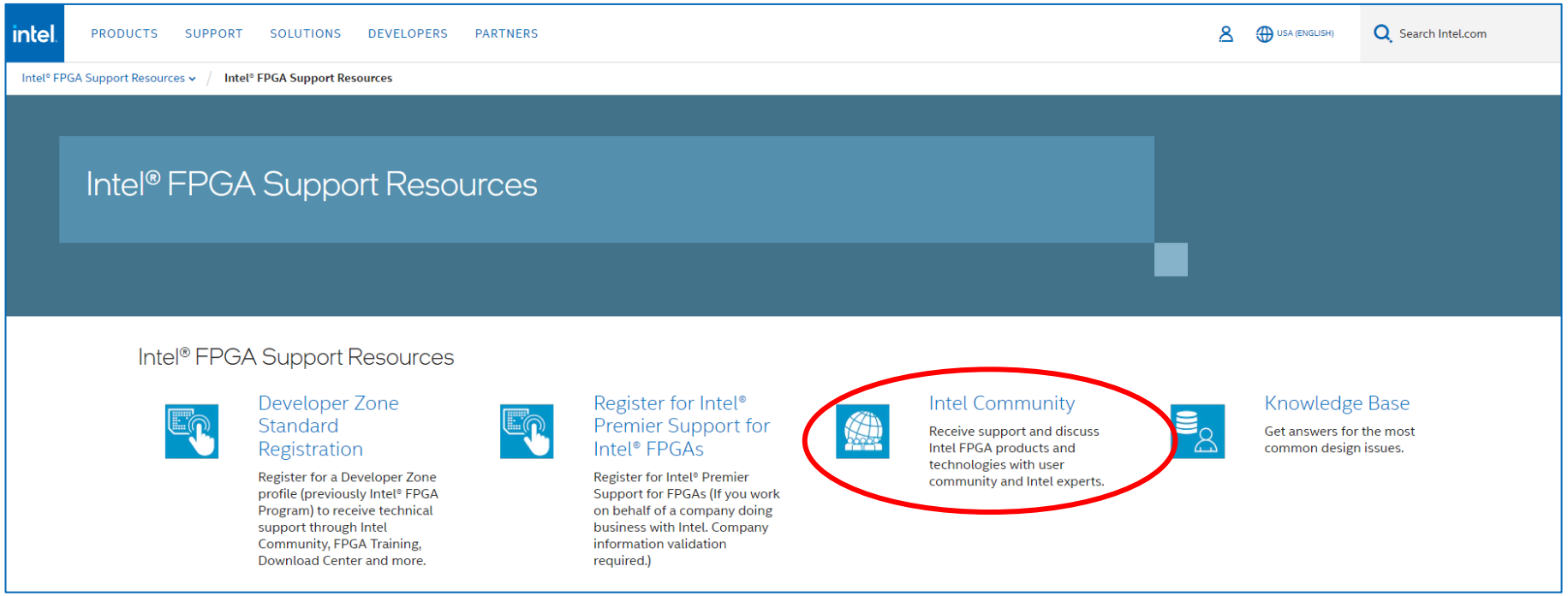
- https://www.intel.com/content/www/us/en/support/programmable/support-resources/overview.html



Intel® Community

Join a community forum to learn from each other

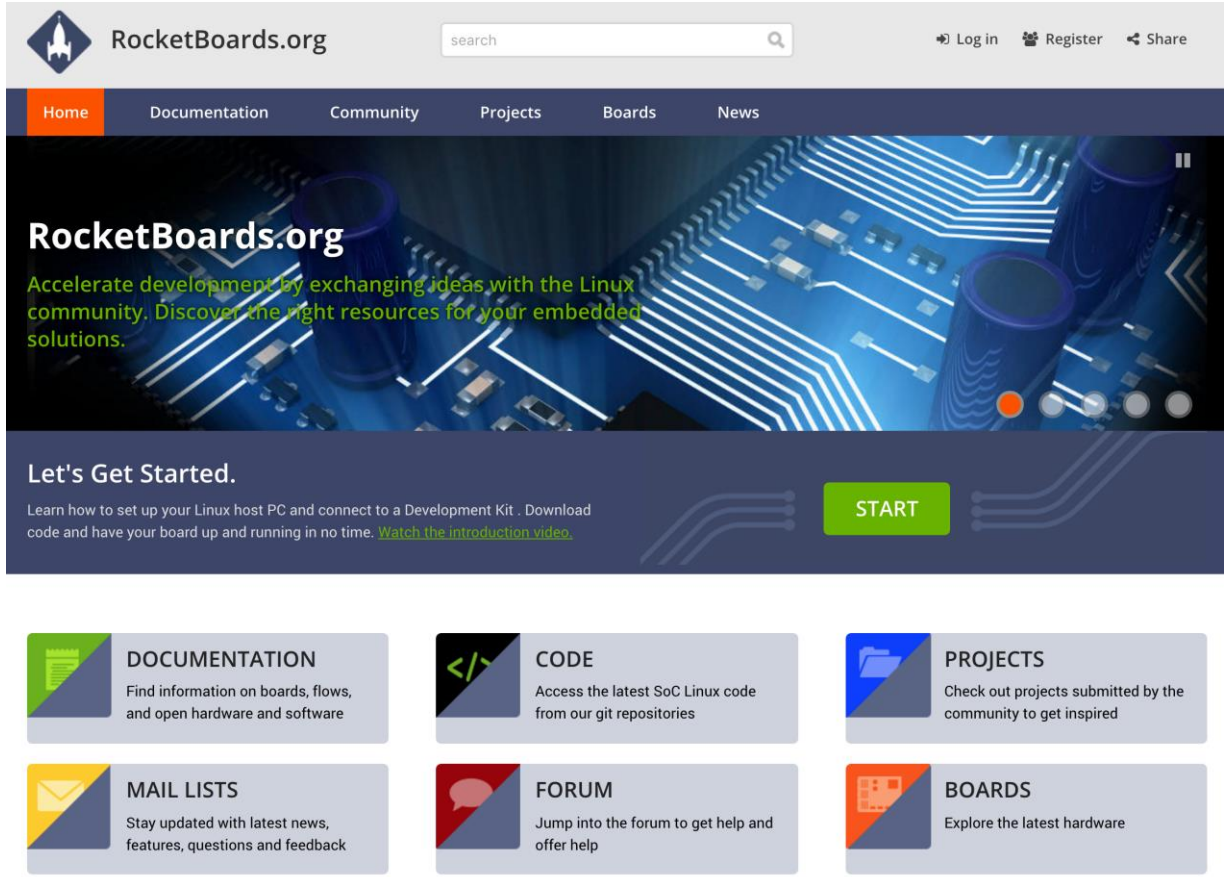
- https://www.intel.com/content/www/us/en/support/programmable/support-resources/overview.html



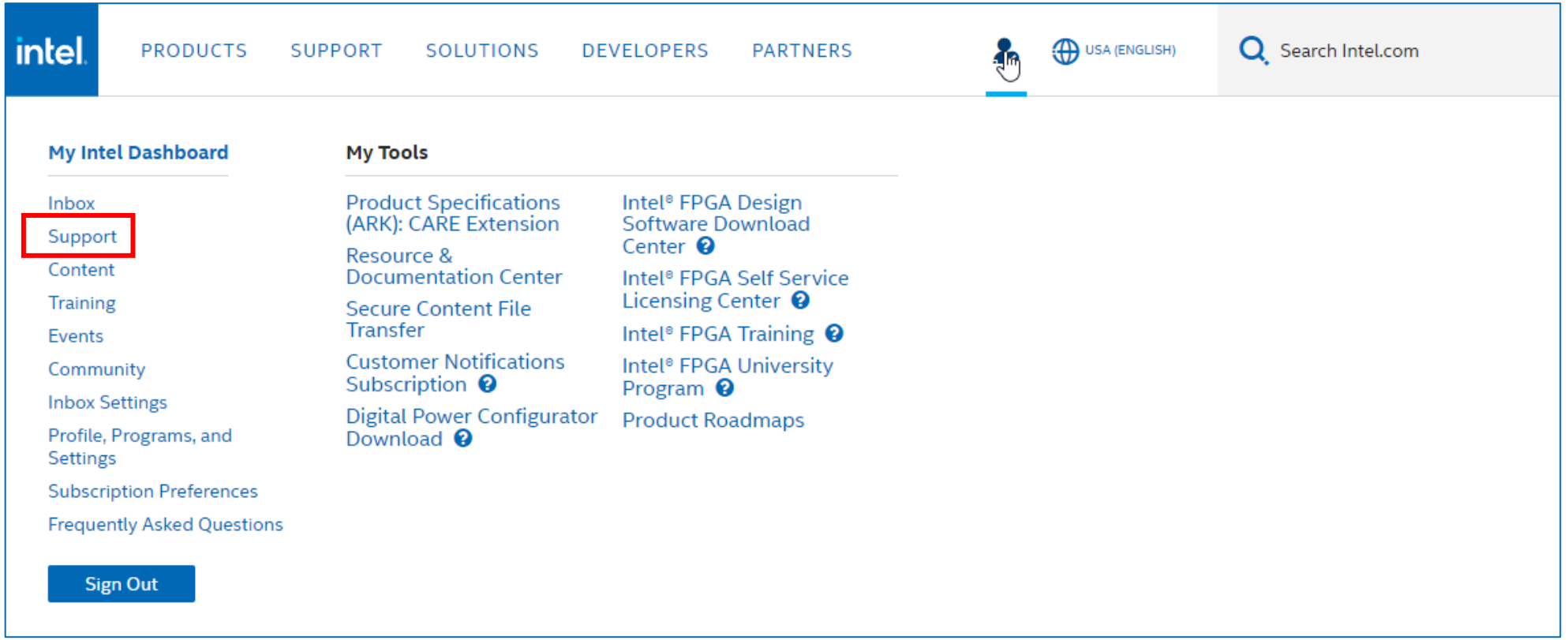
RocketBoards.org for Soc Linux Development

Online community dedicated to running embedded Linux on Intel® SoC devices

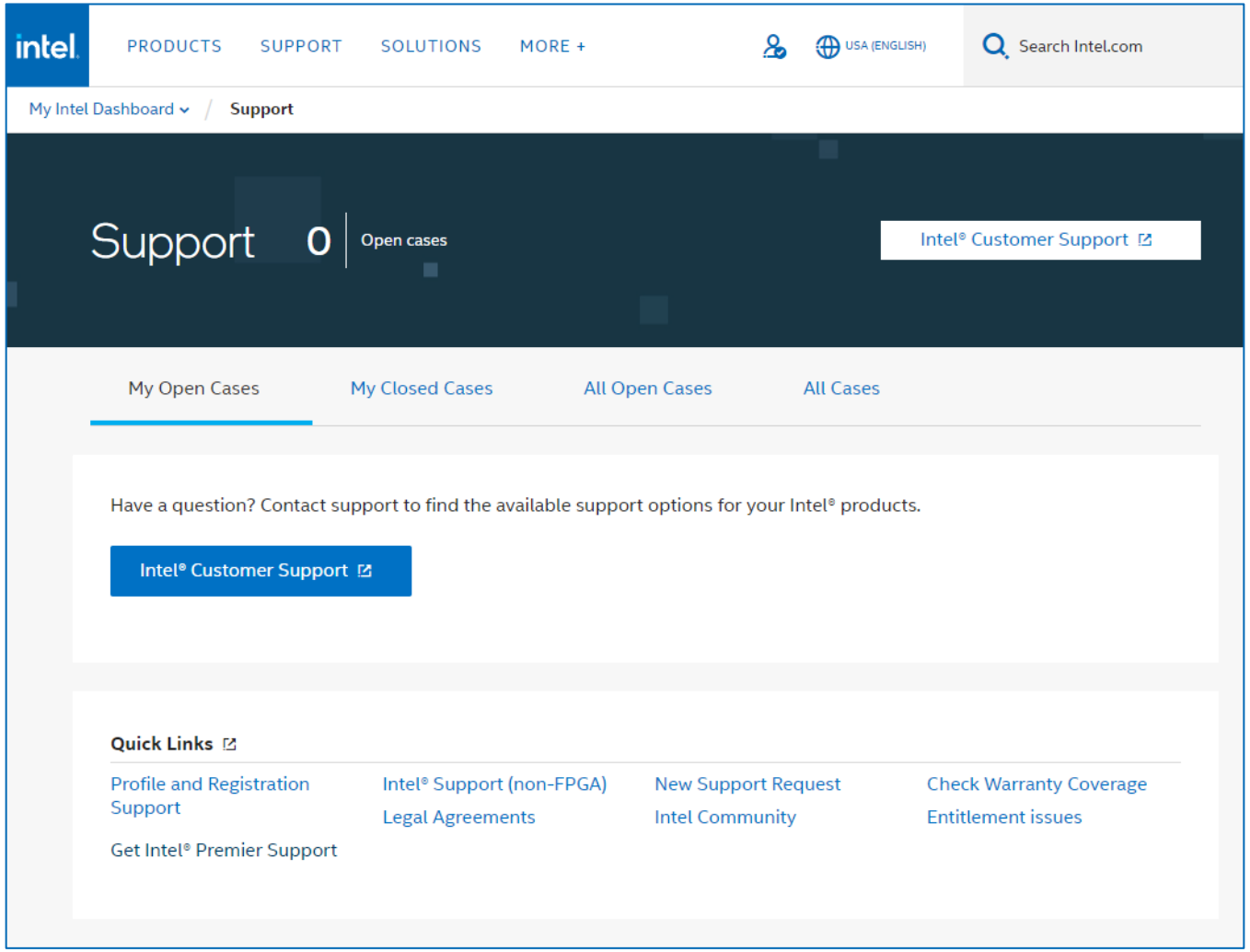
- https://rocketboards.org/



Support



Support – Your Cases



Training

Sharpen your skills

- https://www.intel.com/content/www/us/en/support/programmable/support-resources/overview.html

Additional Resources

Development Kits

Simplify the design process with Intel and partner development kits.

Design Examples

Get started with Intel FPGA products with ready-to-use design examples.

Documentation

Get user guides, data sheets, release notes, and more.

Training

Deepen your expertise with Intel FPGA training courses.

FPGA University Program

Curriculum, tutorials, hardware and software for students, researchers, and educators.

RocketBoards.org

Accelerate development by exchanging ideas with the Linux* community.

How-to Videos

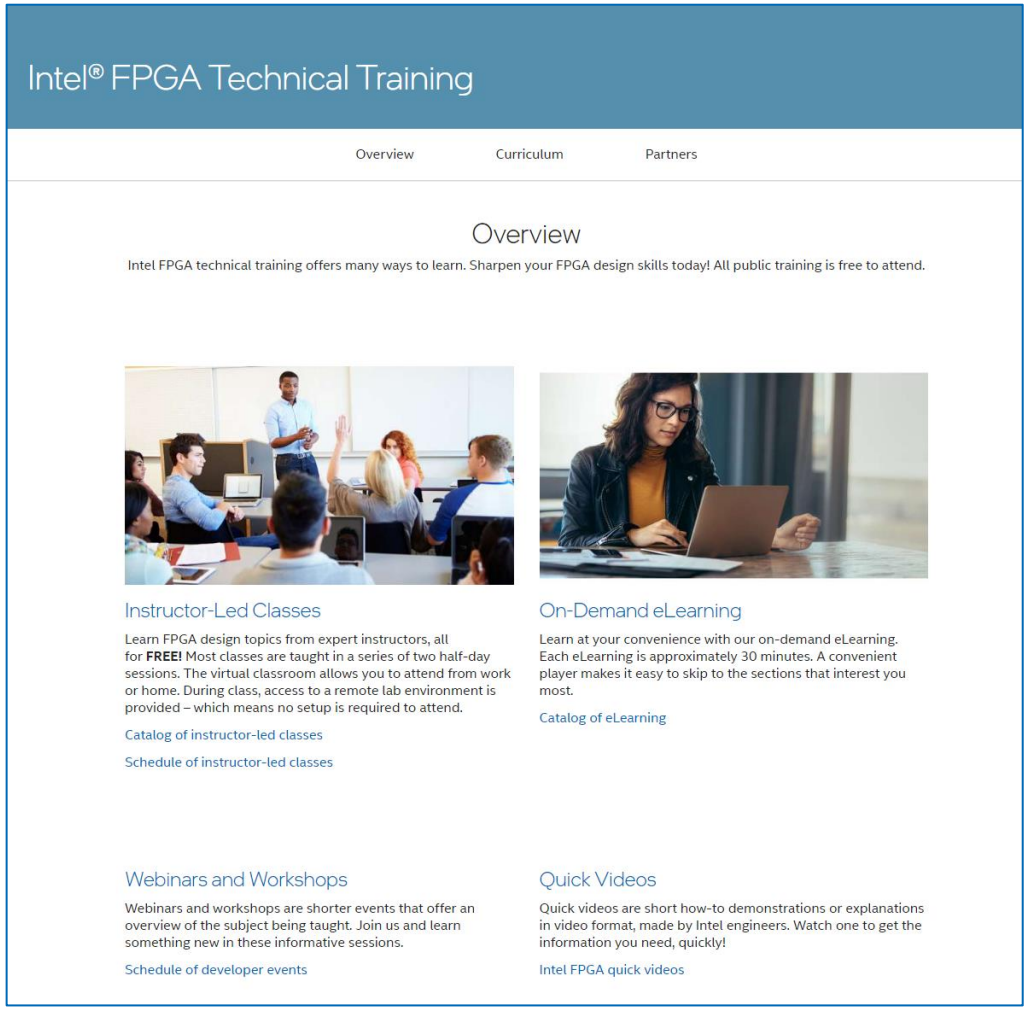
Explore the pool of How-To videos by Intel FPGA engineers.

Quality and Reliability

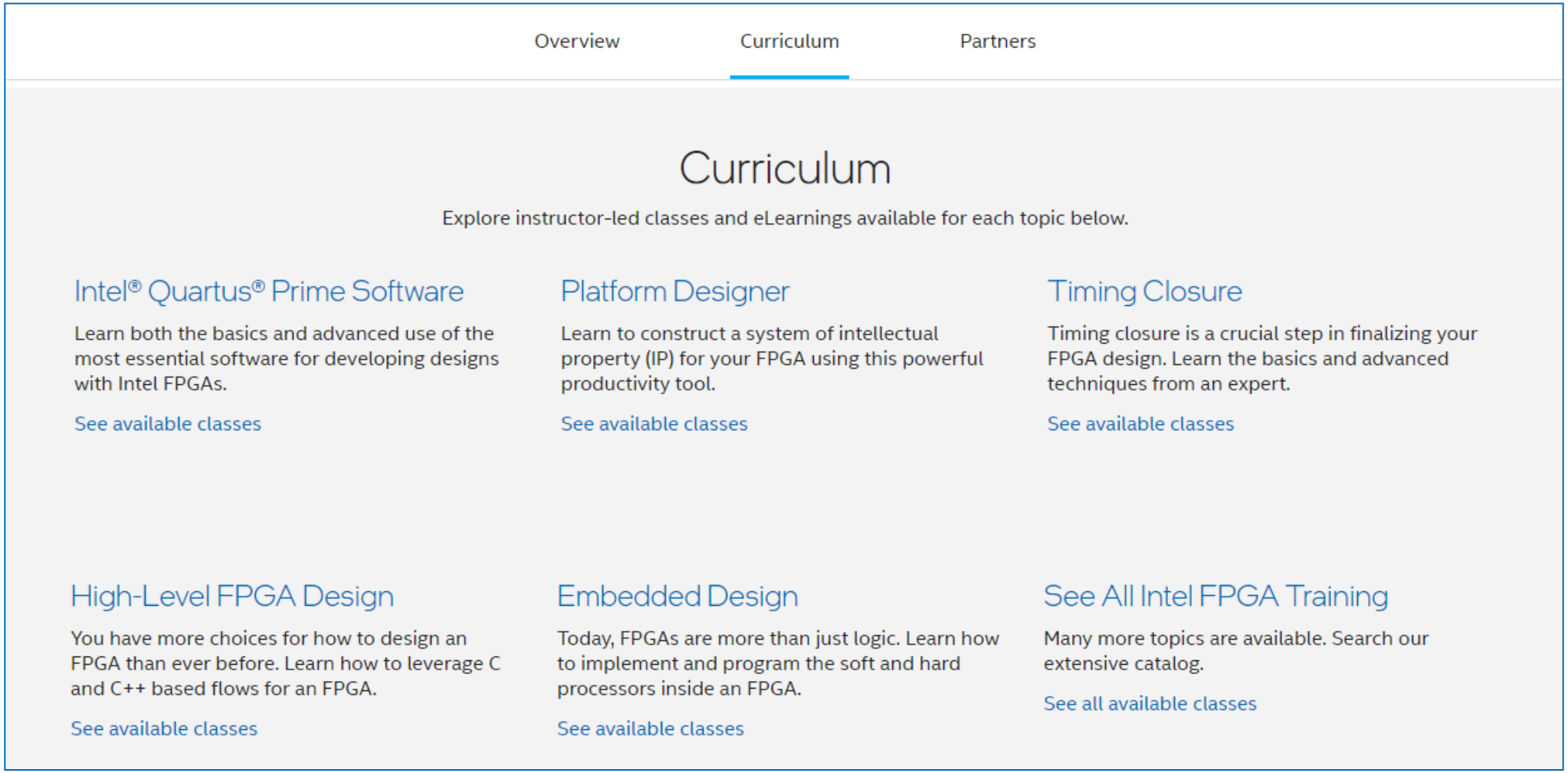
Our goal is to consistently meet customers' quality, reliability, and service requirements.

Training Overview

- Training Curriculum
- Instructor-Led Classes
- On-Demand eLearning
- Quick Videos



Training Curriculum



Instructor-Led Training

Get the most from Intel® FPGA software and devices

- Taught in North America by experienced instructors who can answer your questions
- View and sign up for upcoming classes
  - https://www.intel.com/content/www/us/en/events/developer/overview.html
- Contact our training partners outside of North America
  - https://www.intel.com/content/www/us/en/support/programmable/support-resources/fpga-training/overview.html#editorialtable_1548056245

Web-based Classes

- Conducted live over the Internet
- Interact directly with an Intel® FPGA Technical Training instructor
- Identical content to the in-person class
- Audio provided through Internet interface or separate telephone conference call
- Classes taught in 4.5 hour sessions across consecutive days
- Exercises done through remote hands-on lab interface; no need to install any software locally!

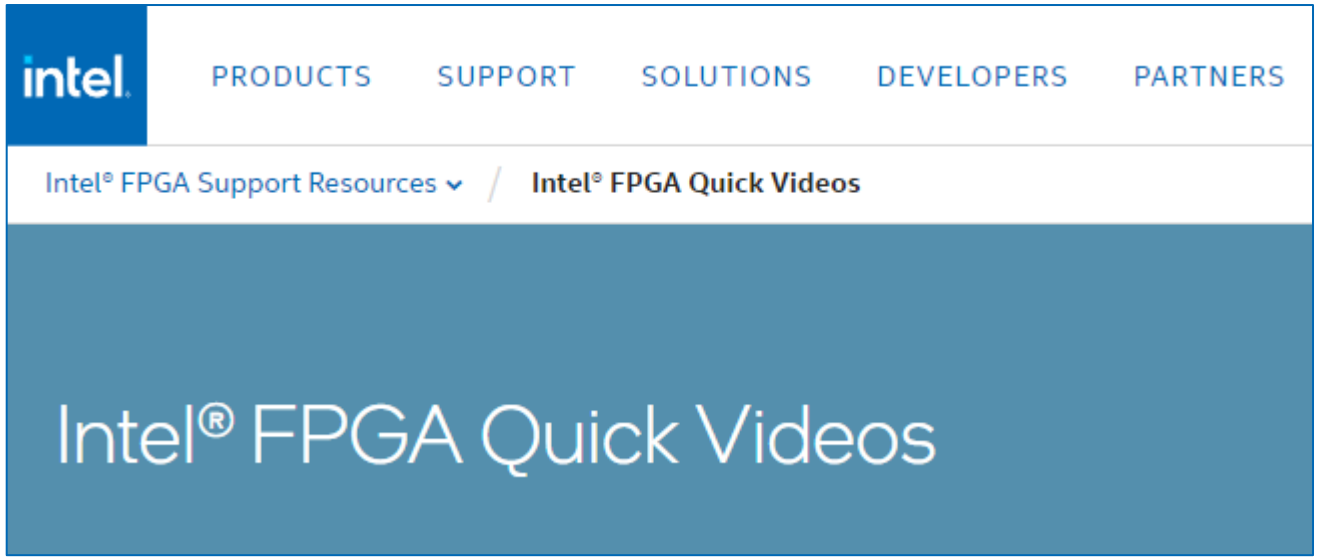
On-Demand eLearning

Hundreds of online trainings

- Usually 20-30 minute presentations
- Most training viewable on a computer or any mobile device
- You control the pace of the course
- Free!!

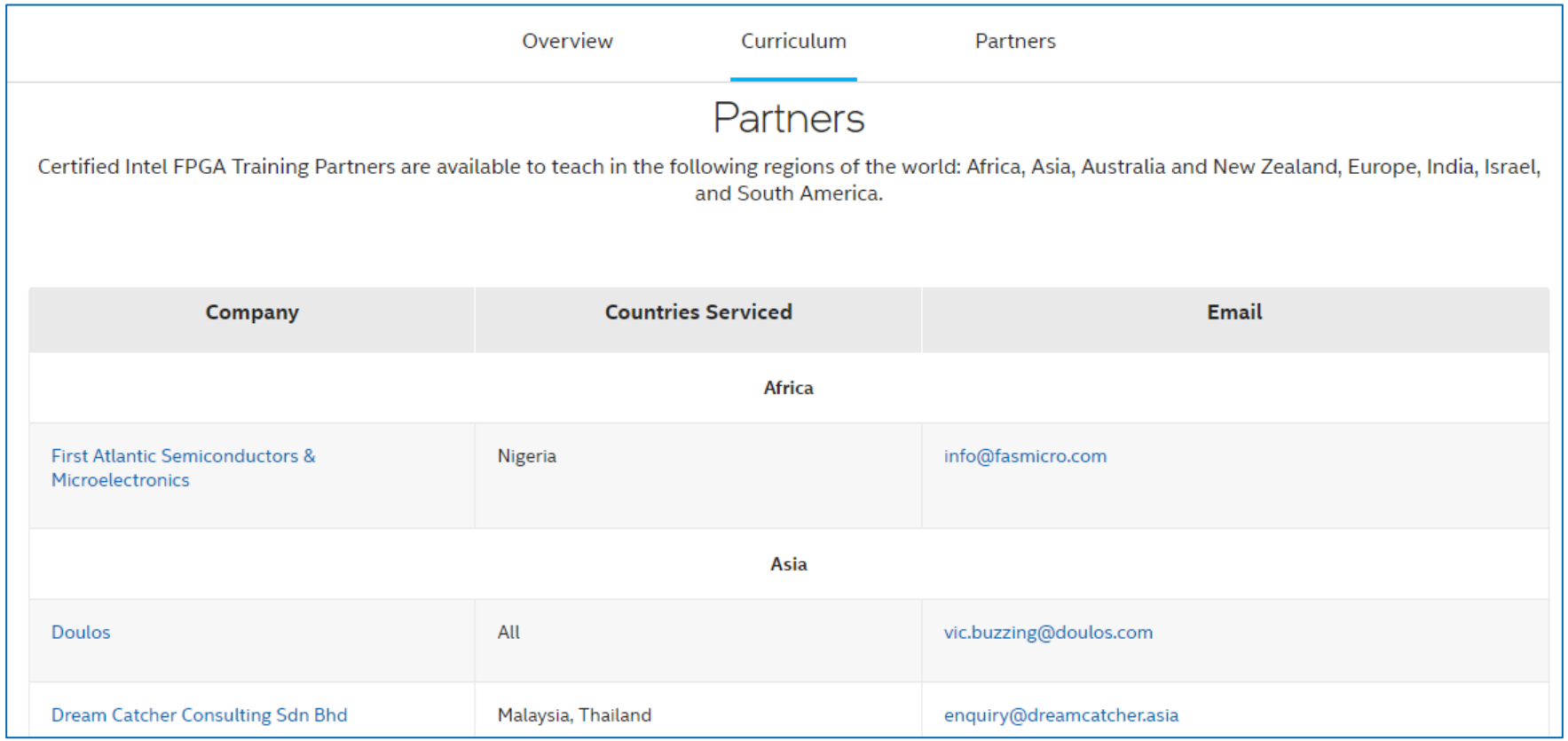
Intel® FPGA Quick Videos

- Short, ~5 minute videos
- How-to videos
- A single, concise topic
- Also published to YouTube



- https://www.intel.com/content/www/us/en/support/programmable/support-resources/fpga-training/fpga-quick-video-index.html

Training Partners



Overview | Curriculum | Partners

Partners

Certified Intel FPGA Training Partners are available to teach in the following regions of the world: Africa, Asia, Australia and New Zealand, Europe, India, Israel, and South America.

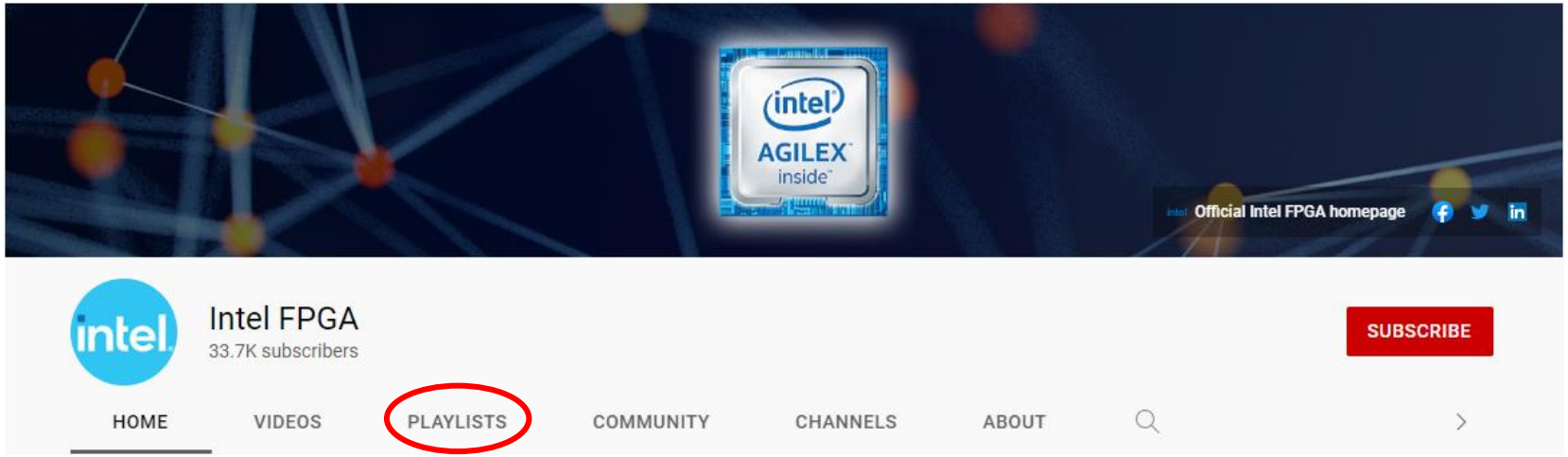
Company	Countries Serviced	Email
Africa		
First Atlantic Semiconductors & Microelectronics	Nigeria	info@fasmicro.com
Asia		
Doulos	All	vic.buzzing@doulos.com
Dream Catcher Consulting Sdn Bhd	Malaysia, Thailand	enquiry@dreamcatcher.asia

- https://www.intel.com/content/www/us/en/support/programmable/support-resources/fpga-training/overview.html#editorialtable_1548056245

Training on YouTube

Subscribe to the Intel® FPGA YouTube Channel

- https://www.youtube.com/c/IntelFPGA



- Engineer-to-Engineer playlist
  - Most videos are 5 minutes or less
  - https://www.youtube.com/c/IntelFPGA/playlists?view=50&sort=dd&shelf_id=1

Agenda


Getting Started


Preparation

Software Developers


Hardware Developers


Research


Support


Design Resources

Design Resources

- Ensuring the Success of your Project
- Intel® FPGA Support Resources
- Power Solutions
- Signal Integrity and Power Integrity
- Pin Connections
- Device Review Worksheets
- Design Solutions Partners
- References

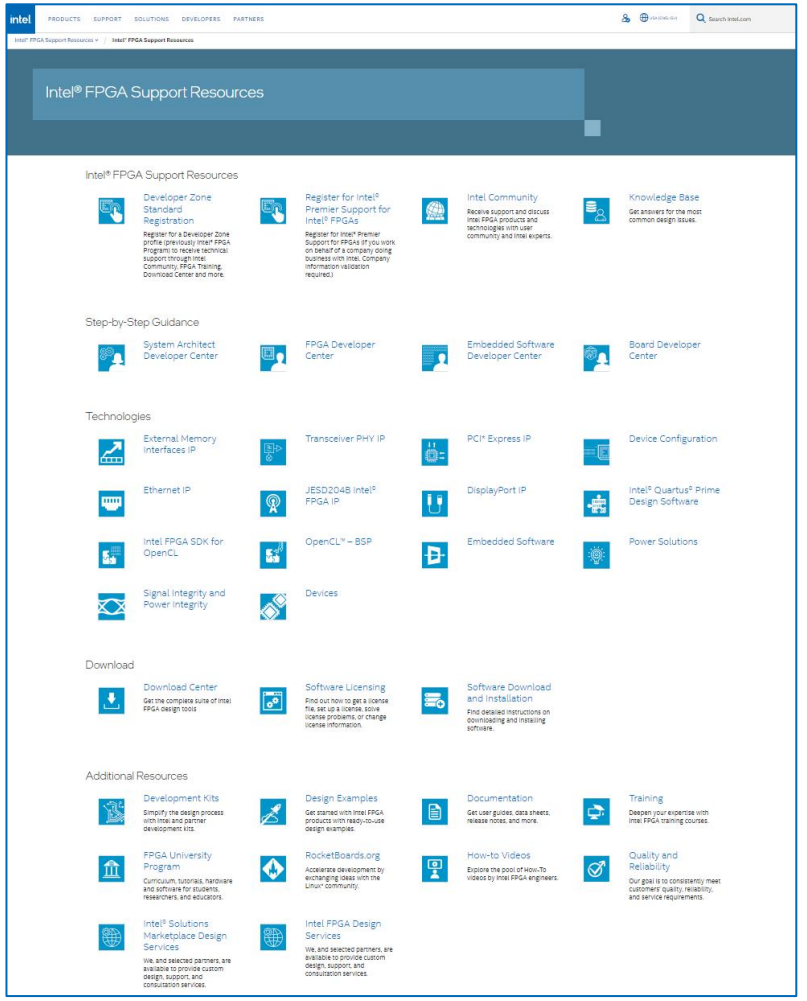
Ensuring the Success of Your Project

- Educate yourself and your team
  - Start with the resources identified in this training
  - Minimize delays and redesign due to incorrect product assumptions
  - Develop a highly skilled team
- Anticipate and keep issues out of your critical path
  - Understand your design flow
  - Evaluate existing boards and solutions
  - Plan your project for maximum efficiency
  - Orchestrate internal resources and external
- Conduct an initial design review
  - A proactive design review may reduce significant design mistakes before they occur
  - Contact your distributor FAE for an Initial Design Review

And again….

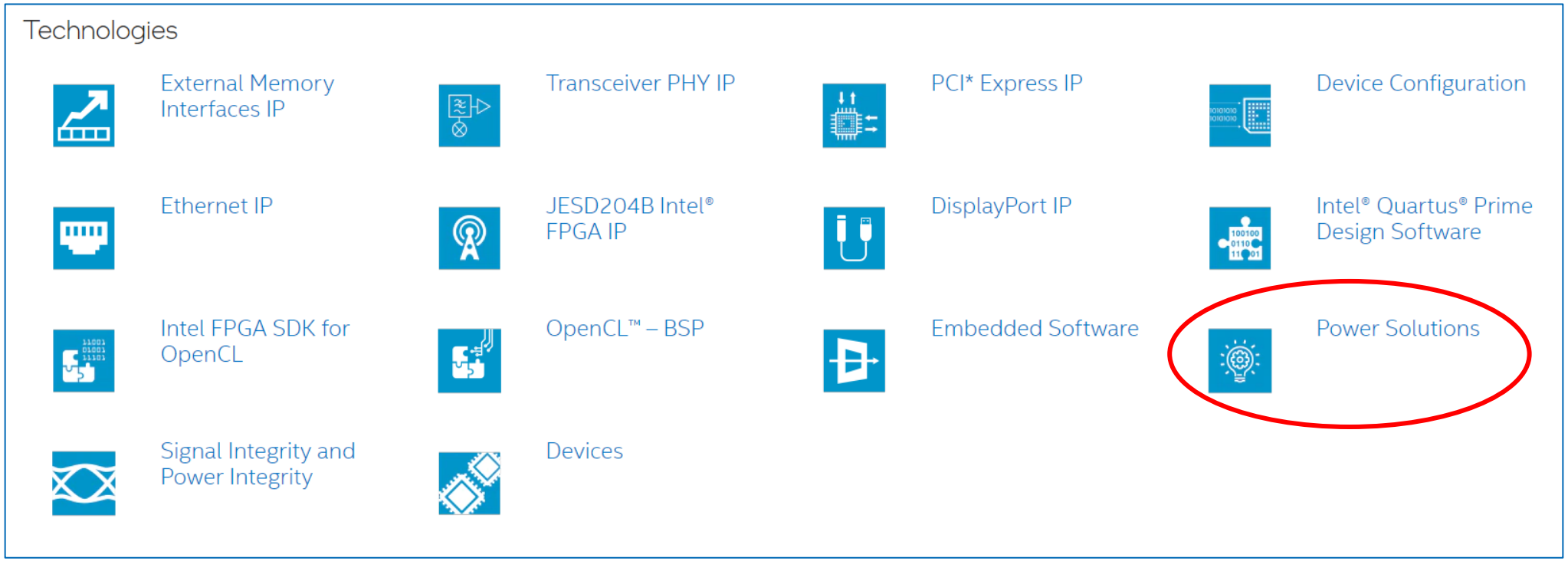
Intel® FPGA Support Resources

- https://www.intel.com/content/www/us/en/support/programmable/support-resources/overview.html



Power Solutions

- https://www.intel.com/content/www/us/en/support/programmable/support-resources/overview.html



Power Solutions – Support Center

Power Solutions - Support Center

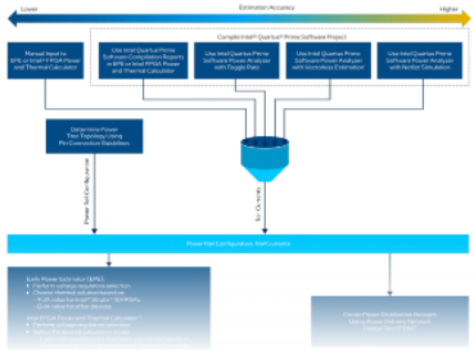
1. Power Architecture – The Power Tree
2. Estimation and Optimization
3. Generation and Distribution
4. Power Dissipation and Thermal Management

Welcome to the Power Solutions support center!

Here you will find information to help you understand power consumption considerations when planning system designs, estimating power requirements throughout the entire design flow, and meeting demanding power requirements using Intel® Enpirion® Power Solution DC-DC converters. These converters feature integrated inductors to deliver an industry-leading combination of high efficiency, small footprint, and low-noise performance.

Enjoy your journey!

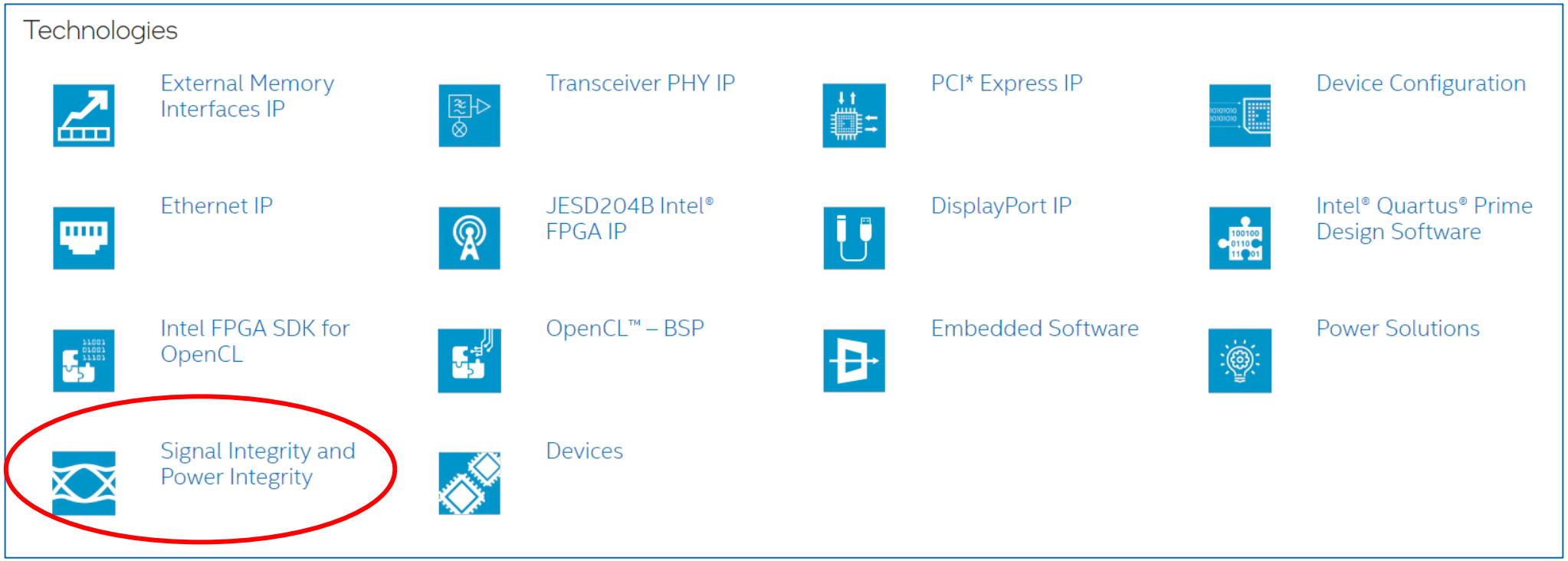
Get support resources for **Intel® Agilex™**, **Intel® Stratix® 10**, **Intel® Arria® 10**, and **Intel® Cyclone® 10** devices from the pages below. For other devices, search from the following links—Documentation Archive, Training Courses, Videos, Design Examples, and Knowledge Base.



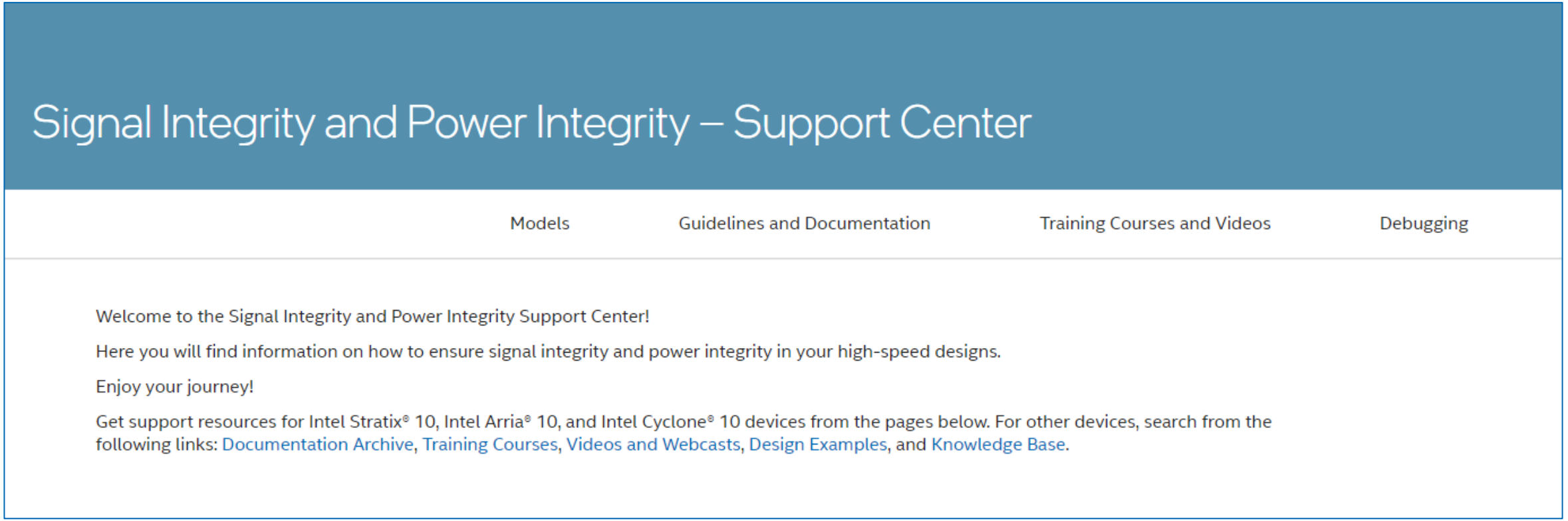
View Full Image

Signal Integrity and Power Integrity

- https://www.intel.com/content/www/us/en/support/programmable/support-resources/overview.html



Signal Integrity & Power Integrity – Support Center



Pin Connections

- Download pin-out files for each Intel® FPGA device family
  - https://www.intel.com/content/www/us/en/support/programmable/support-resources/devices/lit-dp.html
- Understanding how to include an Intel FPGA device on your board can be a complex procedure
  - Get recommendations for connecting pins for specific FPGA families from the Device Pin Connection Guidelines page
  - https://www.intel.la/content/www/xl/es/programmable/support/literature/lit-dpcg.html

Device Review Worksheets

- Device Schematic Review Worksheets
  - Based on respective device Pin Connection Guidelines and other referenced Intel® FPGA literature applicable to board-level pin connections
  - Important to consider when finalizing board schematics to help find mistakes
  - https://www.intel.com/content/www/us/en/support/programmable/support-resources/board-layout/fpga-schematic-worksheets.html

Device Review Worksheets (cont.)

- Device Layout Review Worksheet
  - Based on guidelines found at the Board Design Guidelines Solution Center (https://www.intel.com/content/www/us/en/support/programmable/support-resources/quality/brd-index.html) and other referenced Intel® FPGA literature applicable to board layout techniques and practices
  - Important to consider when finalizing your PCB layout
- All worksheets are downloadable in Word .doc format

Design Solutions Partners

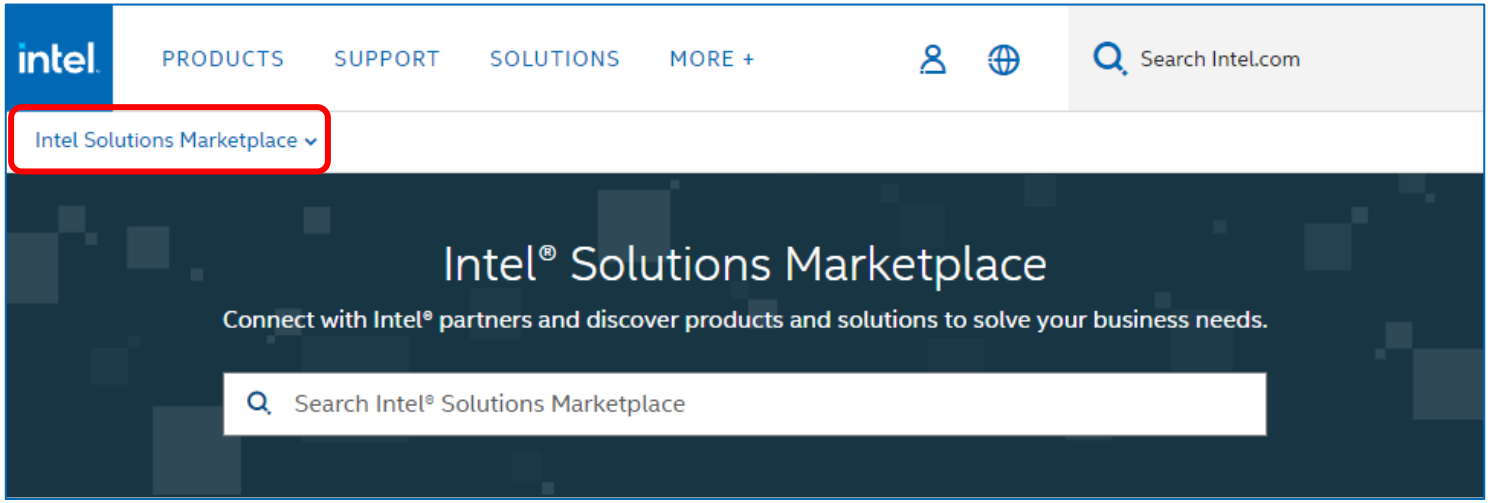
- Sometimes it makes sense to outsource part or all of your project
  - Due to resource limitations, experience, or skill set
- Use the Intel® FPGA network of independent design partners
  - Trained and technically competent
  - Knowledgeable about FPGA products and solutions
  - https://www.intel.com/content/www/us/en/programmable/solutions/partners.html

Summary

- Lots of resources available to you before, during, and at the completion of the design process.
- Use this training as a guide.
- Take advantage of them!
- We're here to help you succeed with your design!

Contacting a Local Distributor

- Distributors have Intel® FPGA-trained and certified field application engineers (FAEs) to answer your technical questions
- Your distributor offers a variety of services to help you use Intel FPGA products



- https://marketplace.intel.com/

Additional Training and Support Resources

Visit the Intel® FPGA YouTube channel for more than 1000 trainings and quick videos

Visit the Intel FPGA training website for eLearning courses narrated in a slide-by-slide player

Enroll in free instructor-led courses that include interaction and hands-on lab exercises

Still have questions? Visit our forums that are monitored by skilled applications engineers

We Welcome Your Feedback

- Intel® FPGA Technical Training Team is continuously looking for ways to improve our training
- Your feedback is an important part of this process
- Please email fpgatraining@intel.com with any thoughts you have on the course you attended

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