



PRESENTED BY



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Using Operating Systems on Zynq

Featuring the Zynq Mini-ITX Development Board

What is the BEST Operating System?

- What is the BEST smartphone?



LG G Flex



Samsung
Galaxy
S5



Windows Phone 7



iPhone 5

Objectives

printable

- Determine the playing field
- Teach you to fish!
- How to get to work
- Accelerate your Success!



<http://hdw.eweb4.com/search/stadium/>



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Agenda

- Operating systems for Zynq
- Ask the right questions
- OS AMP case study
- Next steps



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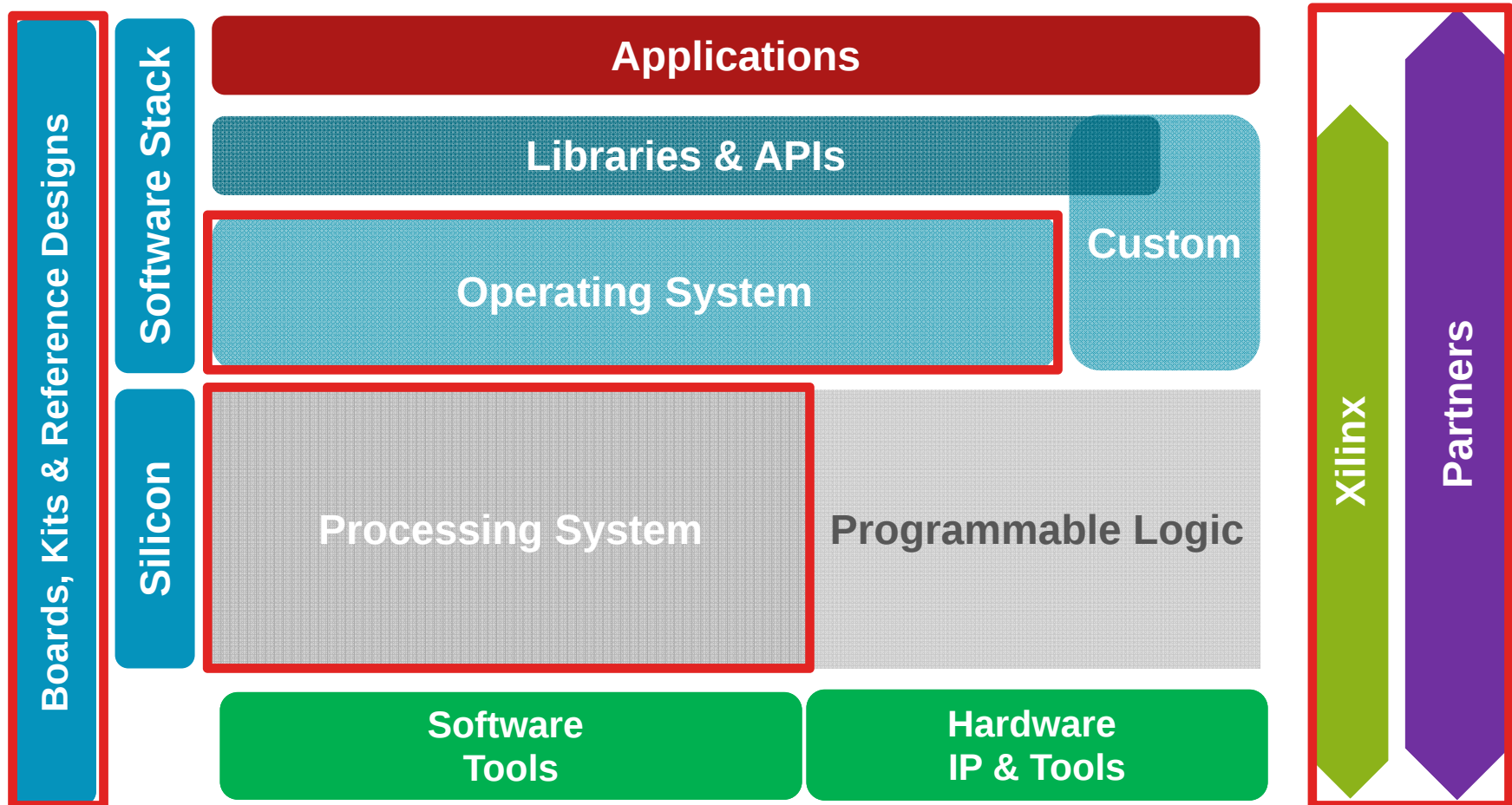
Operating Systems for Zynq



<http://hdw.eweb4.com/search/stadium/>

Zynq-7000 AP SoC

Not just silicon but complete platform



Online support from ZedBoard.org

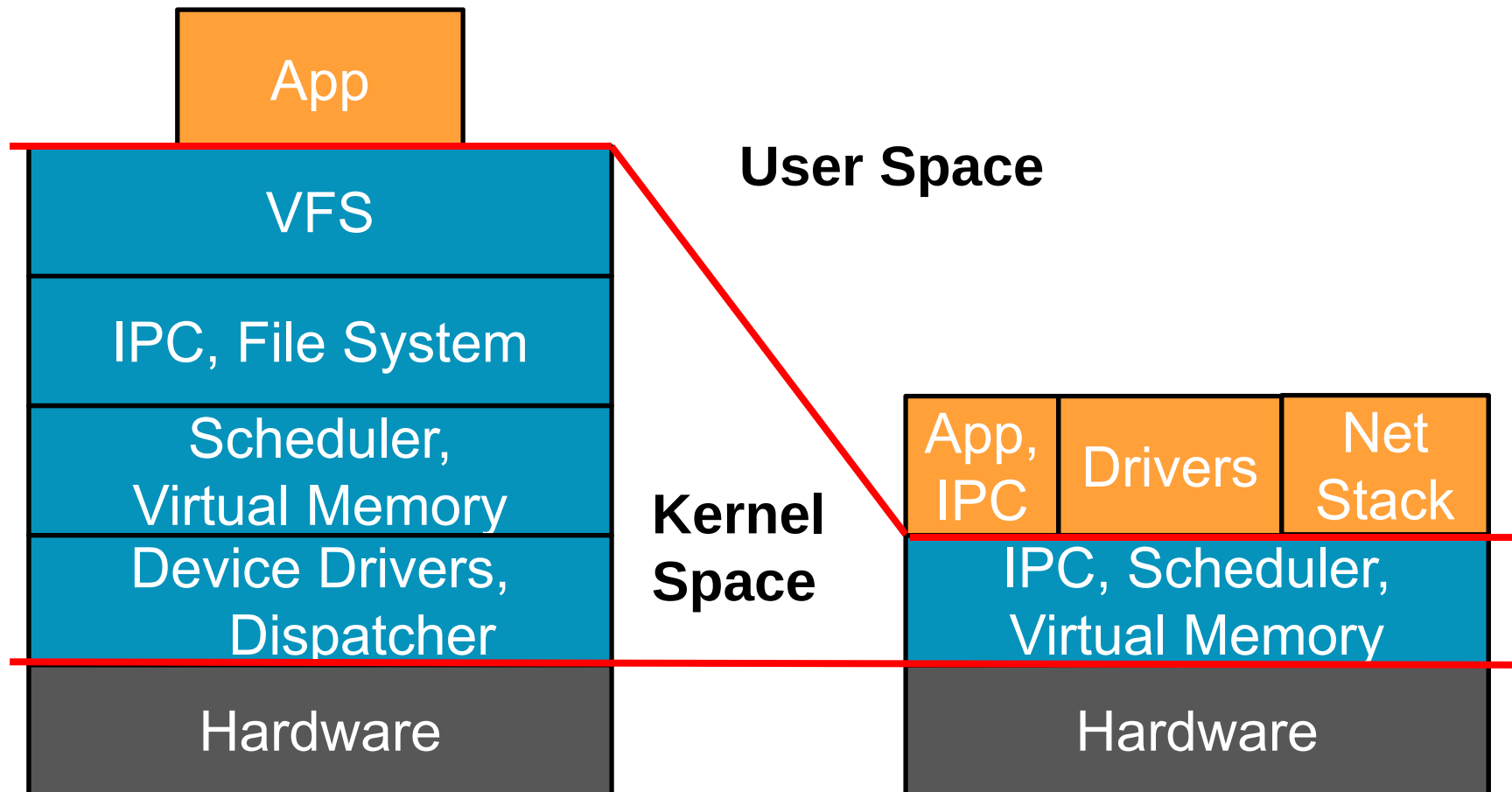
Robust Partnership Ecosystem



Monolithic vs Microkernel

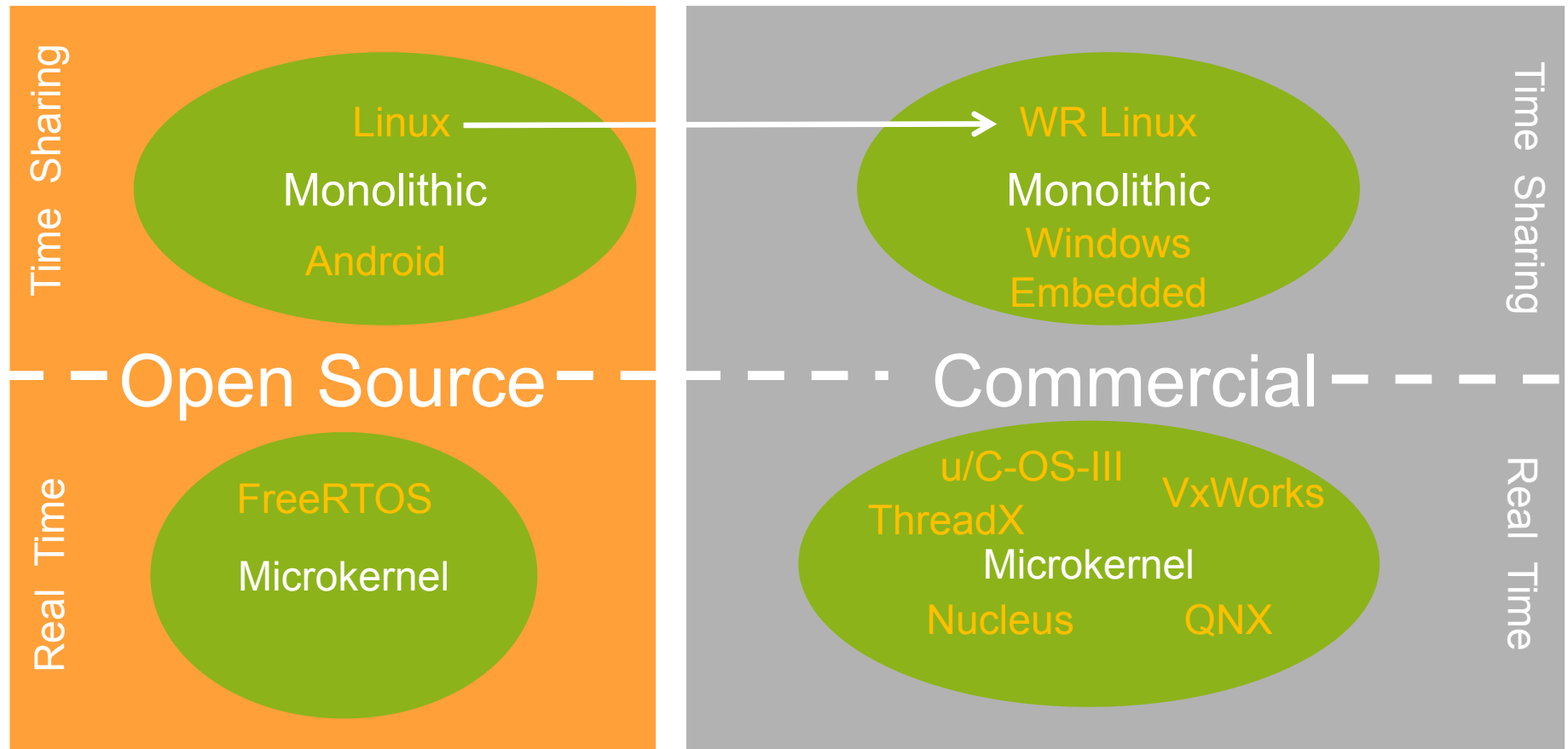
Linux, A Monolithic Kernel based Operating System

Microkernel based Operating System



- Illustration based on <http://en.wikipedia.org/wiki/Microkernel>.
- Also thanks to John Linn of Xilinx for the description.

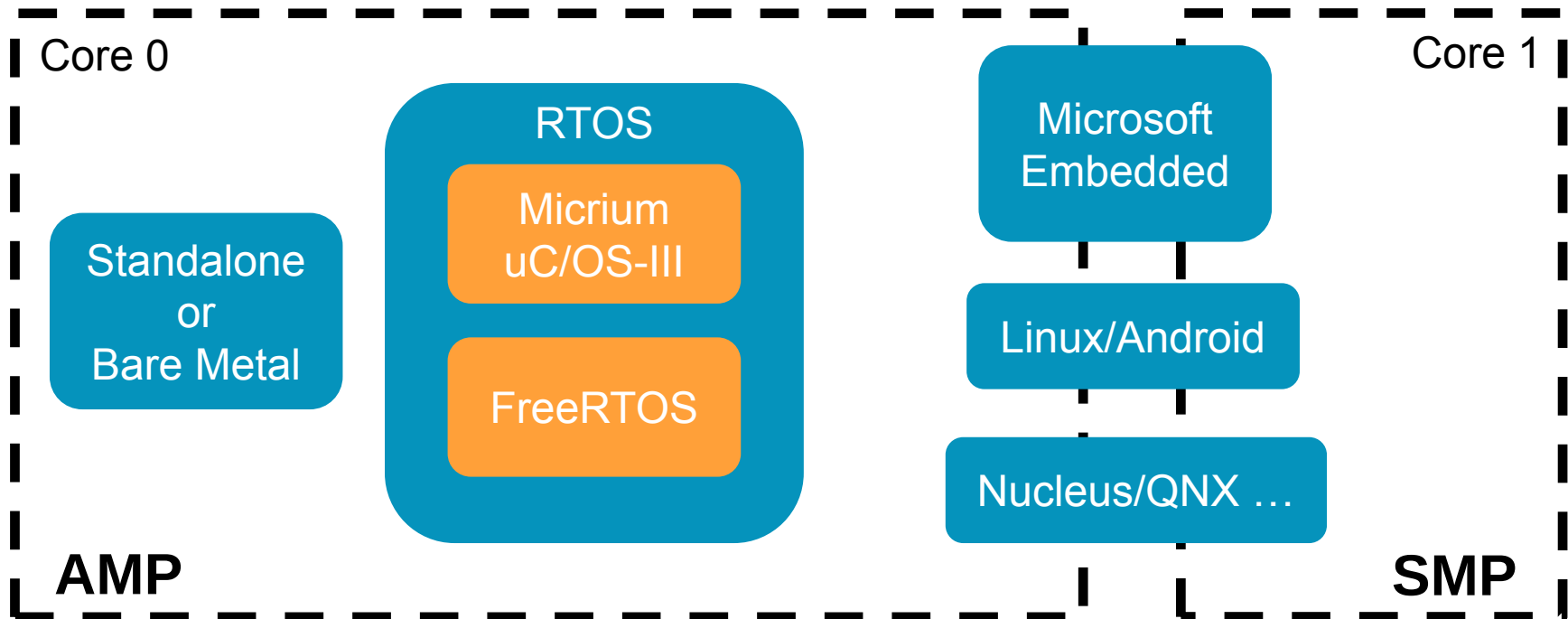
Embedded OS Categories – The Players



Partition the Software System – The Playing Field

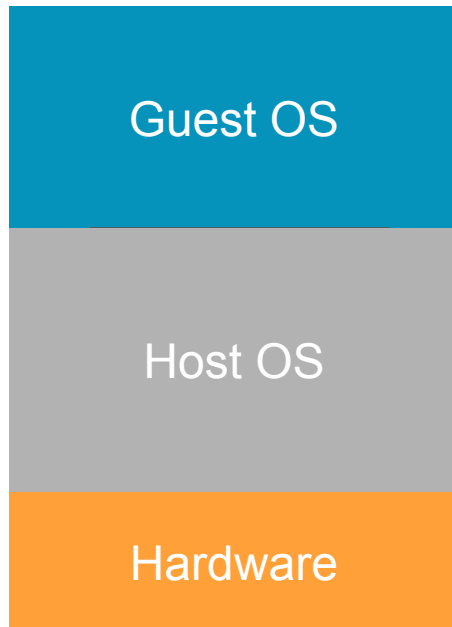
Real Time Performance

High System Performance

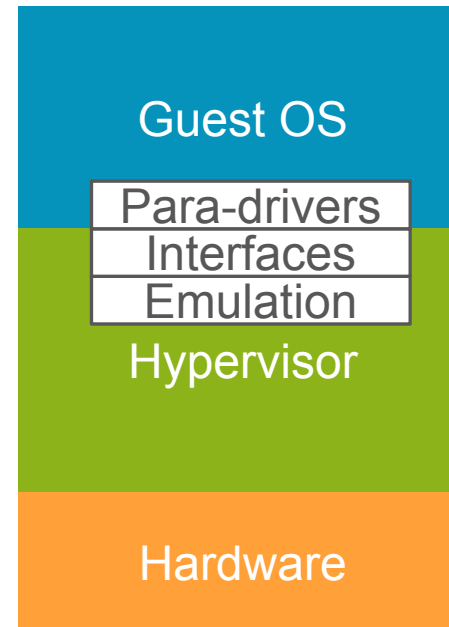


Platform Virtualization

- What is virtualization?



Full virtualization

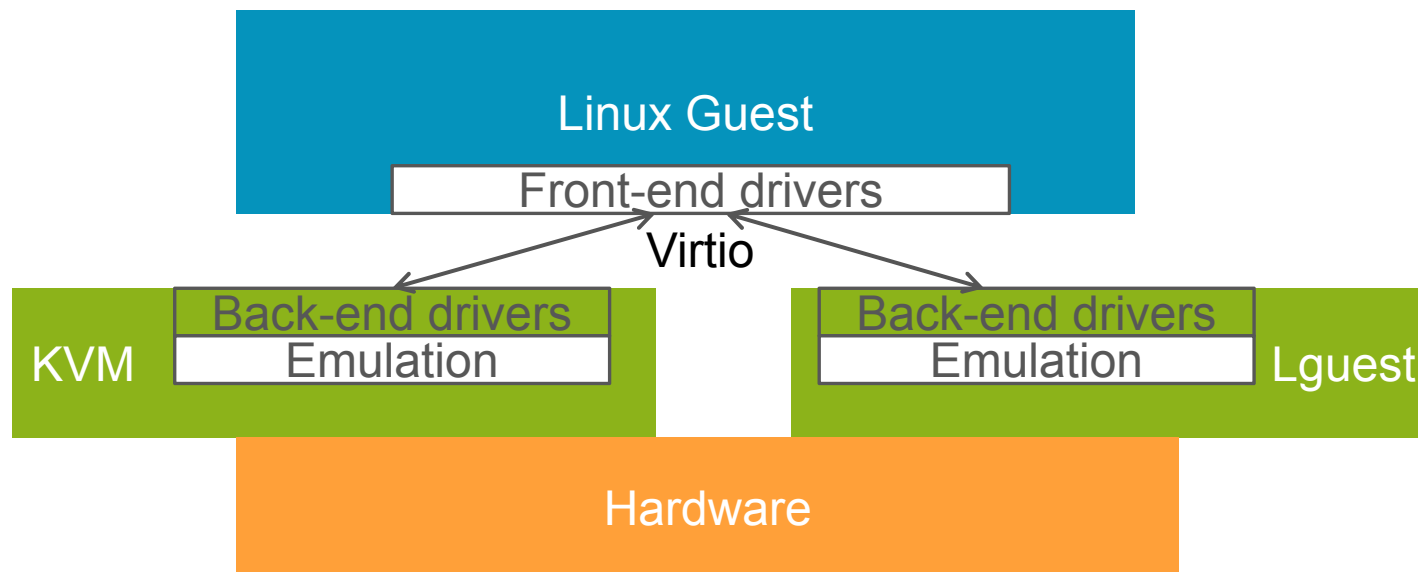


Paravirtualization

Virtio Framework

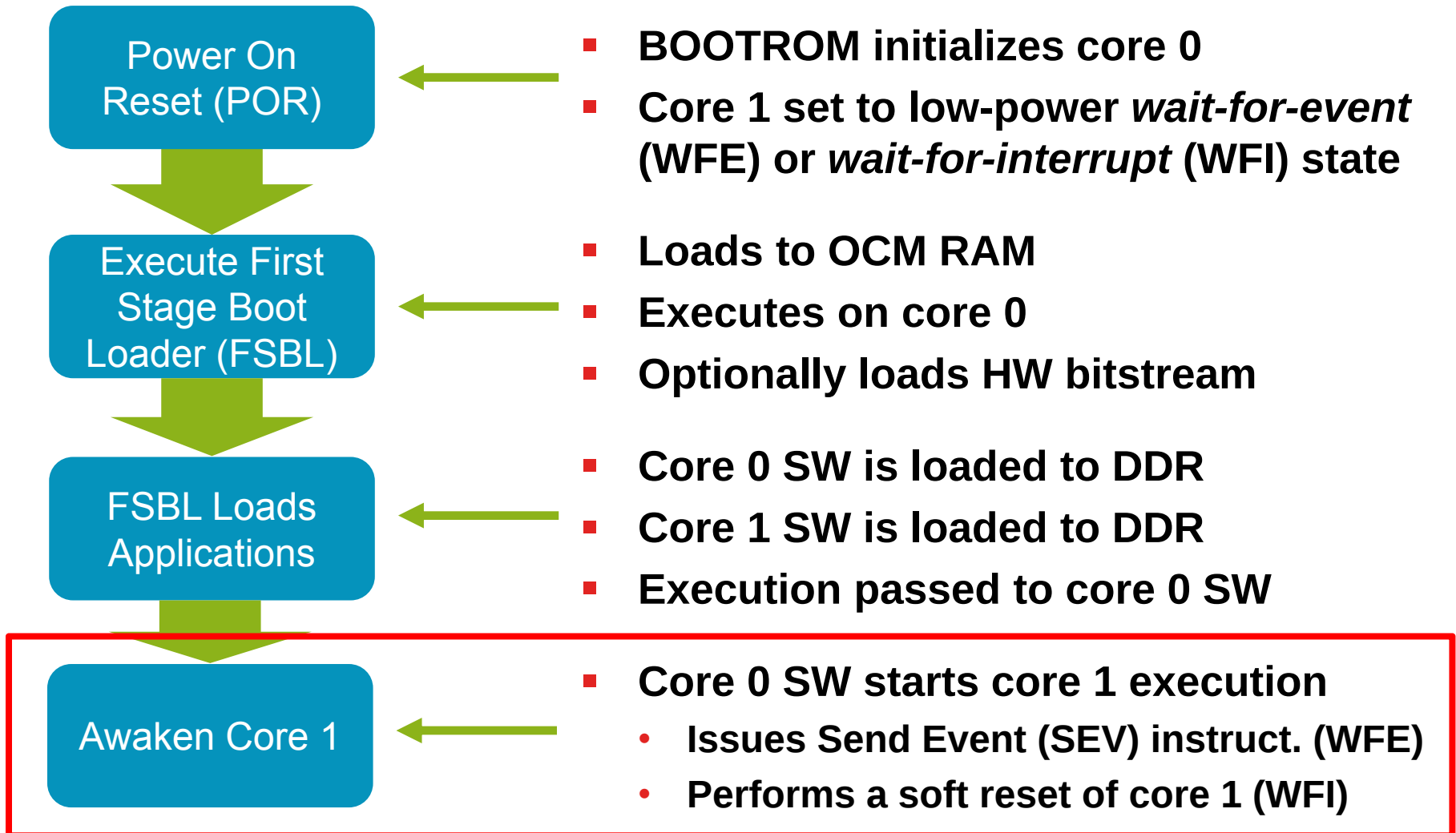
- Abstraction of a common set of emulated devices
 - Exports a common API to Guest OS
- Implemented in Linux as KVM* and Lguest
 - Linux has become the embedded hypervisor of choice

* KVM = Kernel-based Virtual Machine



How does this theory translate to something real?

Processor Boot Sequence



How do we do this from Linux?

remoteproc and rpmsg

- remoteproc framework
 - Allows control of remote processors via a common API
 - Architectural HW differences are abstracted
 - Includes rpmsg Virtio devices for communication
 - Linux provides drivers to implement the framework
- rpmsg messaging bus
 - Built on the Virtio framework
 - rpmsg “devices” are actually communication channels
 - Each channel is identified by a unique 32-bit integer
 - Channels are bound to a source addr and destination addr
 - Similar to the TCP/IP address/port identification

These features are part of the Linux hypervisor



Ask the Right Questions



Standard Fare – 2014 Embedded Market Survey

What are the most important factors in choosing an operating system?*



* Source: UBM Tech 2014 Embedded Market Survey



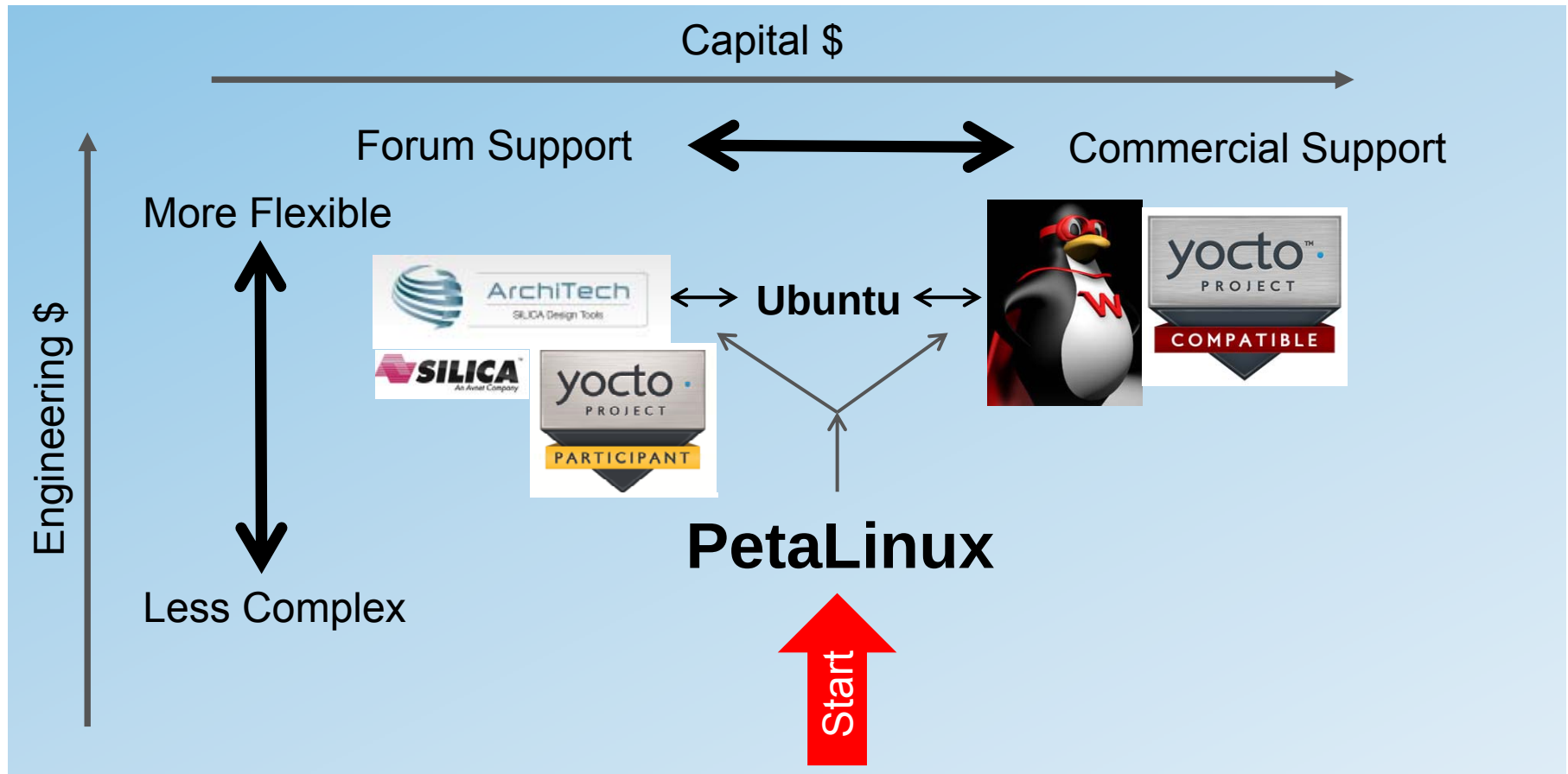
First, make sure you understand what you are comparing!



Linux: What's the difference?

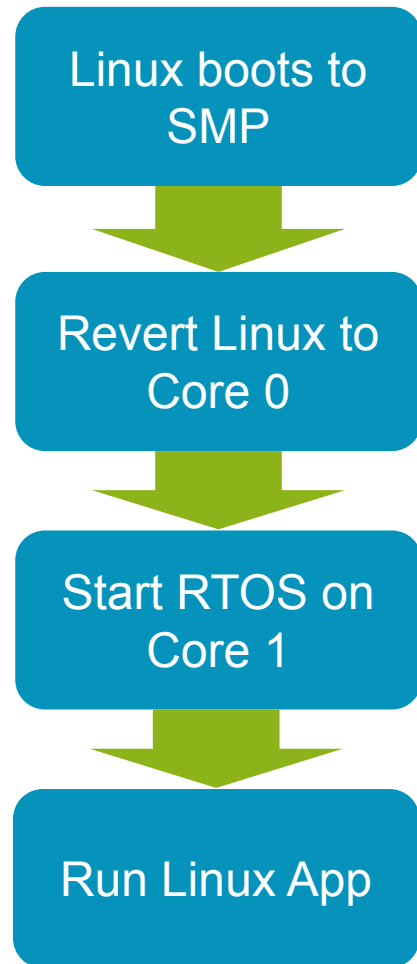
- Xilinx OSL 
 - Xilinx source code repository on github
 - Zynq-specific configs + IP drivers
 - Updated quarterly
- PetaLinux 
 - Custom tool-chain packaged with OSL snapshot and BSPs, updated semi-annually
 - Simplified commands for easy build & board boot
- Yocto 
 - Standards for Linux distributions
 - Recipes for Avnet boards pioneered by Silica
- Wind River 
 - Complete distribution with Zynq BSPs
 - WorkBench Integrated Development Environment
 - Commercial support levels available
- Ubuntu 
 - Desktop environment in user-space that runs on top of a Linux kernel
 - Avnet reference designs use Analog Devices components for video/audio

Which Linux is Right for Me?



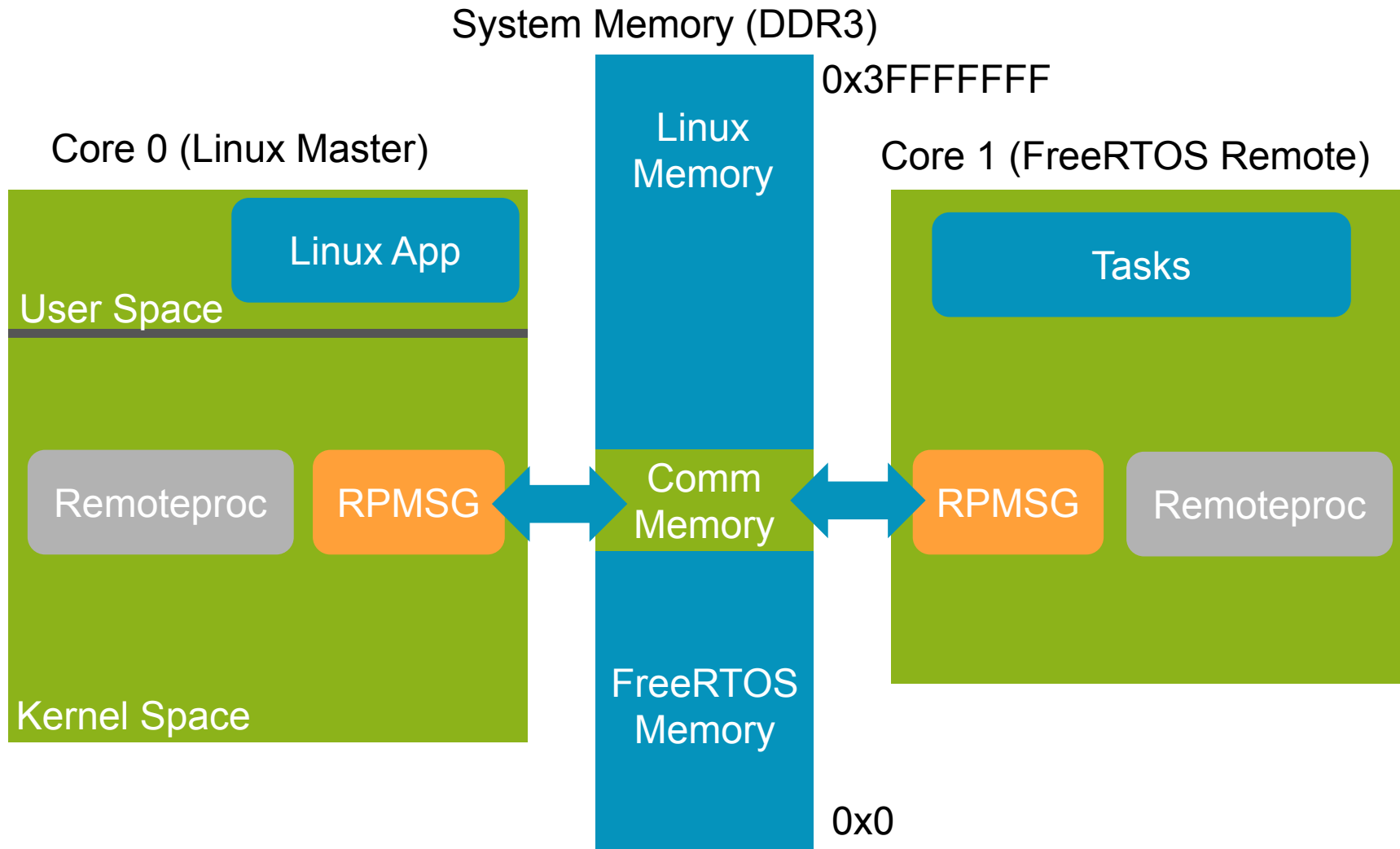
This is SMP, but what about AMP?

AMP Boot Procedure



- BOOTROM invoked at POR for core 0
- Core 1 is forced to low-power wait state
- FSBL on core 0, loads HW & U-boot
- Linux is loaded and awakes core 1
- remoteproc shuts down core 1 and enables virtualization layer
- rpmsg loads/runs RTOS firmware and creates a Virtio comm channel
- Start Linux application
- Send instructions to remote via Virtio
- Core 1 task executes, response written to shared memory
- Linux app reads and displays

OS AMP System



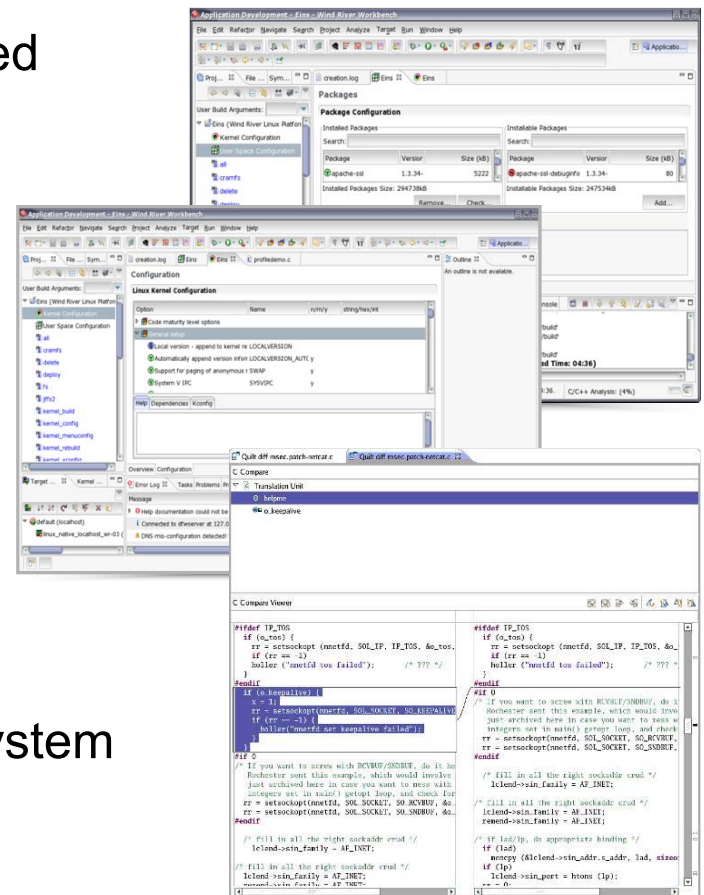
What About App Development?

- Spend the majority of your development dollars here
 - Maximize efficiency by minimizing development environments
- Learning curve for OS API and frameworks
 - This is much steeper for monolithic systems
- Eclipse IDE fits well with Microkernel OS
 - Restrictions on OS-awareness can limit debug capability
 - Consider 3rd party hardware for difficult problems
 - Vivado ILA useful for cross-trigger debug

Consider the benefits of a single development environment!

Wind River Workbench

- Integrated Patch Manager
 - Compatible with diff, patch and quilt
 - Patches can be applied, refreshed, and reverted
- Linux Kernel Configuration Editor
 - View and modify the kernel
 - Find, view & resolve dependencies
- Linux Package Configuration Editor
 - Manage RPMs and dependencies
 - Prepare Packages for Patching
- Linux Run-Time File System Config
 - Utilizes traditional file manager workflows
 - View, add and remove files on the target file system
- QEMU Simulator and Simics integration
 - Provides QEMU as a target directly in the IDE
 - Wizards provide easy configuration

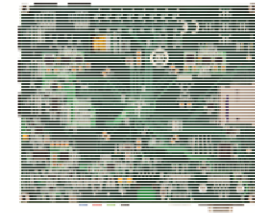
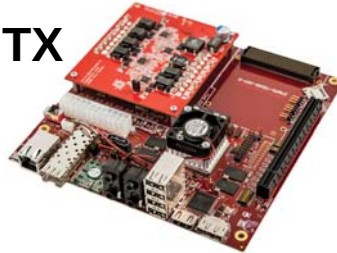


How to Access PL from the OS?

- Microkernel OS
 - Use bare-metal drivers
- Monolithic OS
 - Drivers must conform to OS infrastructure
- Zynq-7000 All Programmable SoC Speedways
 - Developing Hardware in Vivado
 - Chapter 9 covers Linux Device Drivers from User Space
 - Designing Accelerators in Vivado
 - How to create custom hardware to replace SW operations

Target Migration? Advantages of Reuse

Zynq Mini-ITX



Custom PCB

- DDR3 Interface
 - Reuse the Board Definition File for PS DDR3 config
 - Use the same DDR3 PCB placement and routing
- Ethernet PHY
 - Use the same software driver and device tree entry
- High-speed GTX Interfaces
 - Copy working PCB placement and routing for SFP+, SATA-III and PCIe
- I2C Bus Structure
 - Reuse the same software API for I2C communication

Buy vs Build



Zynq MMP



Zynq Mini-ITX

MicroZed



- Proven design examples improve time-to-market and reduce development risk
 - PCIe x4 Root Complex example to assist with PCIe prototyping
 - IBERT design for verifying the GTX transceiver operation
 - Embedded standalone and Linux example designs
 - Ubuntu Desktop with HDMI and stereo audio
- Platform flexibility
 - Mini-ITX board supports Zynq 7Z045 or 7Z100 in FFG900 package
 - Customizable user application with FMC modules
 - Avnet LVDS touch panel interface
 - USB 2.0 4-port hub

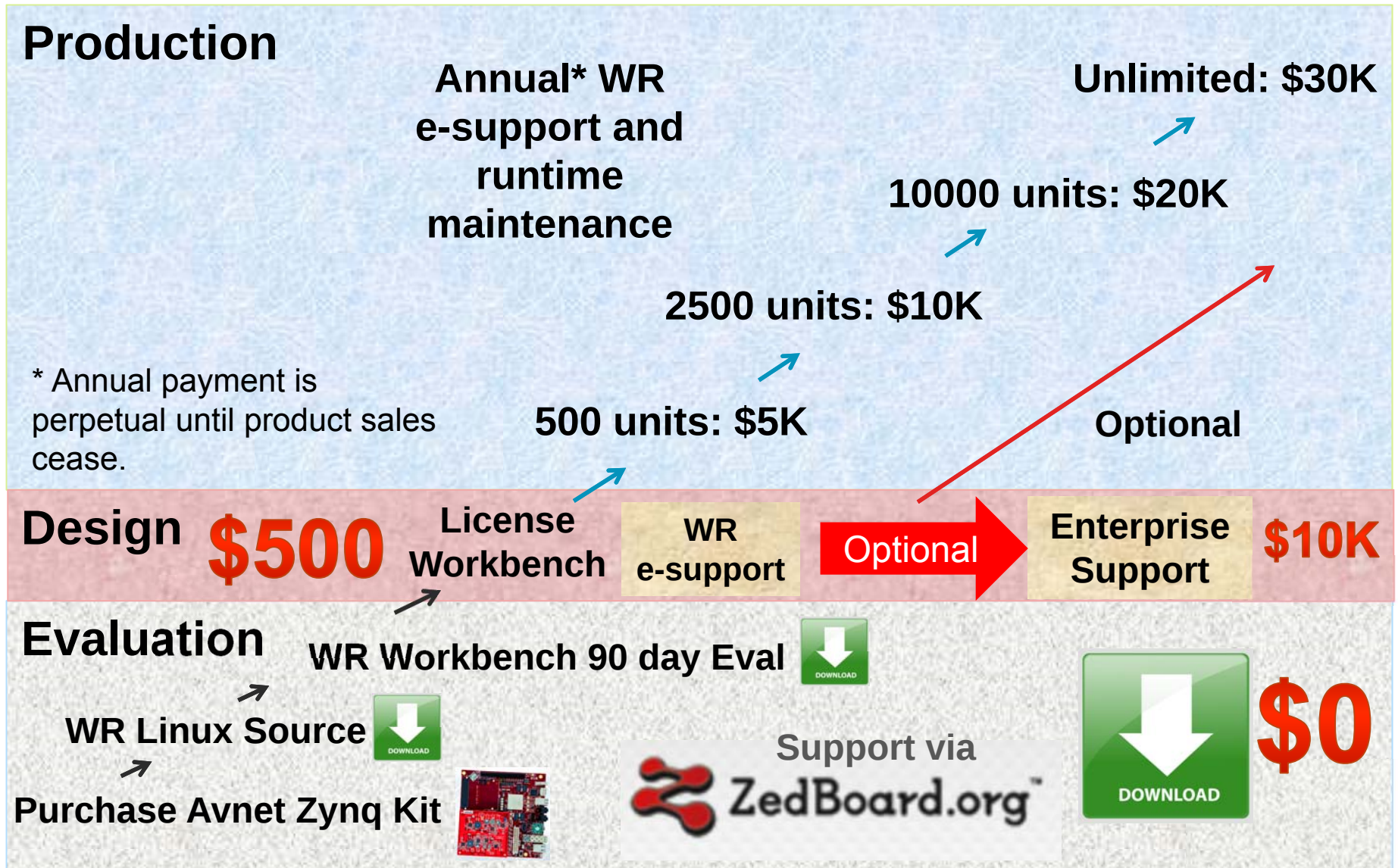
How Do I Manage My Product Life Cycle?

- Scheduled field upgrades
 - Parallel OS update is likely
- Unscheduled field upgrades
 - You don't know what you don't know!
 - Heartbleed is a recent example of a forced firmware update
- Maintaining the Linux kernel is costly and probably not your core-competence



This is a growing issue. What can be done?

Wind River Linux and Avnet Partnership



OS AMP Case Study



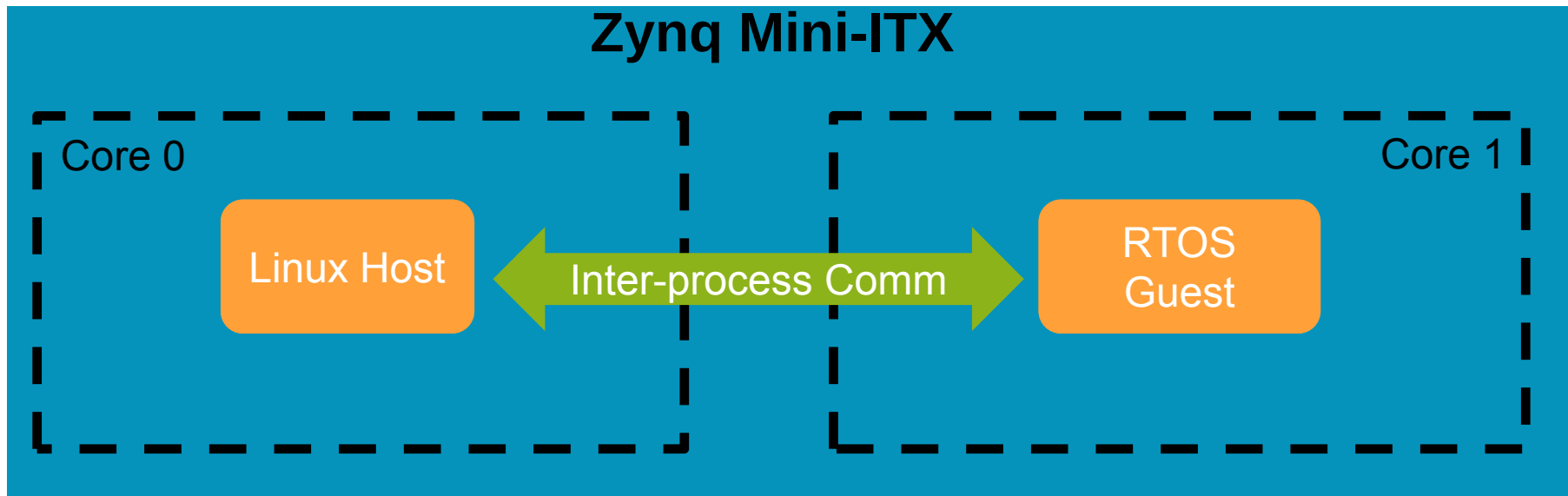
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Zynq Mini-ITX OS Demo Goals

- Demonstrate two operating systems in concert
 - Show communication between processor cores
 - Use time-sharing OS and RTOS
- Make OS selection using relevant questions
 - Validate with industry survey
- Highlight Linux virtualization technology
 - Experiment with distribution migration

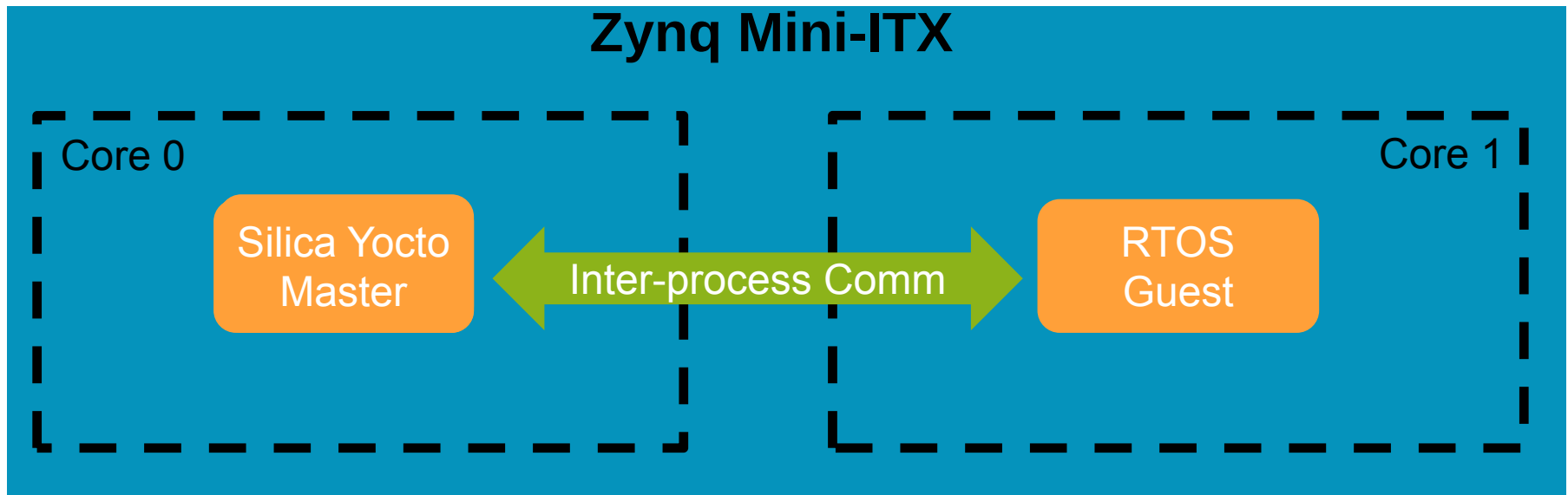
Decide on the Zynq System Partition

- Target the Zynq Mini-ITX
- Show a co-operative two OS system
- Exercise virtualization
- Combine time-sharing and real-time



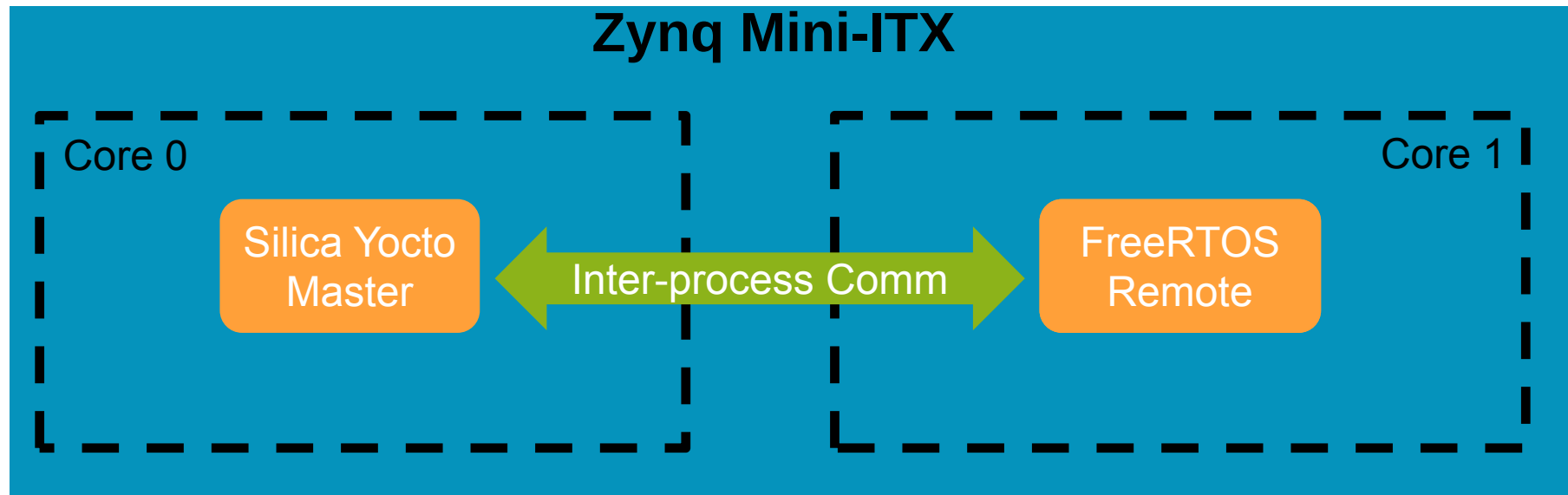
Pick a Linux Implementation

- Begin with PetaLinux
 - Original implementation and simplest starting option
- Migrate to Silica Yocto implementation
 - Demonstrate move between Linux options



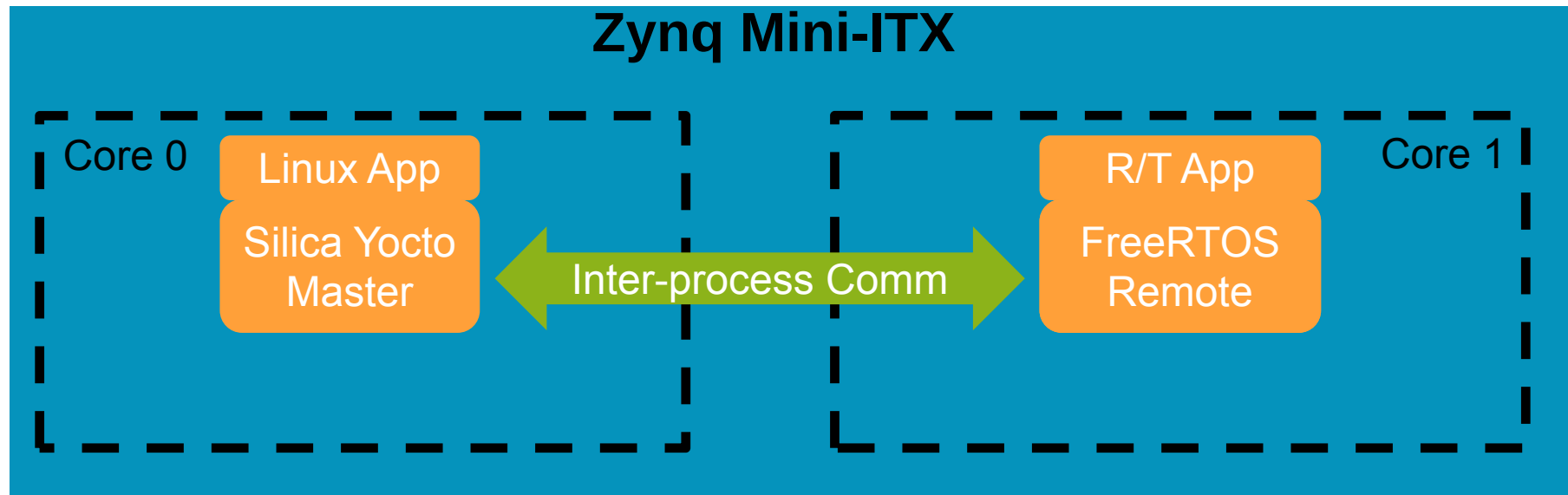
Select a Remote Real Time OS

- Virtio compatible
- Low entry cost
- Open source preferred



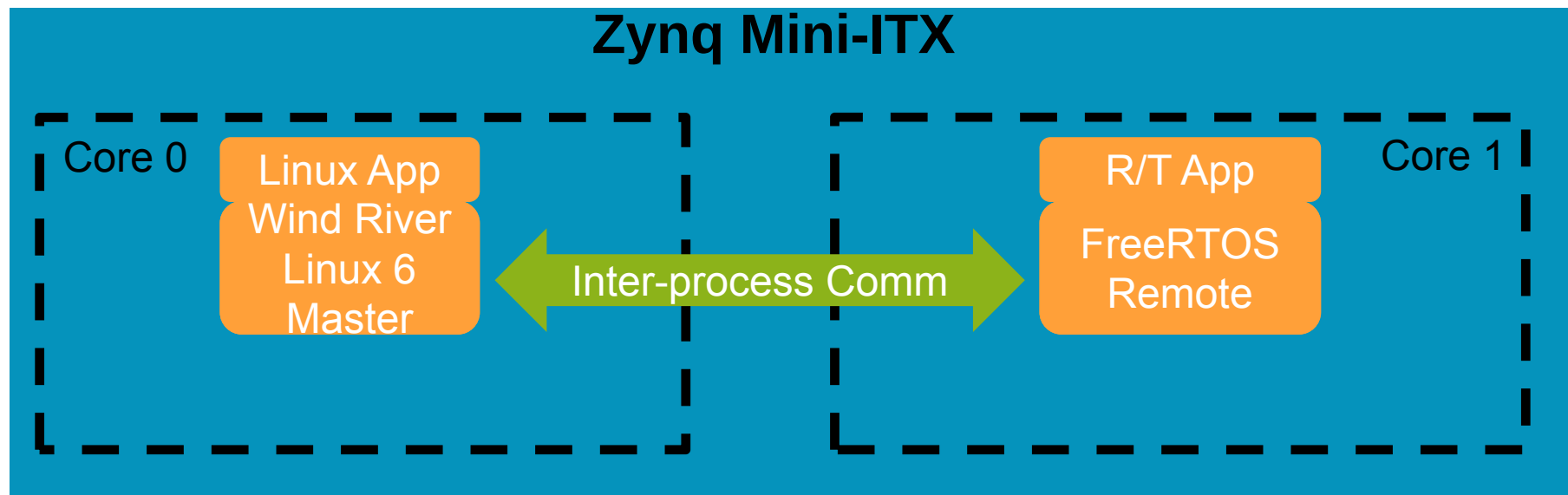
Application Development Environment

- FreeRTOS integrates with the Xilinx SDK
- PetaLinux and Architech SDKs for Linux host available for free download

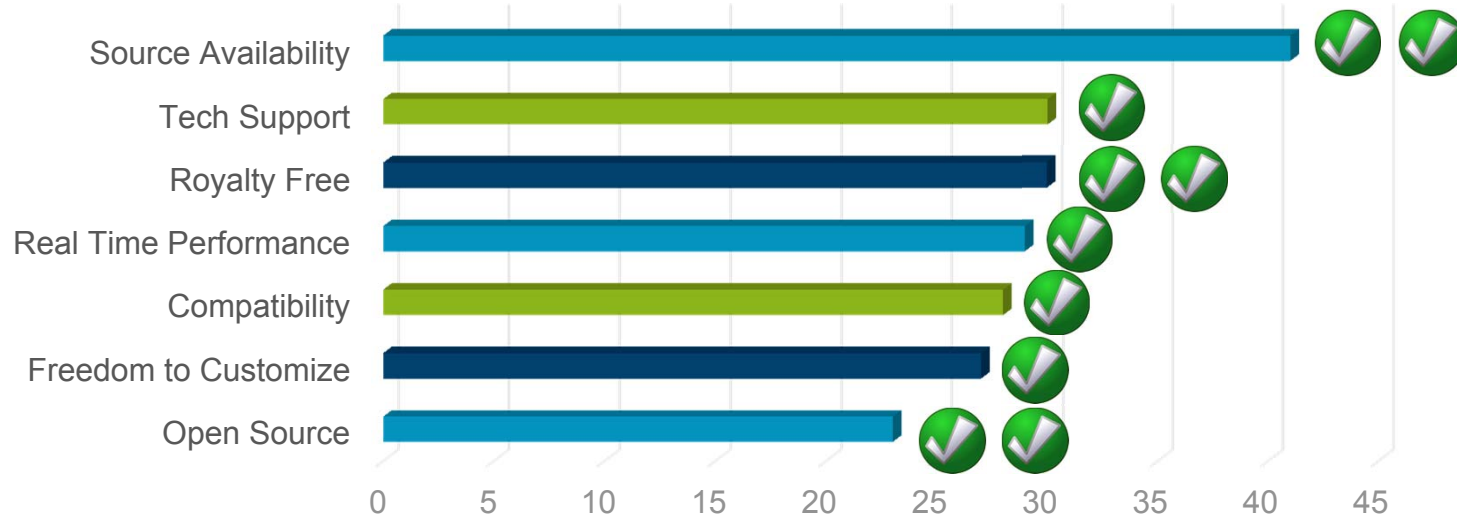


Support the Design Post-Release

- Consider external support to manage
 - Unexpected OS patches
 - Product field upgrades utilizing new OS features

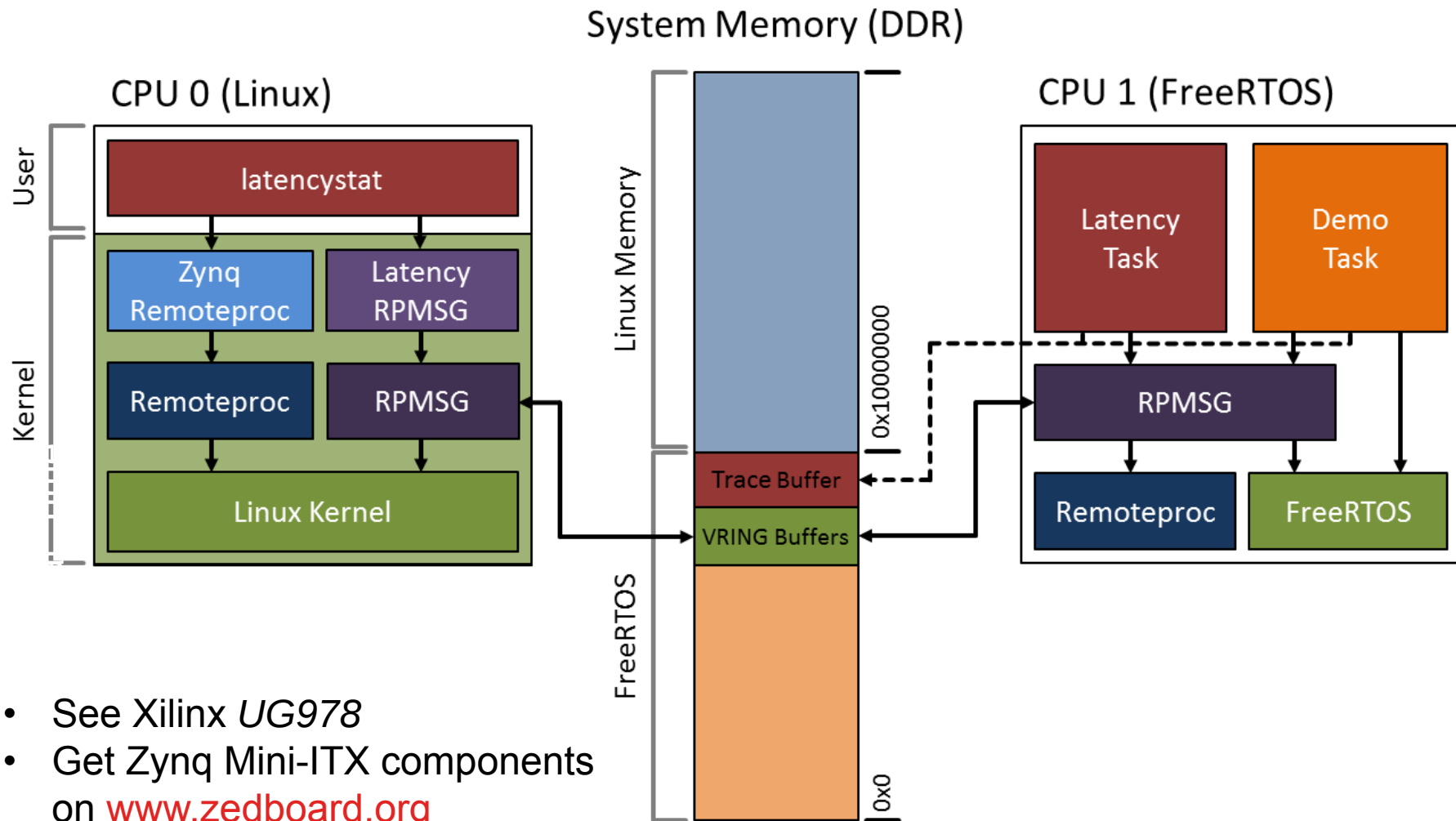


Address the Standard Questions



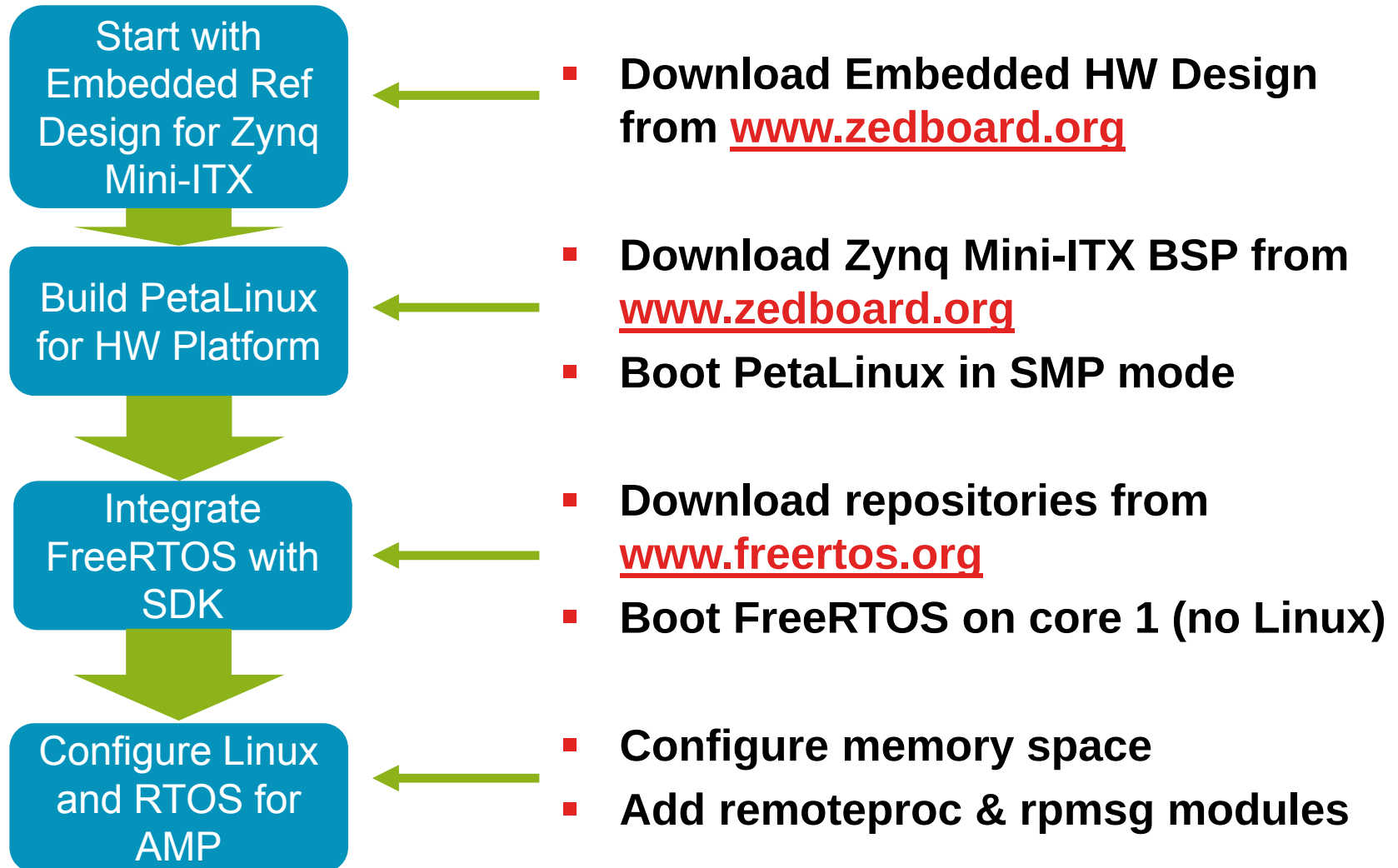
- Linux
- FreeRTOS
- Virtualization
- PetaLinux -> Silica Yocto -> Wind River Linux 6

OS AMP Demonstration

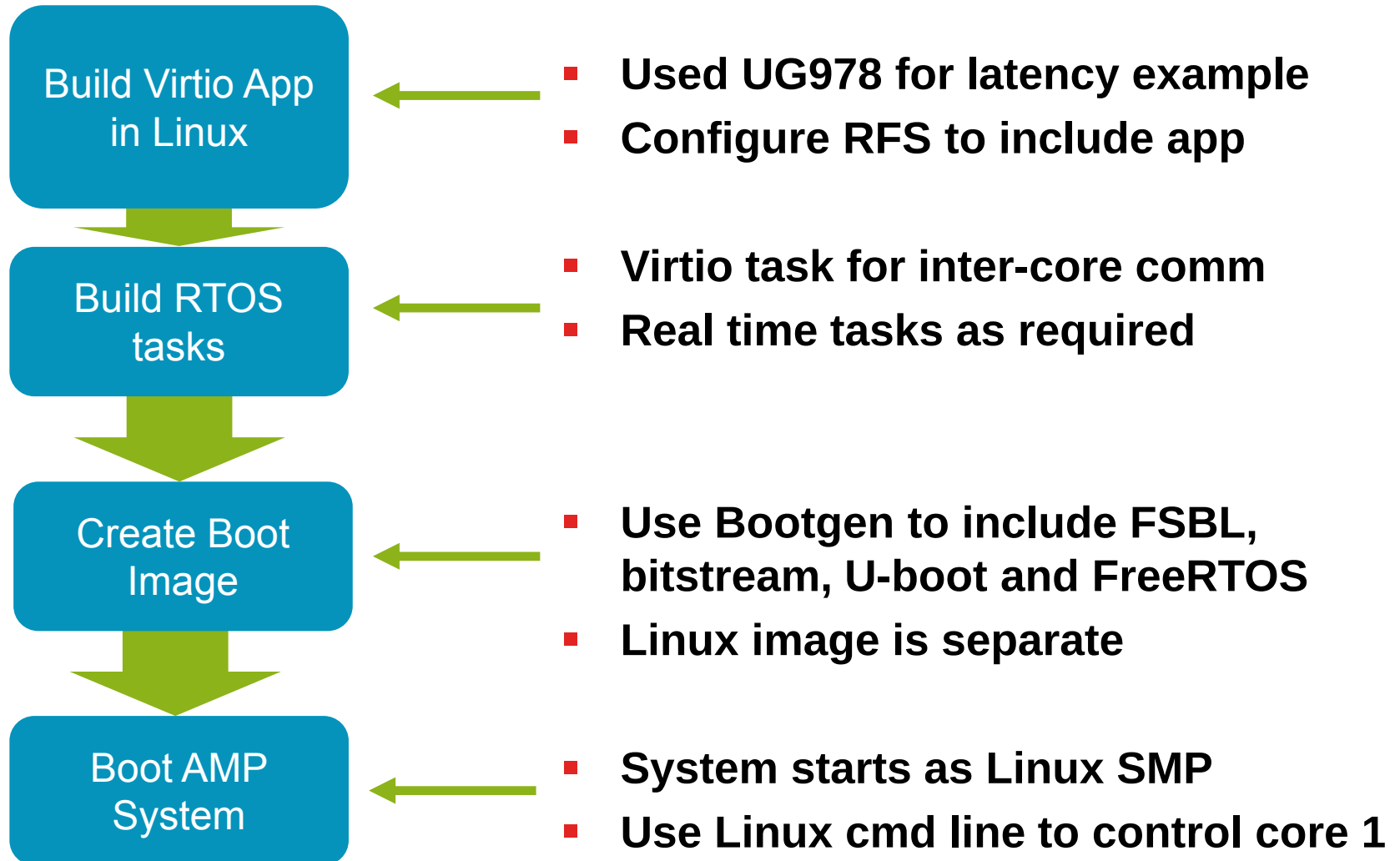


- See Xilinx UG978
- Get Zynq Mini-ITX components on www.zedboard.org

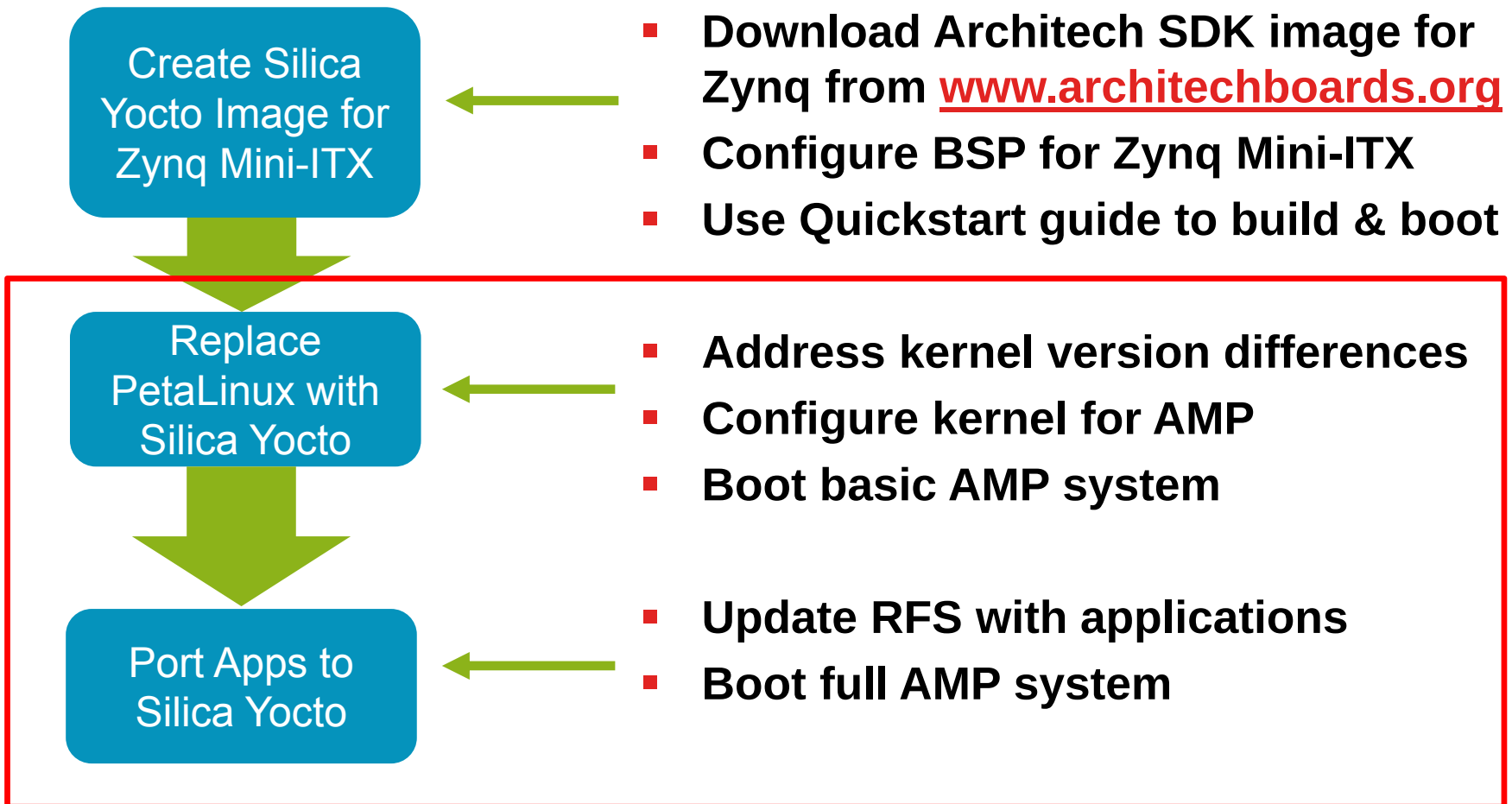
Build AMP System with PetaLinux and FreeRTOS



Create AMP Applications



Replace PetaLinux with Yocto



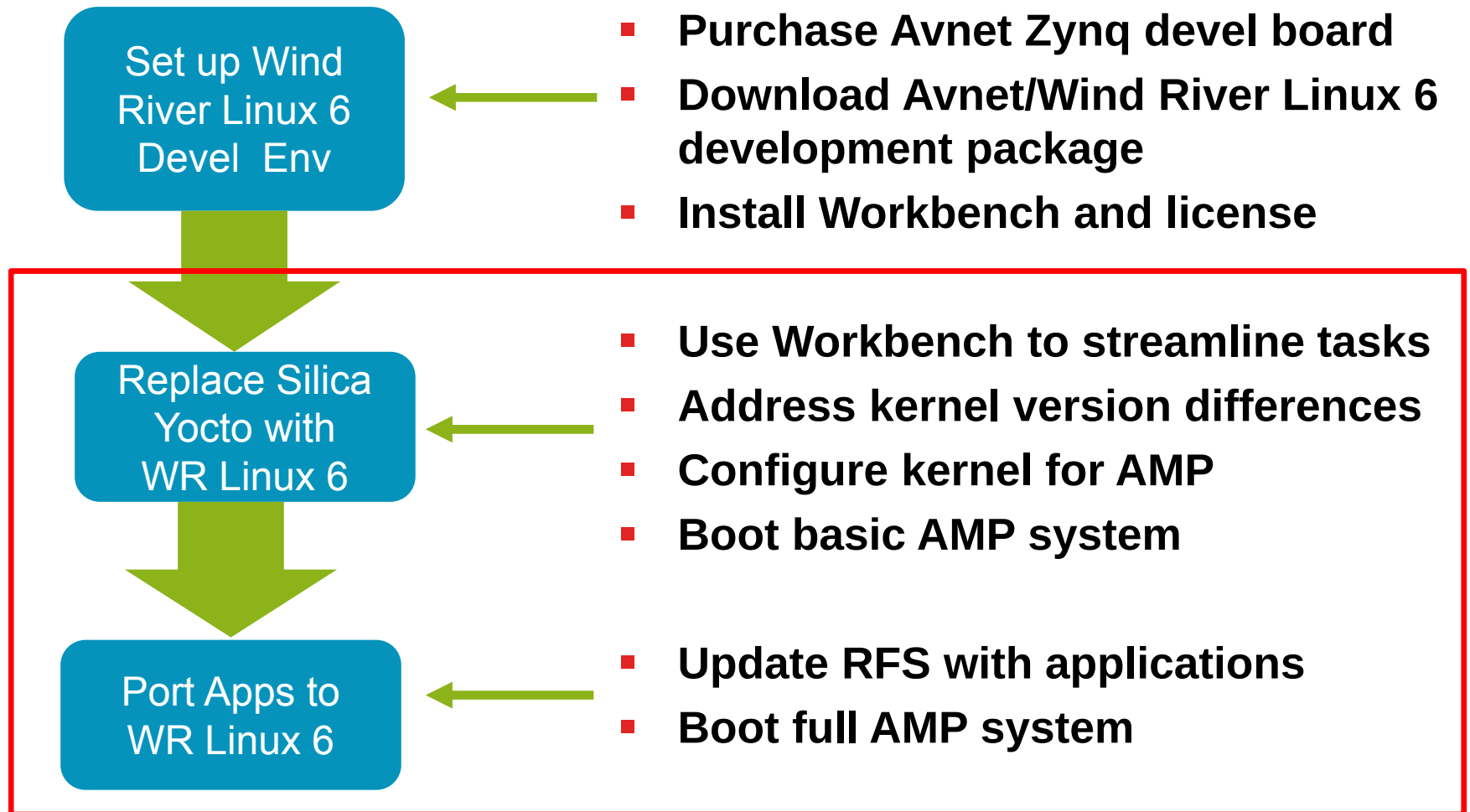
Work in Progress

Using the ArchiTech Yocto SDK

- All boards supported by ArchiTech Linux Distribution
- SILICA is an active participant in the Yocto Project
- ArchiTech SDK removes complexity
 - VirtualBox Virtual Machine image – Linux devel host
 - Pre-installed Yocto and SDK tools
 - Pre-configured with ArchiTech BSP
 - No separate Linux development host setup
- Quickly create boot loader, kernel and RFS
- Simple to customize kernel and RFS



Replace Yocto with Wind River Linux 6



Work in Progress

Next Steps



<http://www.soc.hawaii.edu>



Remember These Points!

- **Differences between “Linux” flavors**
 - Operating systems are not created equal!
 - Don’t assume, validate your understanding
- **Virtualization**
 - A growing technology with broad market applications
- **Avnet WR Partnership**
 - Look ahead to production
 - Lack of support here can cripple your company’s future

Select the OS for how it fits with your project, don’t try to modify your project to conform to a particular OS!

Avnet Embedded Software Store

- Zynq Mini-ITX Development Kit options
- Other ZedBoard.org development kits
- Commercial Operating Systems

<http://www.embeddedsoftwarestore.com/>



USB
File Systems

WIND RIVER

Open
Source



JTAG
Tools



Embedded
SSL



DSP
Libraries



BSPs
Training



IDE
Tools



RTOS
& More



Additional Follow-up

- For more information on *Zynq Operating Systems*, please refer to the following documents/application notes
 - *UG976, UG977, UG979-UG983* (PetaLinux)
 - *XAPP1078, XAPP1079, UG978* (AMP designs)
 - www.xilinx.com/products/silicon-devices/soc/zynq-7000/operating-systems/
- Please visit www.zedboard.org for reference designs, tutorials and information on Avnet Zynq development boards & SoMs



Mini Module Plus



Mini-ITX Motherboard



MicroZed

- All course slides & X-fest Q & A Forum:
www.xfest2014.com

A word cloud centered around the words "Thank" and "You" in large red font. Surrounding these are various expressions of gratitude in many languages, including: Vinaka, Maake, Asante, Shukria, Dhanyavadagalu, Manana, Dankon, Matondo, Biyan, Mauruuru, Arakish, Kam Sah Hammida, Kiitos, Dankscheen, Vinaka, 감사합니다, Dank Je, Blagodaram, Ngiyabonga, Dziekuje, Juspaxar, uthanzi, Bedankt, Dakujem, Ua Tsaug Rau Koj, Dėkuji, Suksama, Rahmat, Matur Nuwun, 谢谢, Misaotra, 谢谢, Grazas, धन्यवाद, Welalin, Di Ou Mesi, Hvala, Danke, Merci, Go Raibh Maith Agat, ขอบคุณคุณคุณ, Nais Tuke, Kia Ora, Kop Khun Khap, Paldies, Tingki, Gratias Tibi, Obrigado, Djidere Dieuf, Eskerrik Asko, Mochchakkeram, Grazie, Tack, Terima Kasih, Diolch i Chi, Chokrane, Arigato, Gracias, cảm ơn bạn, and many others.