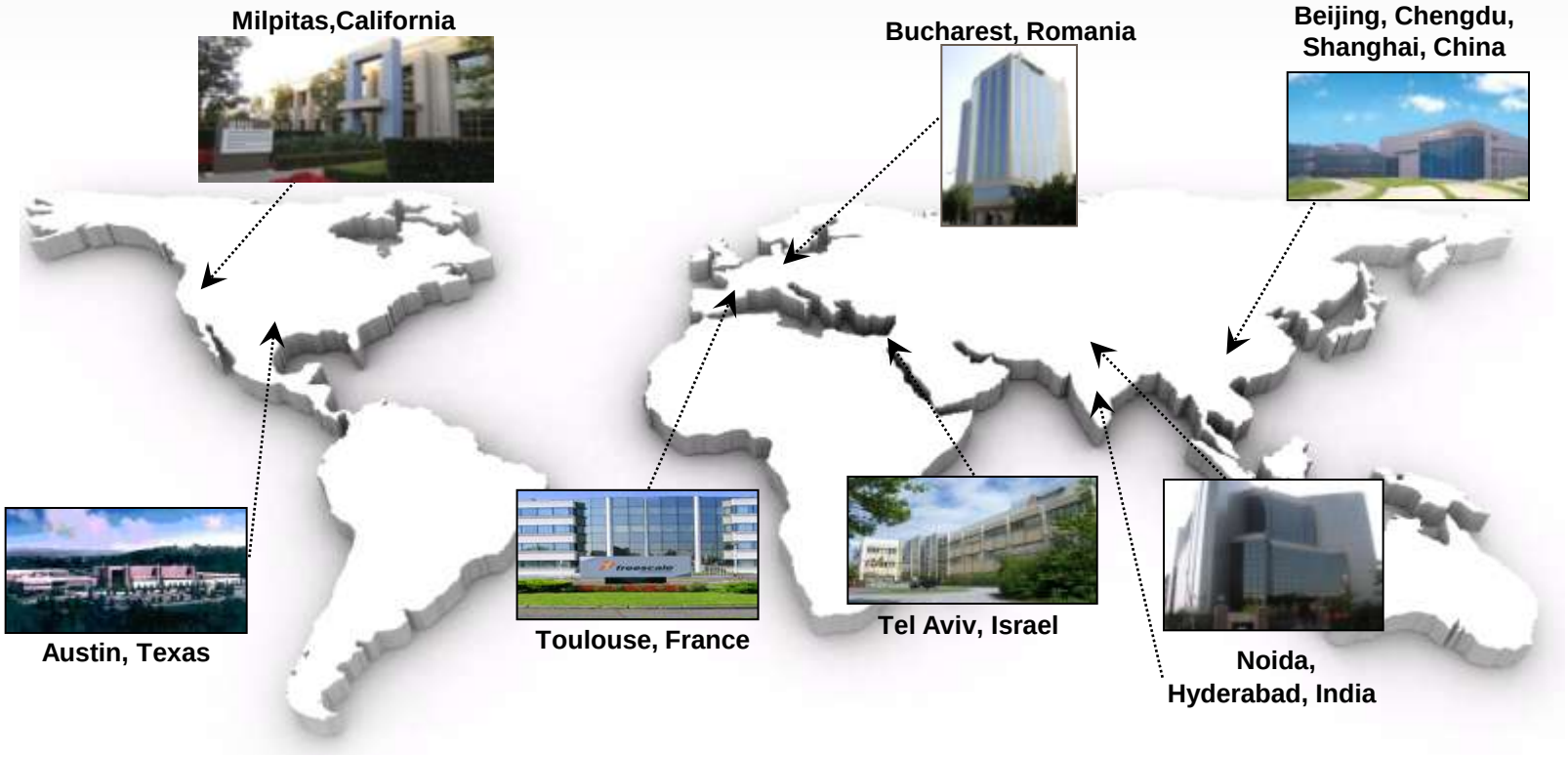
Designing in the QorIQ T Series Product Family: Software Considerations

October 2013

Software and Solutions Technology: Digital Networking



- Freescale has over 1,000 software engineers, over 700 focused on Digital Networking
- Increasing investment on software through hiring and acquisition
- Focus: Heterogeneous Multi-core, Run-time, Tools, Key Applications
- Robust Ecosystem with Freescale Connect Partner Program
- Strategic Partnerships, including Mentor Graphics, ENEA, Green Hills, QNX and Wind River

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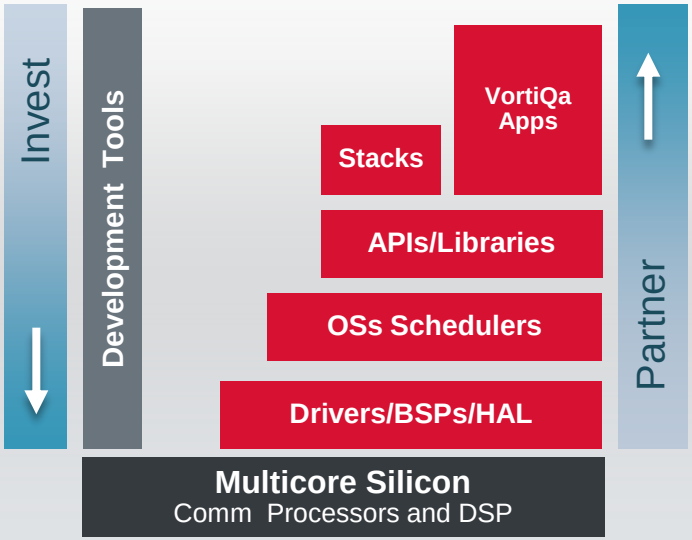
Digital Networking: Software Strategy

Best-in-Class Multicore Software Development and Debug Solutions



Key Software Acquisitions & Investments

1999: Metrowerks
2002: AMC, Lineo
2003: Freescale Professional Services
2005: Seaway Networks
2008: Intoto
2009: MQX Runtime Platform
2010: Processor Expert, Chipwerks
2013: Launch Digital Networking Services

+ Open Ecosystem of Partners

Investment in silicon optimized software IP across our Multicore portfolio

- *Over 1000 in-house software resources*
- Stand-alone base tools and run-time technologies built around standard platforms
- Available throughout the ecosystem

In-house resources & IP *plus* Partners provide open choices for vertical solutions and tools

- Optimized solutions, reference designs and greater application performance
- Alternative to restrictive/captive approaches
- Peace of mind that software IP will not be locked in
- Freescale Professional Services where needed

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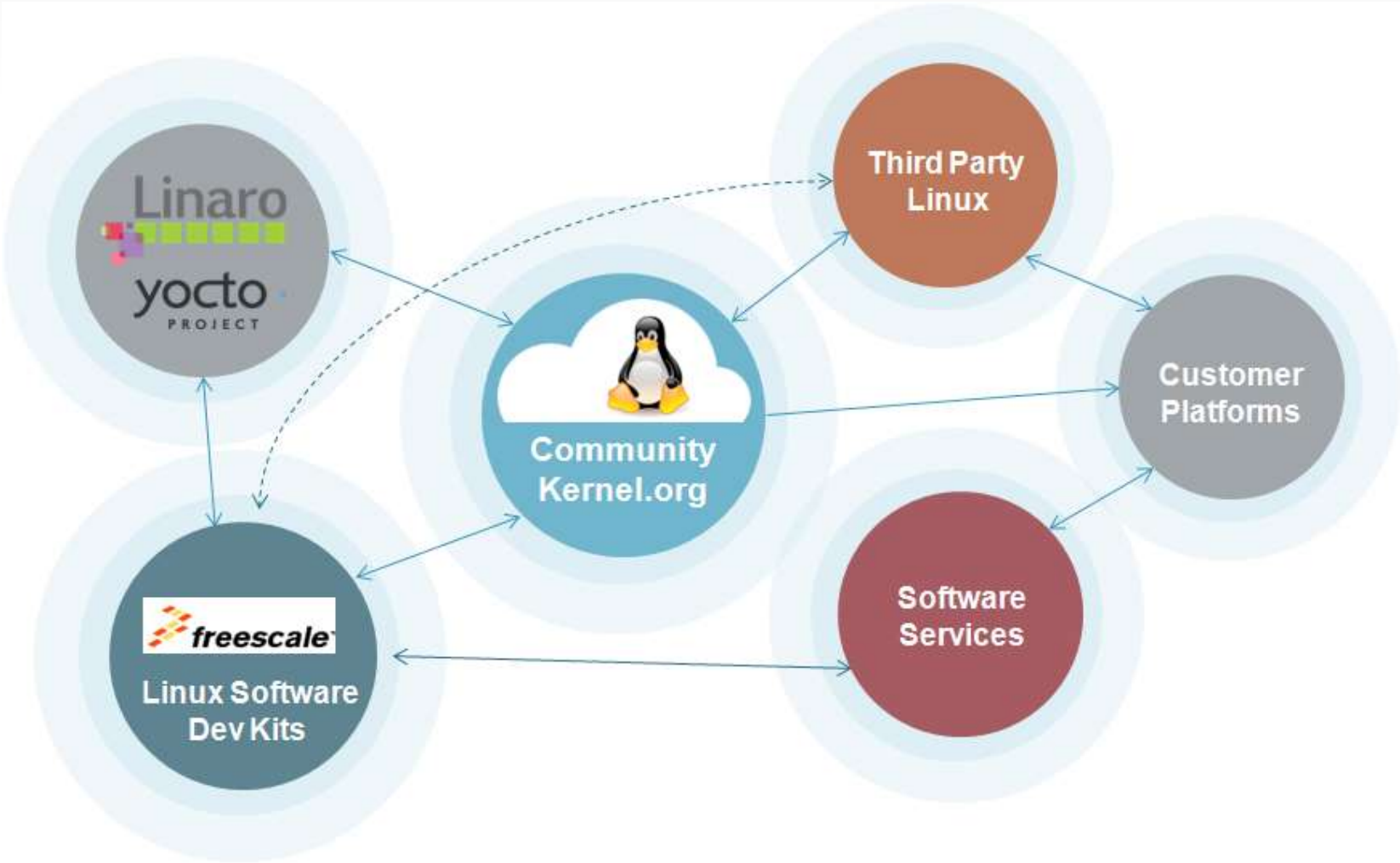
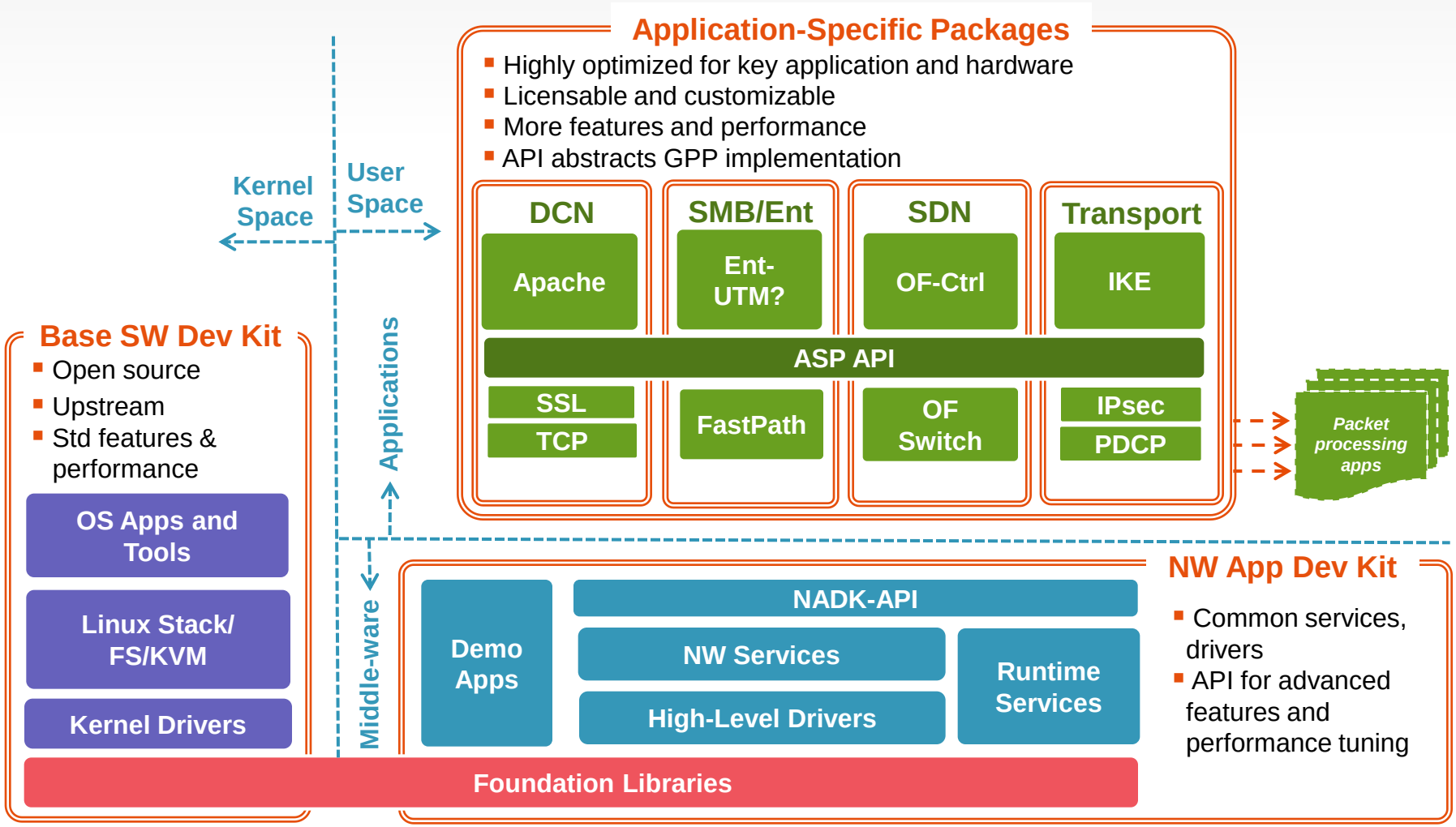
Software Development Stakeholder Model

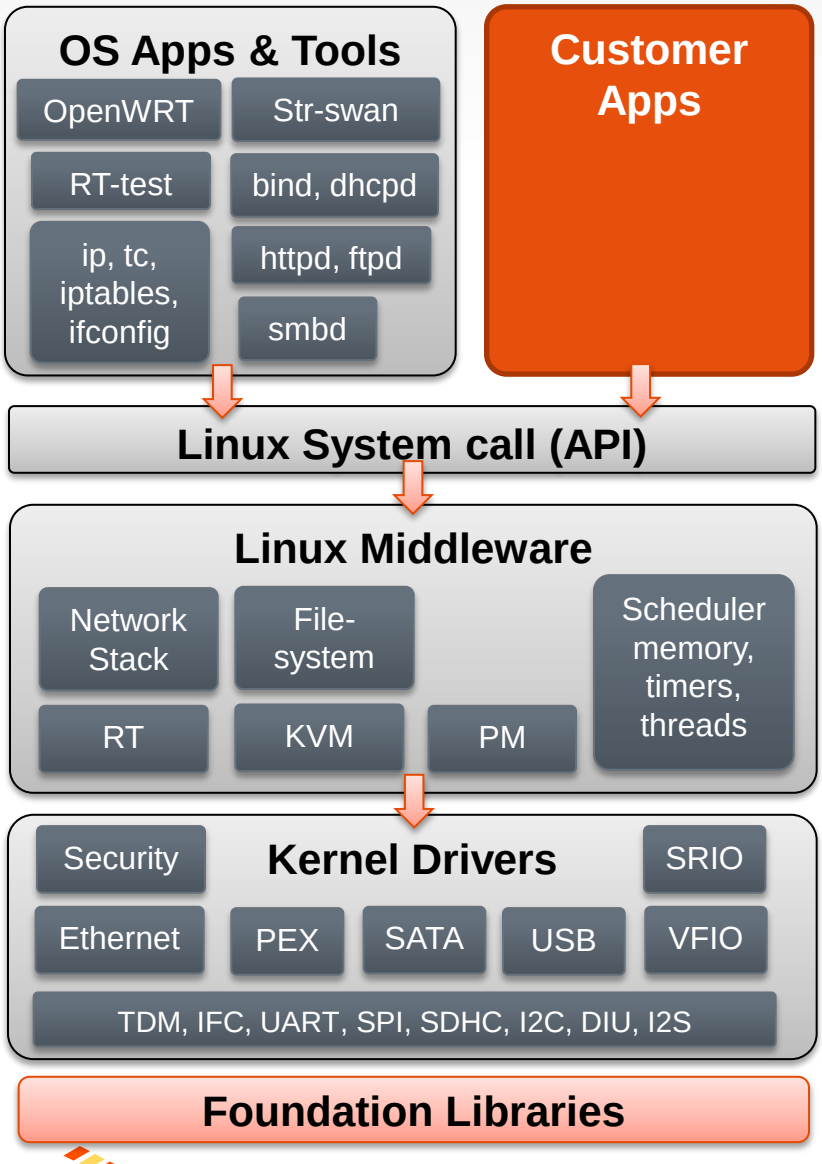


Foundation Software Platforms



Freescale Platforms—QorIQ processors built on Layerscape architecture

Base Software Development Kit



- Targeted for General SW development (a.k.a. everyone)
  - May include NW Applications
- Everything is upstream
  - No deviations
- Don't invest in middleware
  - Don’t force HW features into middleware framework (QoS, LAG)
  - Don’t add new middleware (e.g. ASF)
  - Optimize within bounds of middleware
- Invest in drivers
  - Ensure F-Lib compliance
  - Ensure middleware compliance
- Evaluate and migrate non-compliances to user-space – e.g. ASF, L2-switch

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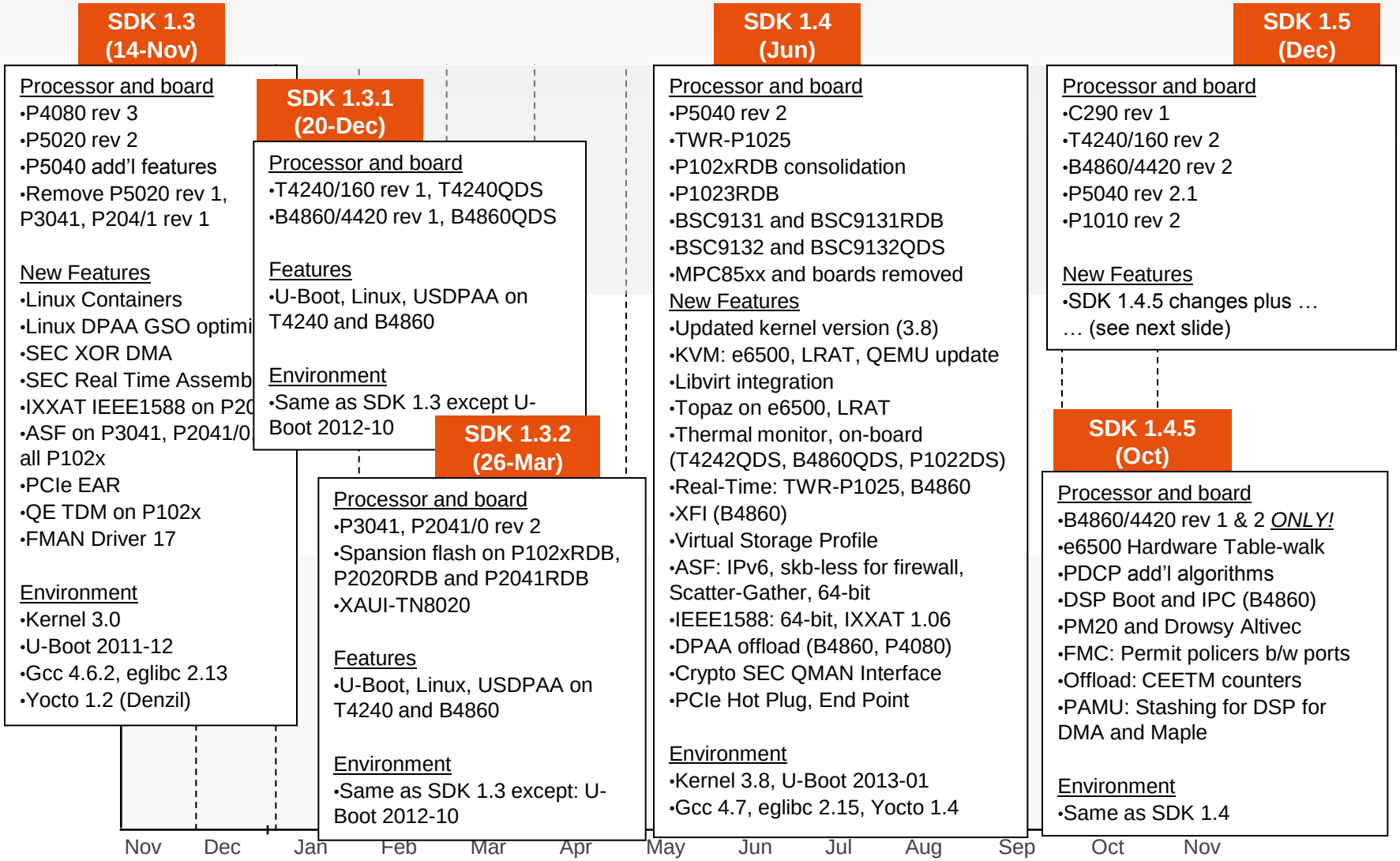
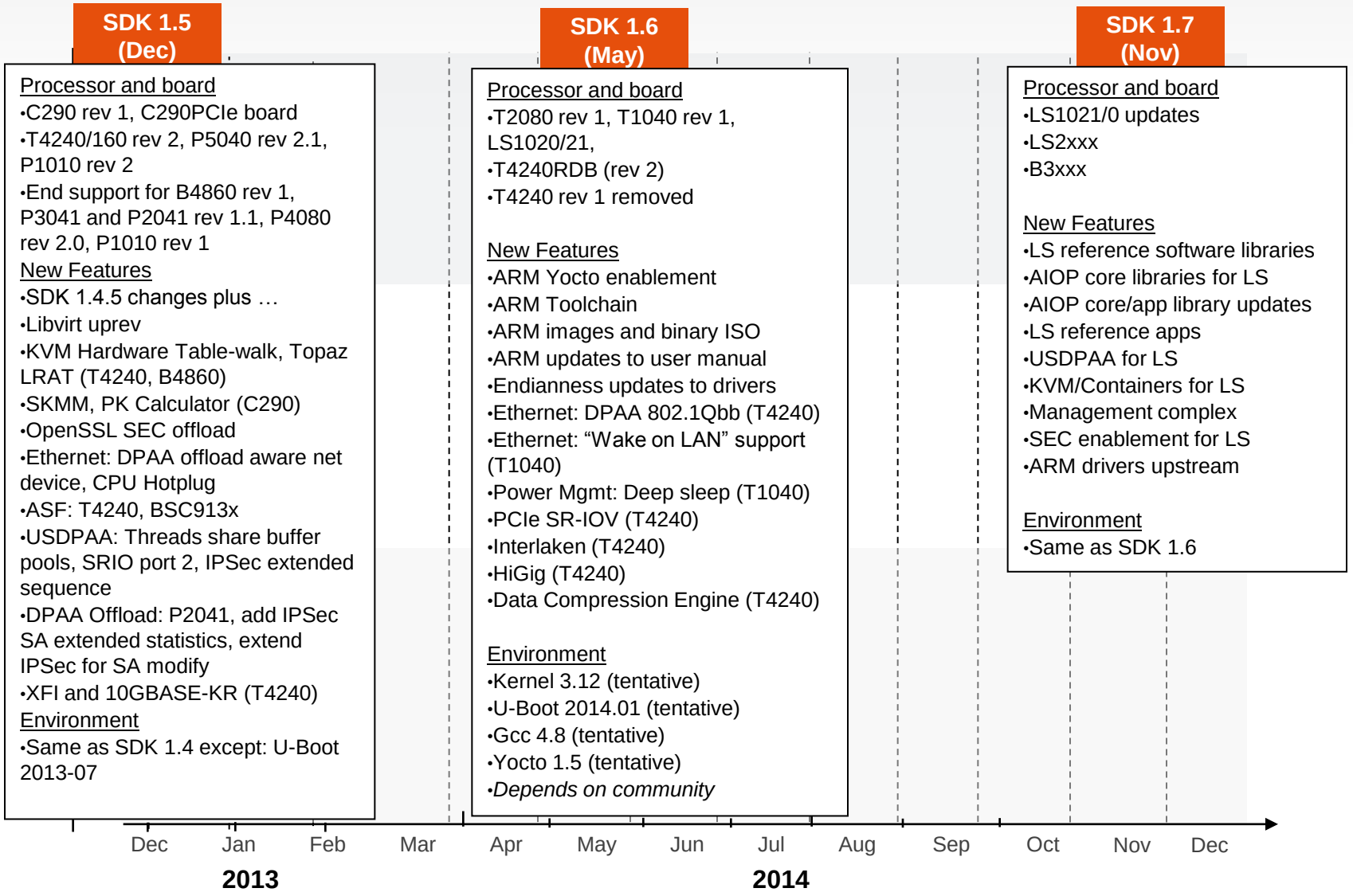
QorIQ/Qonverge SDK Roadmap (2013-2014)



QorIQ/Qonverge SDK Roadmap (2013-2014)



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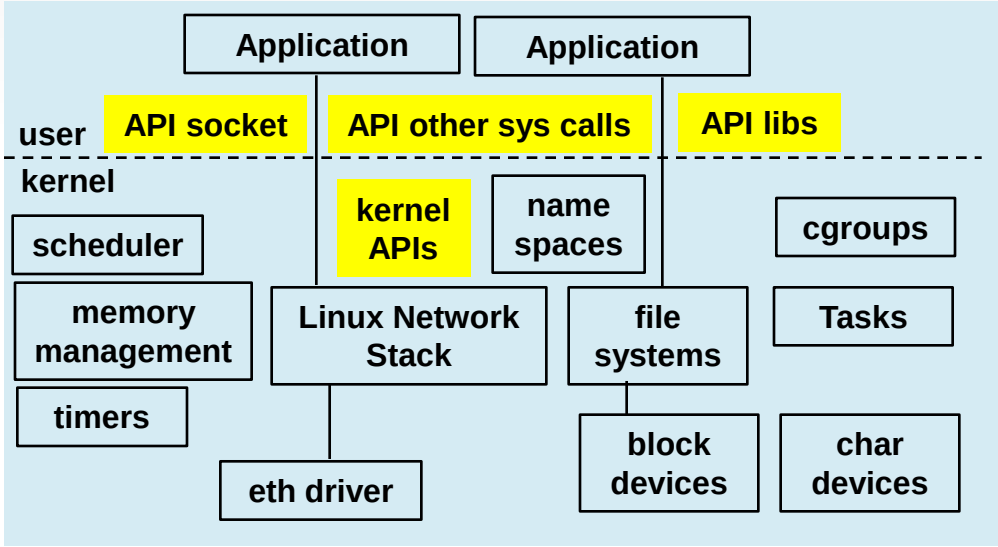
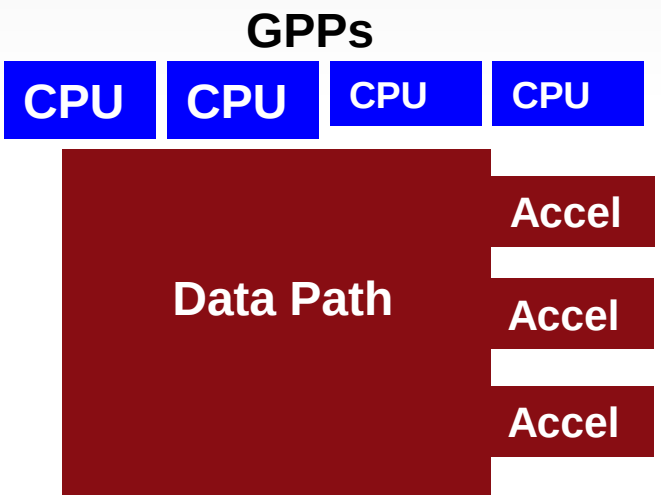
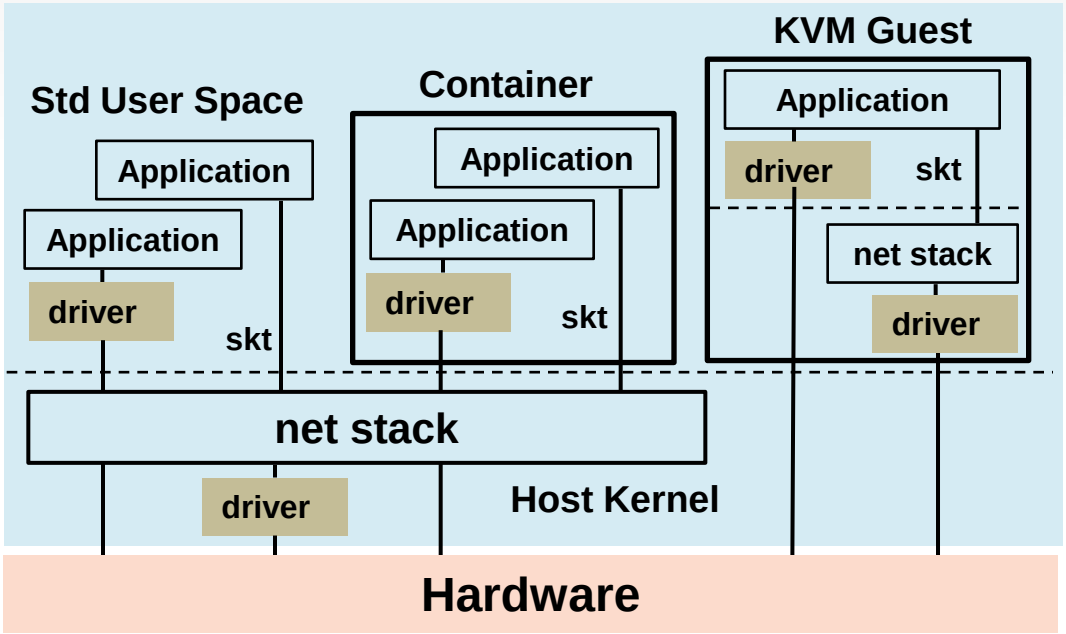
Standard Linux: Baseline Functionality Starting Point





- **SMP multicore Linux as you know it for ARM and Power**
  - Freescale SoC support within broad ecosystem (kernel.org, Linaro, Yocto)
  - Thousands of packages in ecosystem (tools, servers, management, etc.)
  - One source base for all architectures
  - Familiar programming and debug (C, C++, gdb, etc.)
  - Functionality via Linux, not proprietary APIs
  - Full-featured networking and device subsystem
  - RT patch
  - 64b (ARMv8 and Power)
  - big-little (ARM)

Standard Linux Includes Virtualization



HW devices can be directly accessed by containers, VMs, and processes– not just the host kernel. It means load/store to device, use DMAs, etc.

Increased performance via host kernel bypass.

Virtualization support in standard Linux

- KVM
- Containers
- Access isolation
- Performance isolation (via name spaces, cgroups, etc)
- Direct assignment of devices for performance
  - To containers
  - To KVM guests
  - To standard user space processes
- Isolation via IO-MMU

Emerging in standard embedded Linux, an area of Freescale strength

Freescale Linux Software Development Kit

Freescale Linux SDK is a complete Linux development environment (Linux distribution)

- Based on industry standard Yocto/Poky.
- Embedded-style (cross-compilation but native tools also provided)
- Source code provided

Linux SDK main contents:

- GNU tools
- Package system
- Build System
- Kernel source
- Bootloader source
- Package sources
- Hypervisor package sources
- Freescale Network SW packages

Generates

Everything needed to boot and run Linux

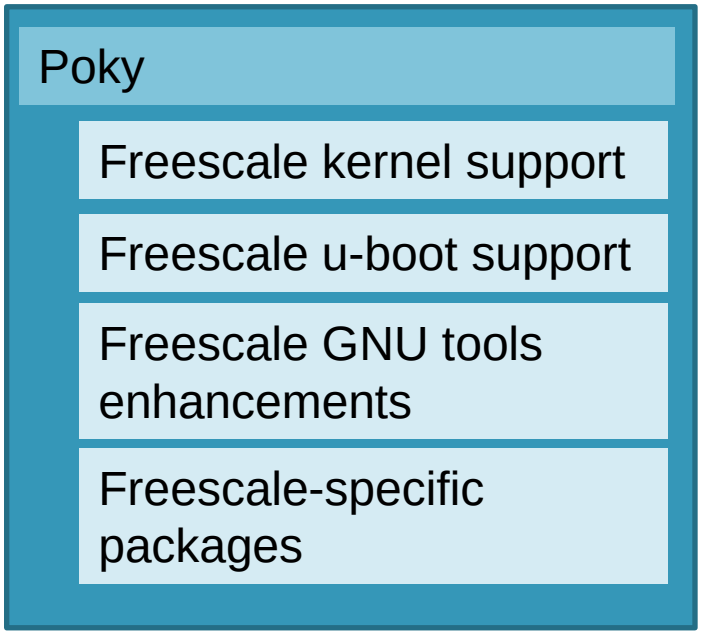
- Bootloader image
- Kernel image
- Customizable file system
- Hypervisor images (optional)
- Freescale optimized package images (optional)

Yocto/Poky

- Widely-supported community project to create tools supporting the creation of Linux distributions.

Poky provides package systems, many standard packages, and build recipes for them based on open embedded.

Freescale Linux SDK



Freescale augments Poky from Yocto with support for Freescale-specific features and packages.

Participating Organizations*

- Cavium Networks
- Dell
- Enea AB
- **Freescale Semiconductor**
- Intel
- LSI
- Mentor Graphics
- Mindspeed
- MontaVista Software
- OpenEmbedded eV
- Panasonic
- NetLogic Microsystems
- RidgeRun
- Secret Lab Technologies
- Sakoman, Inc.
- Texas Instruments
- Tilera
- Timesys
- Wind River

*http://www.yoctoproject.org/community/participating-organizations

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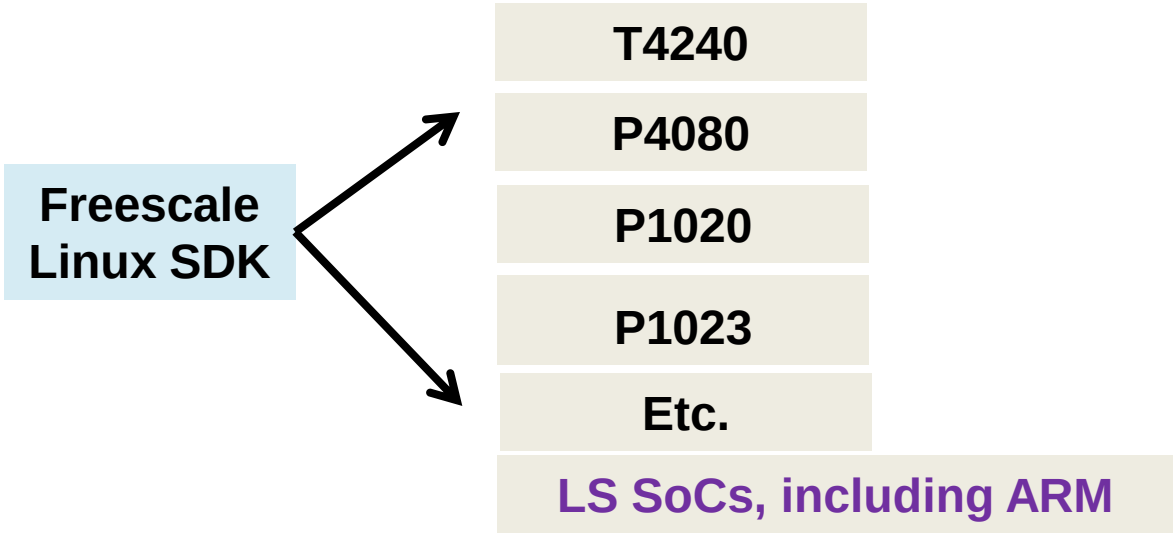
Freescale SDK Is Unified

- One SDK supports all P and T series, and selected other networking SoCs)
- Single source base used for all
- Versions (kernel, etc.) consistent across all
- Freescale ARM-based networking SoCs will be supported by the same unified SDK, ensuring consistency between PA and ARM.
- Power SoCs– big-endian (per Power ecosystem)
- ARM SoCs– little-endian (per ARM ecosystem)



QorIQ SDK 1.5 Schedule

- Milestones (all dates 2013)
  - Feature Freeze: 1-Nov
  - Code Freeze: 29-Nov
  - Release date: 19-Dec

QorIQ SDK 1.5 Environment

- Environment
  - No change compared to SDK 1.4 *except for U-Boot
  - Build Tools: Yocto 1.4
  - Toolchain: GCC 4.7.x and eglibc 2.15
  - Linux kernel version 3.8
  - U-Boot version 2013-07 (upgraded)
- Yocto toolchain
  - Ability to compile with external FSL prebuilt toolchain within Yocto

QorIQ SDK 1.5 Processor & Board Support

- C290 rev 1 and C290PCIe card
  - Carry over features from one-off releases made for C29x plus
  - Silicon and C290PCIe board support
  - Secure Key Management Module (SKMM) and PK calculator
  - Secure Boot

QorIQ SDK 1.5 Processor & Board Support

- T4240 rev 2.0
  - Key silicon errata workarounds to be conditional
  - Rev 1 support remains (to be removed in Spring 2014)
- T4240 XFI and 10GBASE-KR
  - Platform: Modified T4240QDS with XFI support (internal only)
  - 10GBASE-KR Interoperability with Broadcom
- T4240 PCIe performance measure module in PCIe EP driver
  - SR-IOV compatible, SR-IOV support coming in later SDK release.
- B4860: L1 defense
  - Ability to restart the DSP and L1 software without having to restart the entire SoC

QorIQ SDK 1.5 Processor & Board Support

- P5040 rev 2.1
  - Confirmed working using SDK 1.4 – no changes required, replaces rev 2.0
  - MEM_PLL_CFG recommended updates
- P1010 rev 2 and P1010RDB-PB
  - Support for rev 2 silicon and upgraded board
- P4080 8x1G, SerDes 0x16 update
- QSGMII-RISER
  - Supports both QSGMII and standard SGMII, replaces existing SGMII-RISER
  - Affects all boards that support SGMII-RISER: P4080DS, P3041DS, P5020DS, P5040DS, T4240QDS, B4860QDS
- EOL support for various silicon revisions
  - For B4860 rev 1, 3041 and P2041 rev 1.1, P4080 rev 2.0, P1010 rev 1
  - Primarily a testing and documentation statement - no code changes planned.

QorIQ SDK 1.5 Core and Virtualization Features

- CPU
  - MMU Hardware Tablewalk (T4240 and B4860)
- Power Management
  - PW20 (T4240 and B4860)
  - Drowsy Altivec Power Management features (T4240 and B4860)
  - CPU Hotplug for networking (see Linux Networking)
- Virtualization
  - Libvirt uprev
  - KVM Hardware Table-walk (T4240, B4860)
  - Topaz LRAT (T4240, B4860)
  - KVM: Assign pass-through devices back to host once the KVM guest exits

QorIQ SDK 1.5 Linux Networking Features

- Unified DPAA ethernet driver
  - Single, unified driver to be used for termination and forwarding
  - Removal of build time (kernel config) option
- DPAA networking support for CPU Hotplug
  - Ability to remove and add cores in SMP and retain networking interfaces
- Prepare DPAA ethernet code for upstream
- Change license type for config/policy files
  - Will switch from FSL to open source license

QorIQ SDK 1.5 ASF and USDPAA Features

- ASF
  - Migrate existing ASF functionality to BSC913x and T4240
  - ASF to become the default networking configuration for best out of box networking performance
- USDPAA Hello Reflector App – short circuit cores
  - Add mode where all the frames are reflected back unmodified from FMAN directly without reaching cores. Useful to validate FMAN hardware configuration and its ability to withstand line rates.
- USDPAA IPSEC app should support extended sequence number
  - Each tunnel configured in IPSEC app should optionally support extended sequence number. This came out while engaging with a critical customer engagement.
- USDPAA Huge Page support
  - Change memory allocation to utilize hugetlbfs
- USDPAA SRA: Ability to specify SRIO port 2
  - Add srio port 2 support and payload can be specified in SRA application

QorIQ SDK 1.5 DPAA Offload Features

- DPAA Offload – Add support for P2041
- DPAA Offload - Add support for IPSec SA extended statistics counters
  - Extend the IPSec statistics per SA with new counters for 1) Number of packets received for inbound SA and 2) Number of packet sent for outbound SA
- DPAA Offload - Extend the IPSec support for SA modify ASF
  - Extend API to support sequence number and NAT port update for a specific SA. Needed in order to support IPSec High Availability.
- Linux networking: DPAA hardware offloading aware Ethernet net device
  - Provides support for advanced DPAA offloading features: IPSec offload, Virtual Storage Profile based zero-copy frames between USDPAA and kernel stack or OH checksum offload.
- USDPAA: DPAA offloading aware Ethernet net device' (oNIC) in Reflector
  - New net device created for Offline Port, resembles Shared-MAC net device. Uses the OP offloading capabilities (e.g. CSUM offload and VSP based buffer copy offload) and can work with DPAA offload driver.

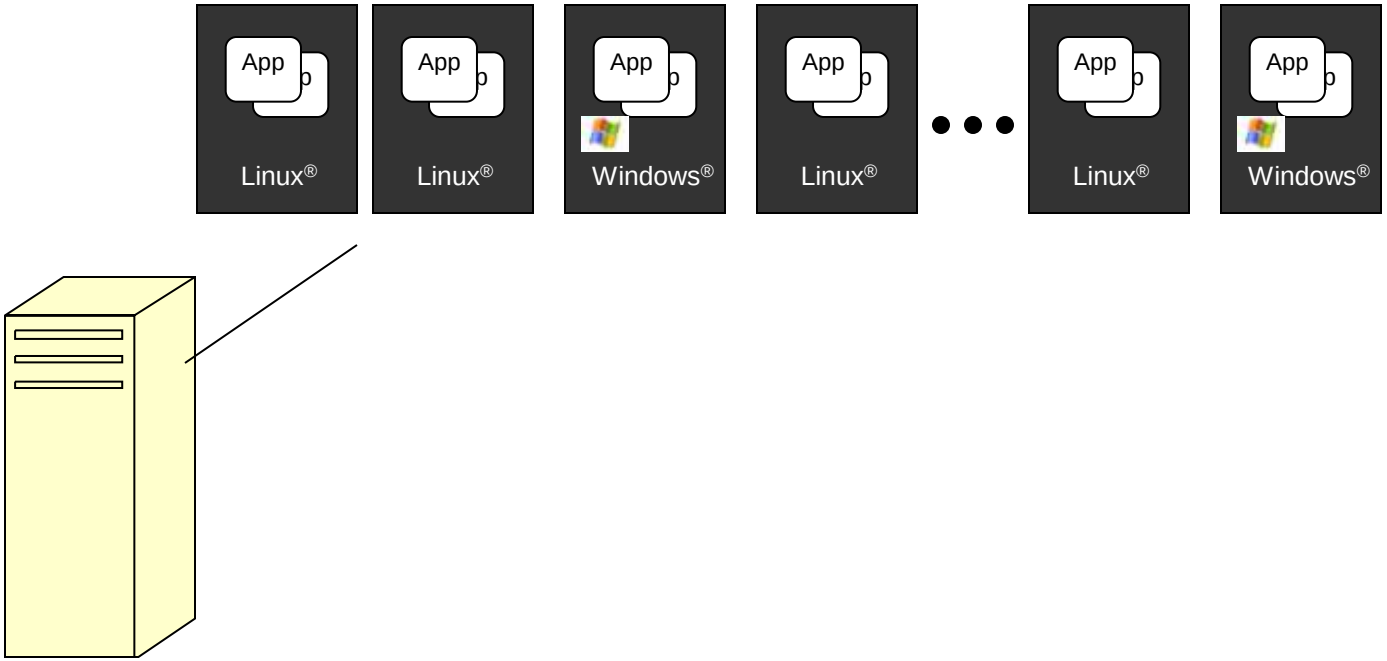
QorIQ SDK 1.5 Other Features

- OpenSSL SEC Offload
  - Defined: Crypto operation SEC offload support for symmetric cipher, digest via Cryptodev interface
  - Processors with SEC 4.0 or later: C29x, P1010, P4080, P3041, P2041, P5020, P5040, T4240, B4860
- Support SDHC after IFC boot (P1010)
  - Enables SDHC after booting from IFC
- U-Boot: Add multiple USB controller support

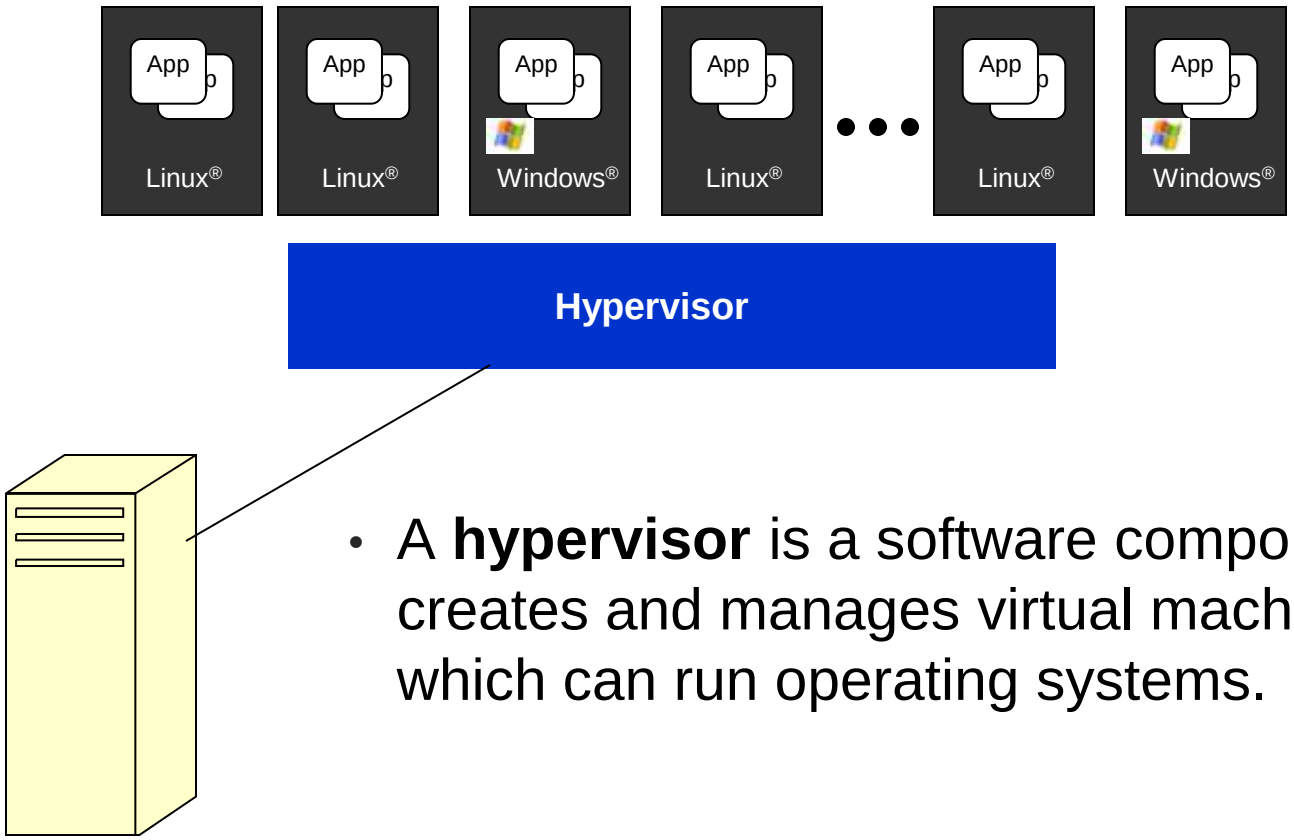
Virtualization

What is Virtualization?

- **Virtualization** – Hardware and software technologies that provide an abstraction layer that enables running multiple operating systems on a single computer system



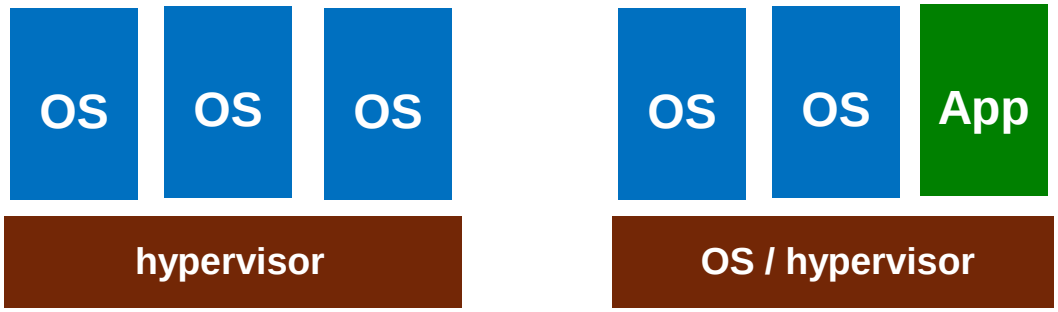
What is a hypervisor?



- A **hypervisor** is a software component that creates and manages virtual machines which can run operating systems.

Type 1 and Type 2 Hypervisors

- Common usage:
  - Type 1 – hypervisor runs only OSes
  - Type 2 – hypervisor is based on conventional OS



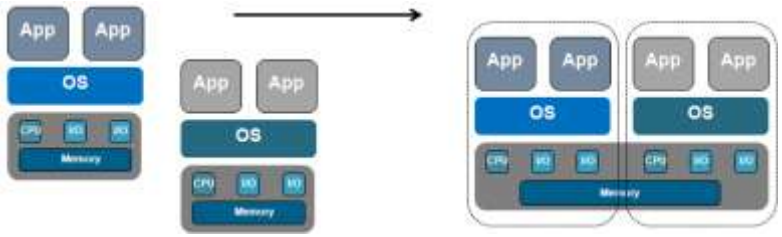
Type 1 Type 2

- My opinion: The distinction is not helpful
- No meaningful conclusions can be drawn by these labels
- For further info:

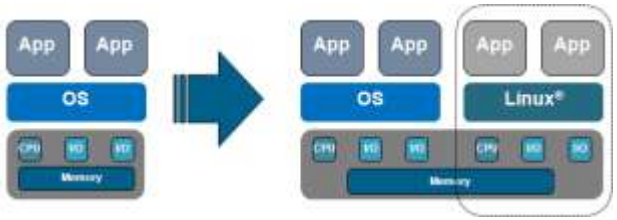
  http://blog.codemonkey.ws/2007/10/myth-of-type-i-and-type-ii-hypervisors.html

Virtualization Use Cases

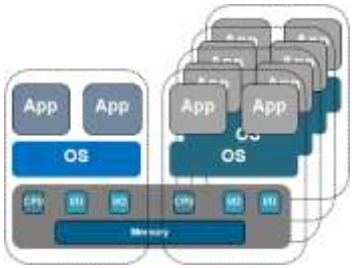
Consolidation



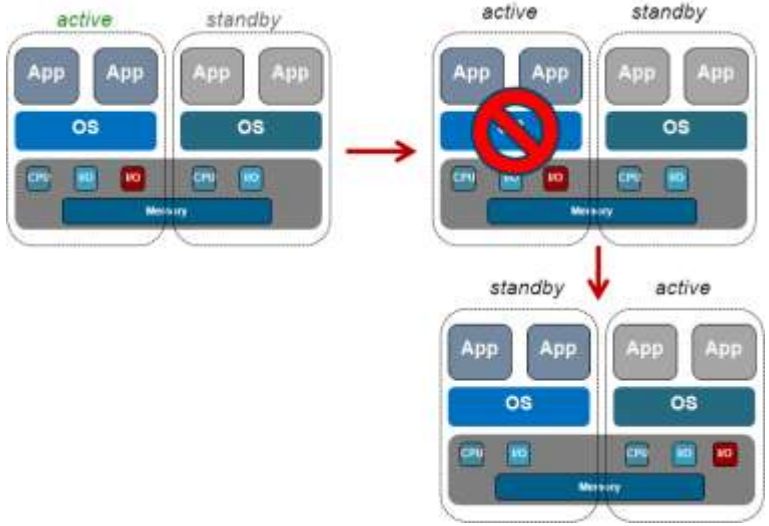
Security/Sandboxing



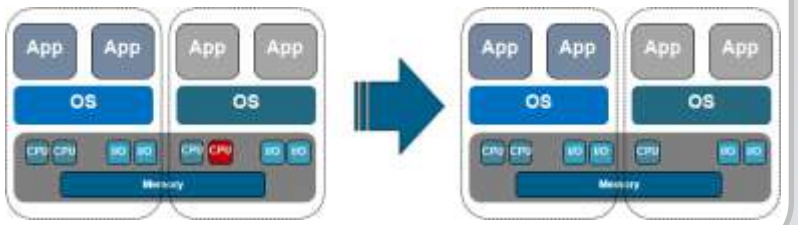
Utilization



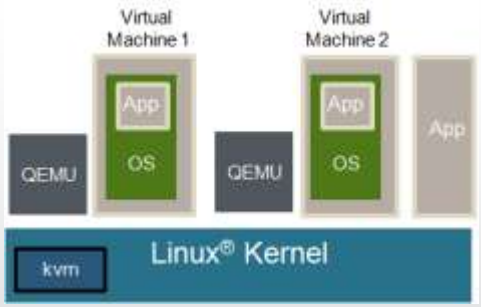
Fail Over



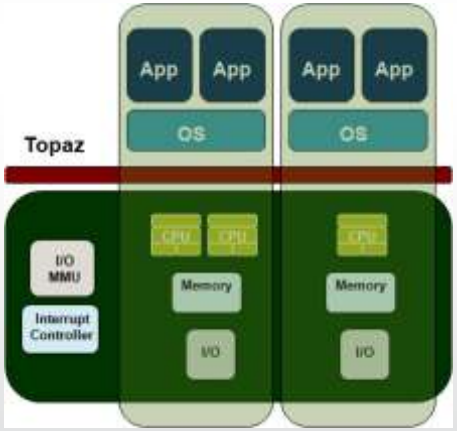
Dynamic Resource Management



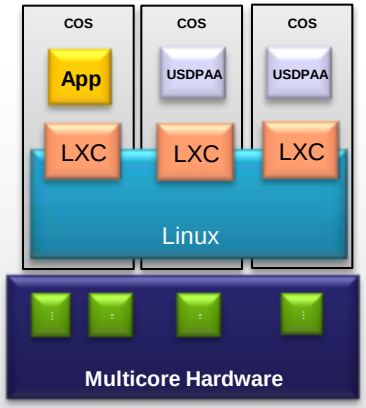
Freescale Virtualization Technologies



- KVM is a Linux kernel driver
- User space tool, QEMU, is used in conjunction with KVM
- Solution is open source
- Number of virtual machines is only limited by available resources (CPU cycles, memory)

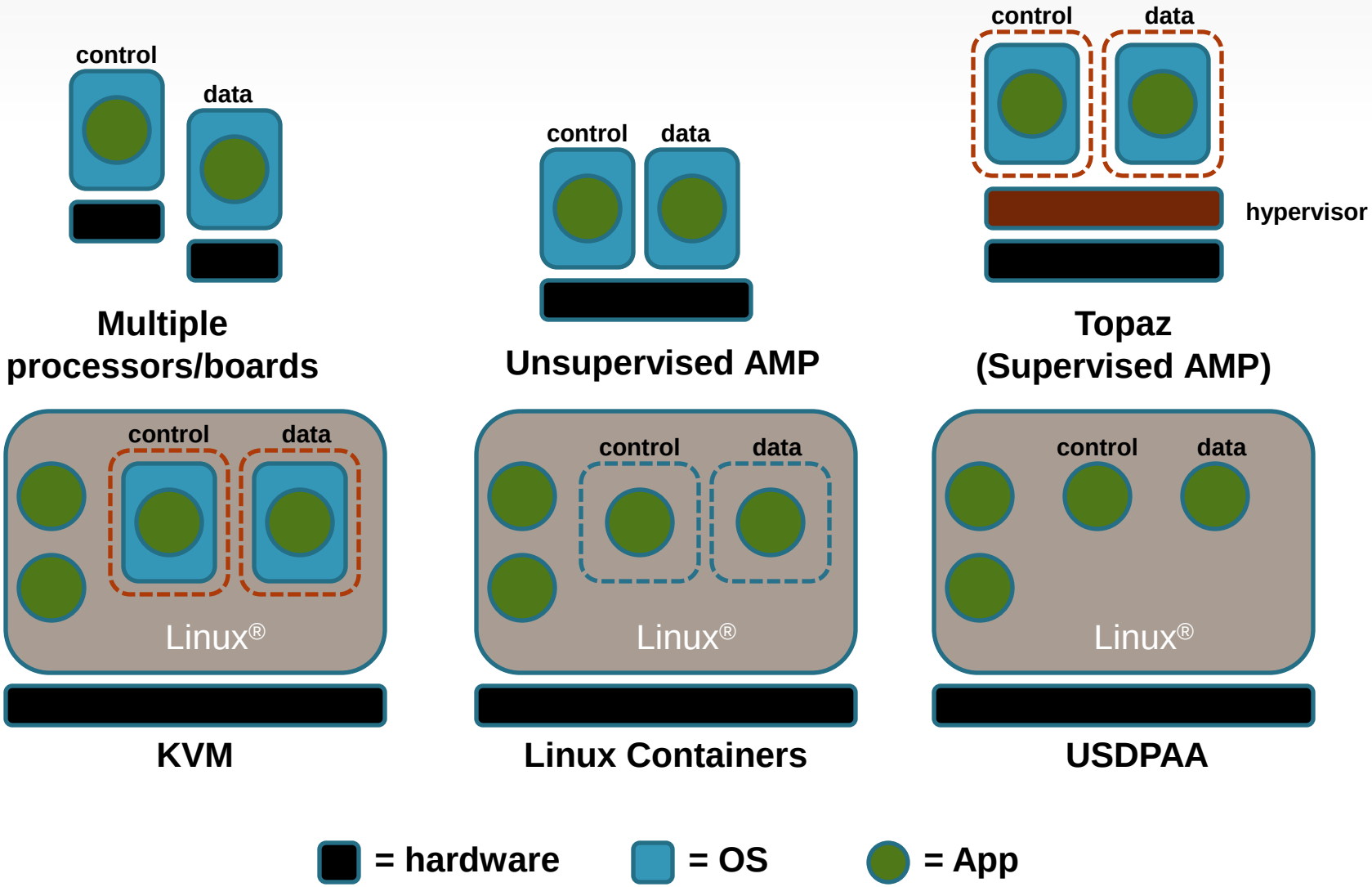


- Lightweight framework for partitioning an SoC
- Best of both worlds—bare metal performance with enforced partitioning, fully architected approach to meeting AMP requirements
- Solves many headaches of running multiple unsupervised OSs
- Threads appear as cores to OS



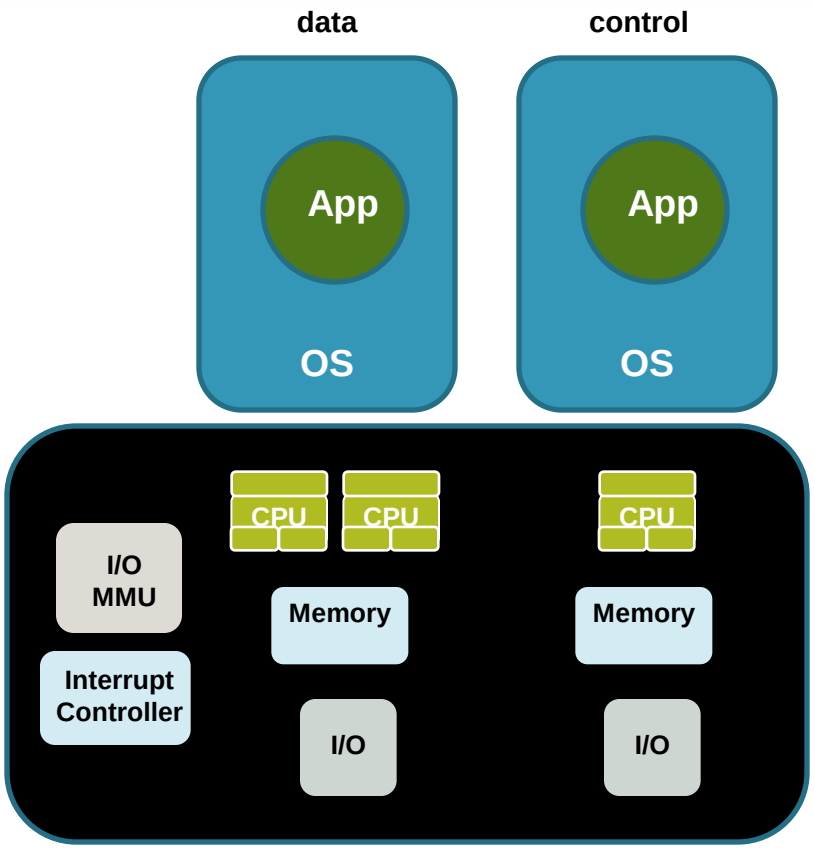
- Containers provide OS level virtualization
- Provides low overhead, lightweight, secure partitioning of Linux applications into different domains
- Can control resource utilization of domains—CPU, I/O bandwidth

Consolidation Overview



Unsupervised AMP

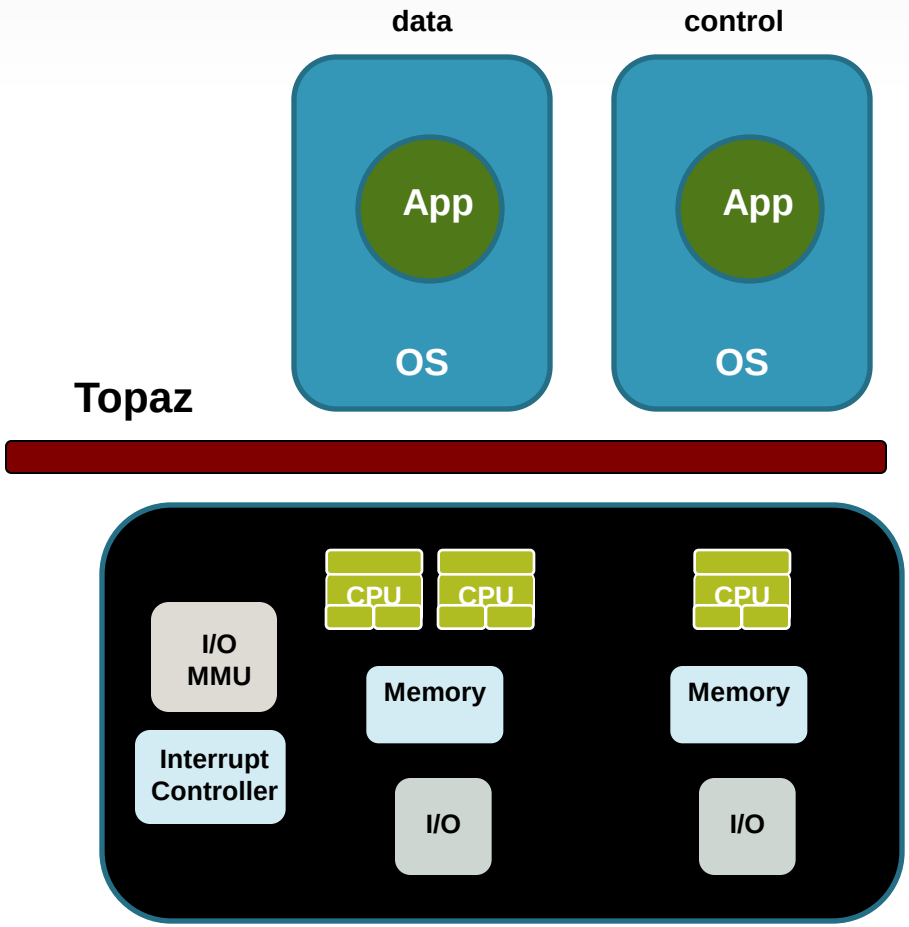
- Good performance, but at cost of fragility and complexity
- Agreement by all OSes required on how memory and I/O devices are partitioned
- Cooperation by all OSes required for initializing & managing global resources
- Complexities: boot sequence, OS reboot, error management, debugging



Unsupervised AMP

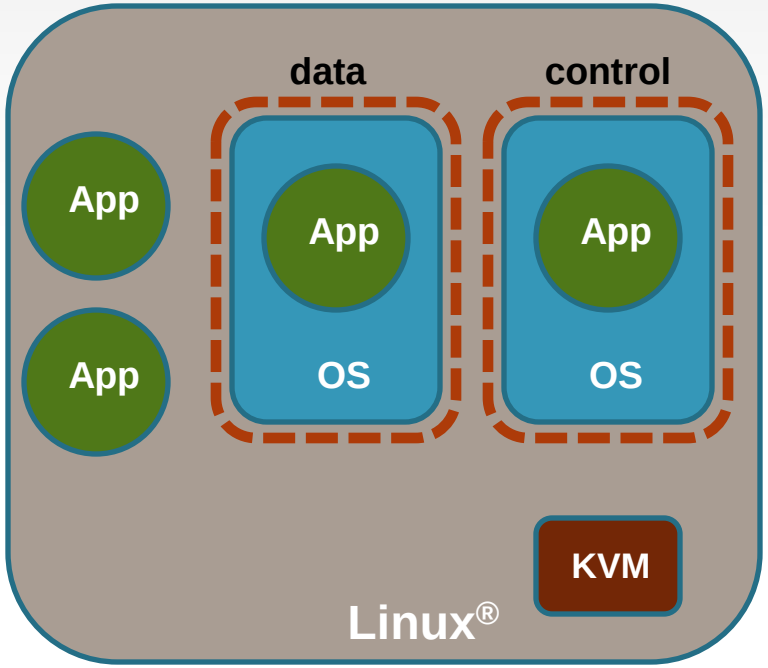
Freescale Embedded Hypervisor (Topaz)

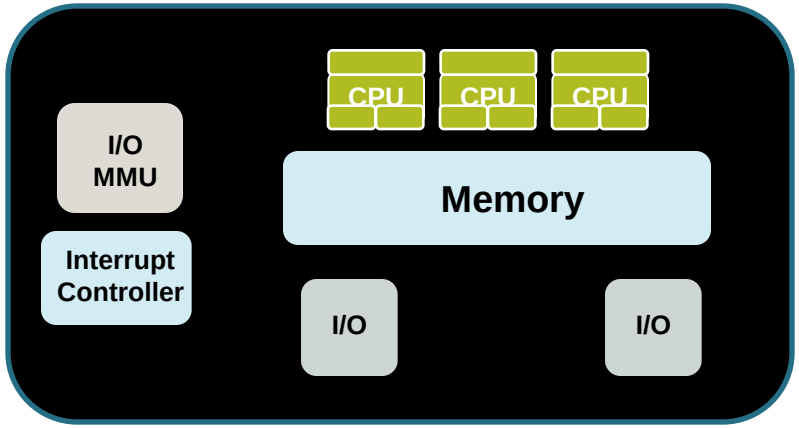
- A lightweight framework for partitioning an SoC
- Gives you the best of both worlds– bare metal performance with enforced partitioning and fully architected approach to meeting AMP requirements
- Solves many of the headaches of running multiple unsupervised OSes
- Threads appear as cores to OS



KVM - Overview

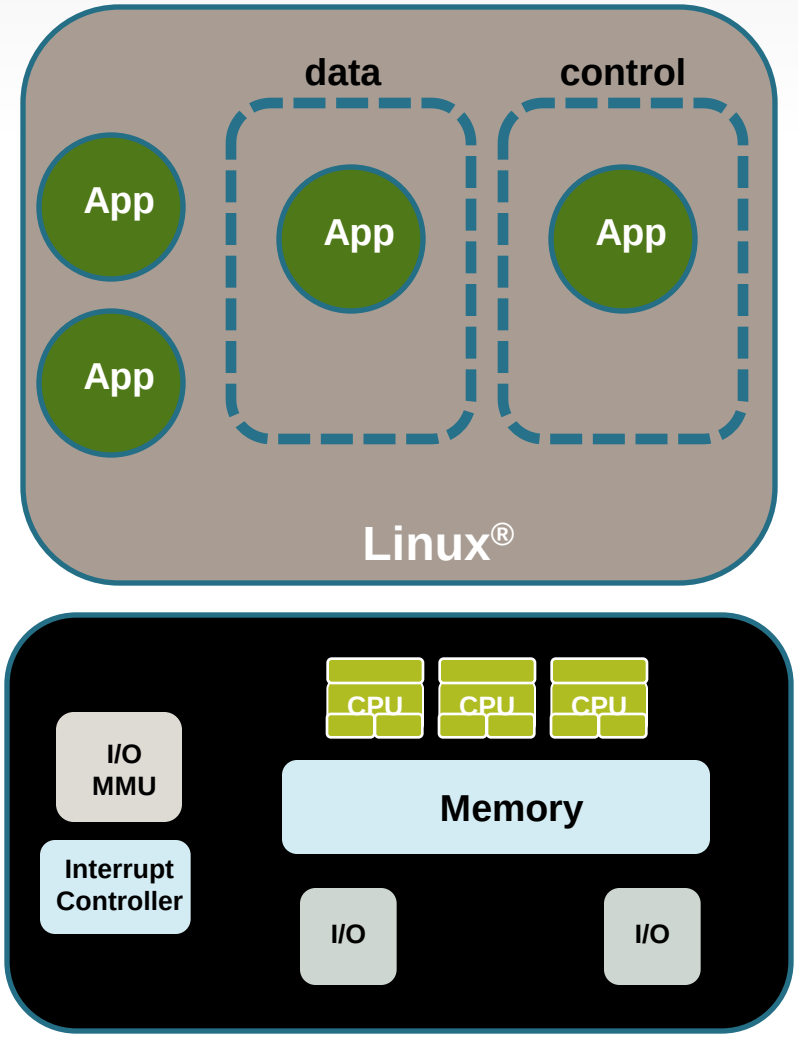
- KVM/QEMU– open source virtualization technology based on the Linux® kernel
- Run virtual machines alongside Linux applications
- VMs are fully isolated from rest of the system
- Number of VMs supported limited only by available resources (CPU cycles, memory)
- Virtual I/O capabilities





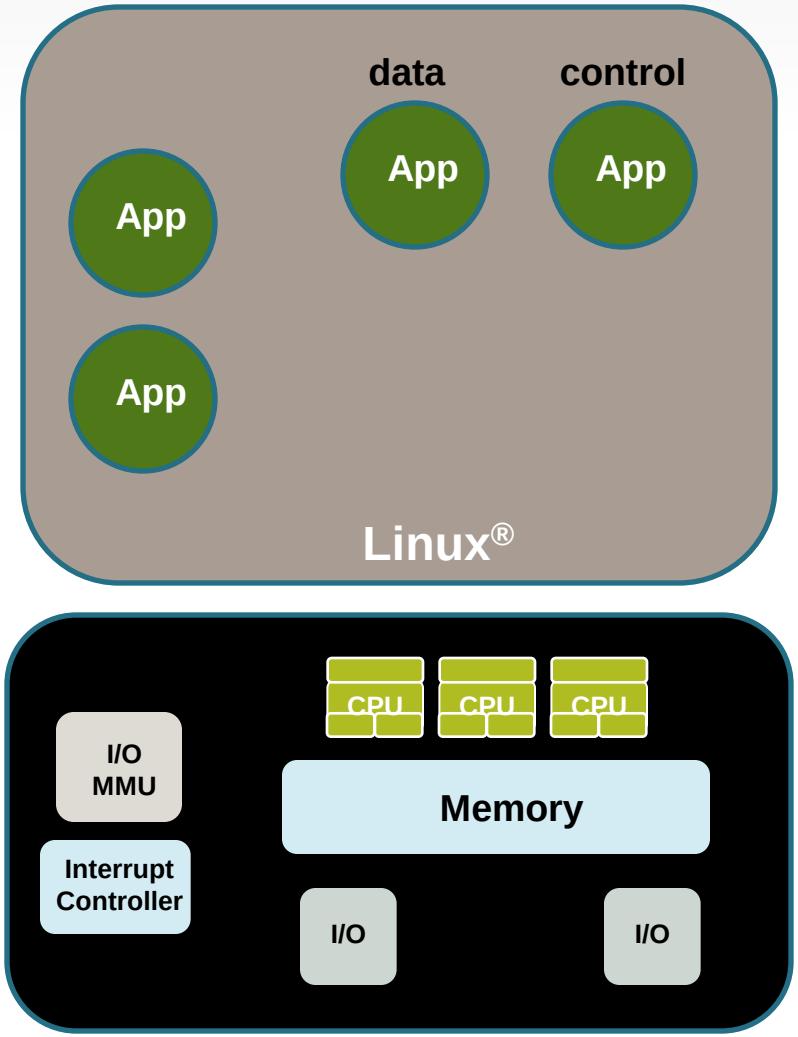
Linux Containers Overview

- Containers provide OS level virtualization
  - Provides low overhead, lightweight, secure partitioning of Linux applications into different domains
  - Can control resource utilization of domains– CPU, I/O bandwidth
  - Linux Containers is based on a **collection of technologies** including kernel and user-space components.



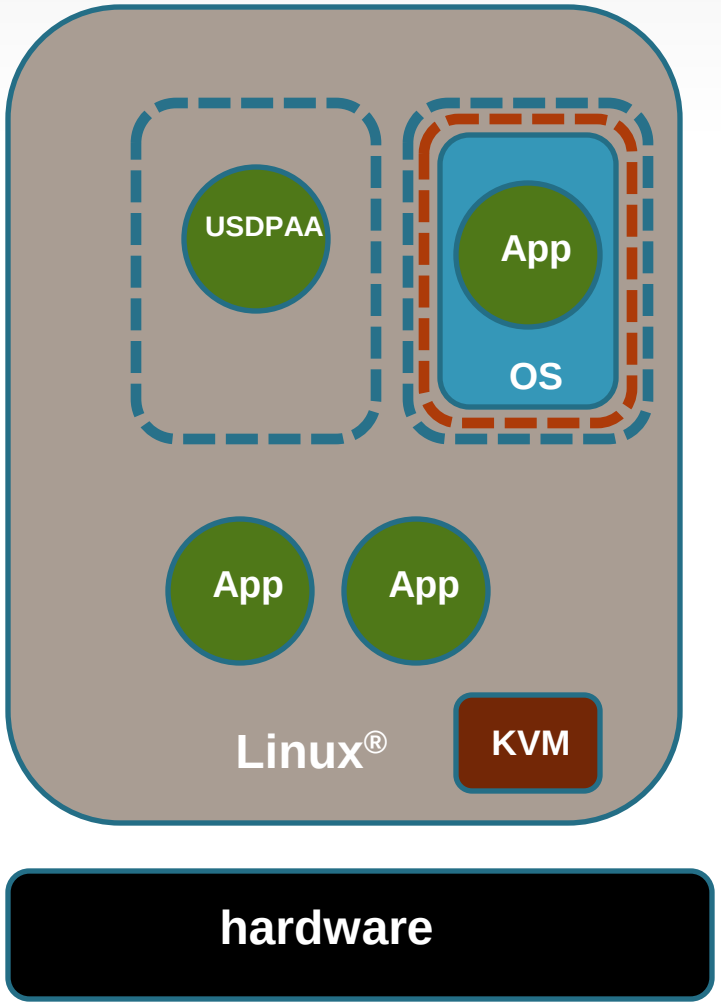
USDPAA

- Infrastructure to build Linux®-based networking applications
- Bare metal performance with the rich APIs available in Linux



Combining Technologies

- These technologies are not mutually exclusive:
  - Run USDPAA on a Linux guest on Topaz
  - Run USDPAA in a Linux container
  - Run a KVM virtual machine in a Linux container

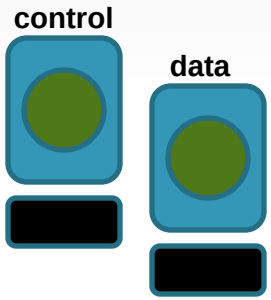


Consolidation: Benefits

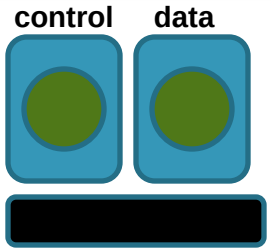
- Cost savings– bill-of-material, power
- Flexibility

- Examples
  - Combine multiple domains– control plane, data plane
  - Migration — move to new hardware, preserve investment in software
    - Run legacy software alongside new software
    - Add Linux® to a system
  - Provide an isolated environment where untrusted software can run
  - High availability — active/standby configuration without additional hardware

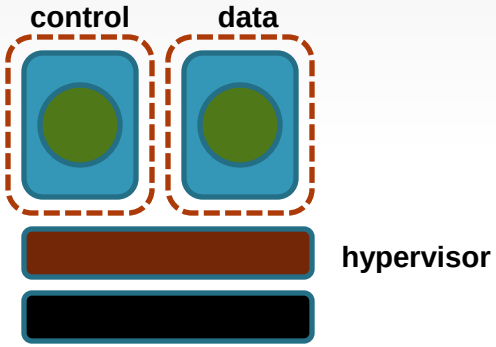
Consolidation Overview



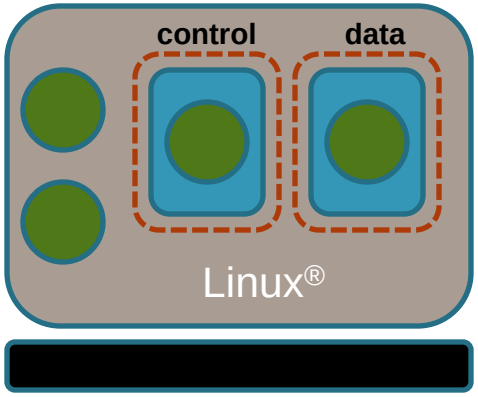
Multiple processors/boards



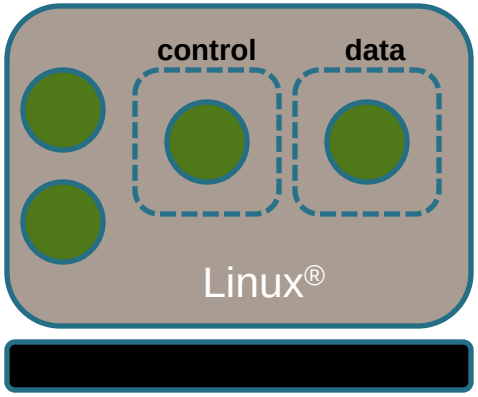
Unsupervised AMP



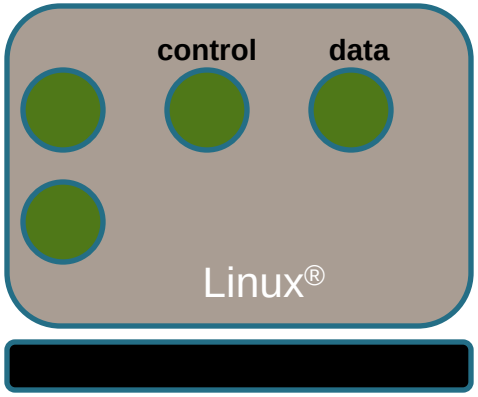
Topaz (Supervised AMP)



KVM



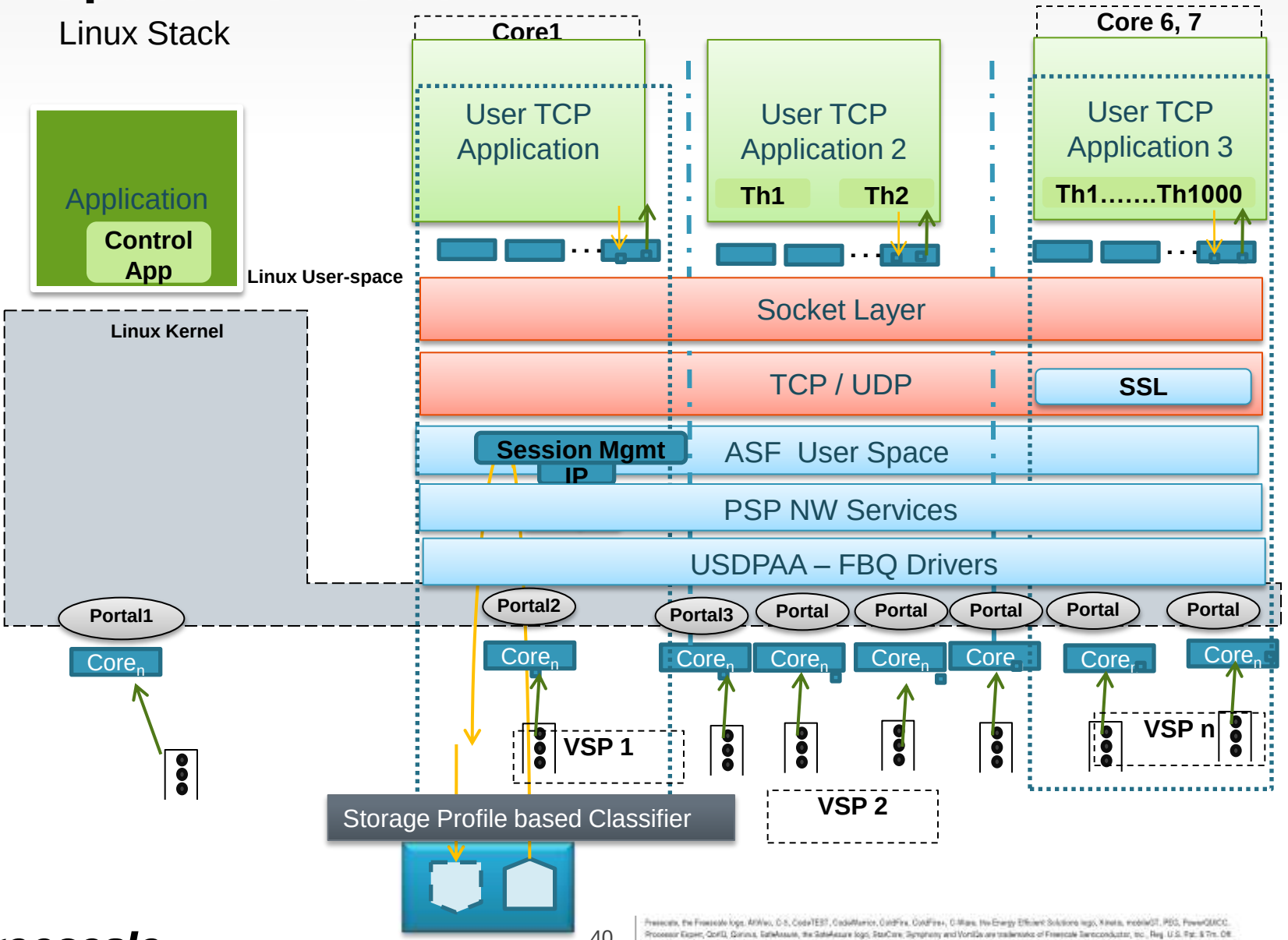
Linux Containers



USDPAA

User space technology

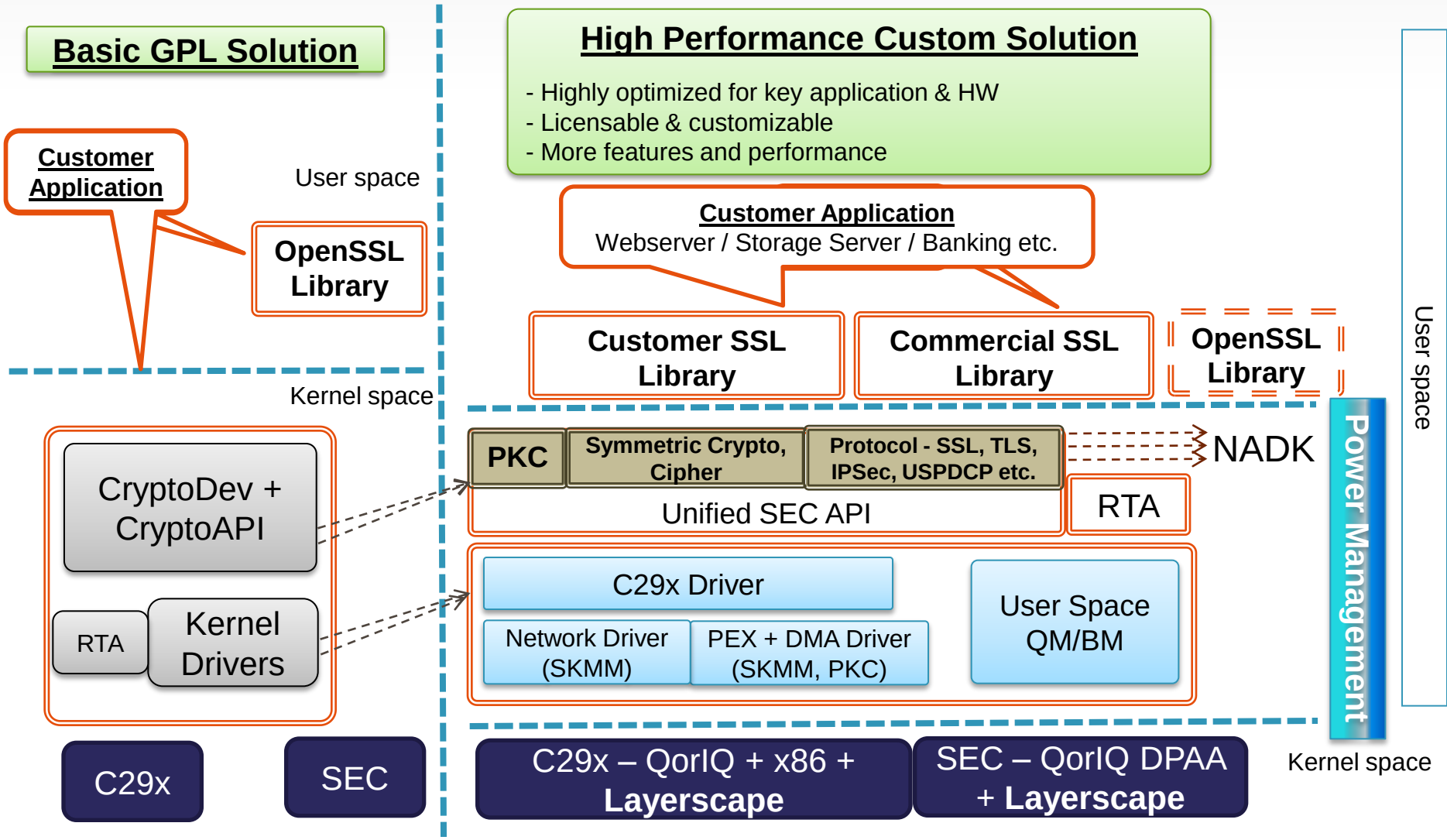
User Space TCP Stack



FMAN Ports

Security enablement

Security Enablement



Power Management

Power Management Features

	Description	Hardware applicable	Availability
cpufreq	Enable the operating system to scale the CPU frequency up or down at runtime in order to save power.	P1-P5, T4/B4	SDK1.3.1
cpu hotplug	Each core of multi-core chips can be enabled or disabled individually.	P1-P5, T4/B4	T4/B4:SDK1.3.1 PH30: SDK1.4
sleep	Suspend when power on, namely Power-On Suspend in Linux. It features high wake latency.	P1-P5, T4/B4	SDK1.3.1
deep sleep	Suspend to ram when power on, namely Power-On Suspend-to-RAM	MPC8536	SDK1.3
Hibernation			
wake on magic packets			
wake on user defined packets			
wake on USB			
wake on internal timer			
wake on eSDHC			

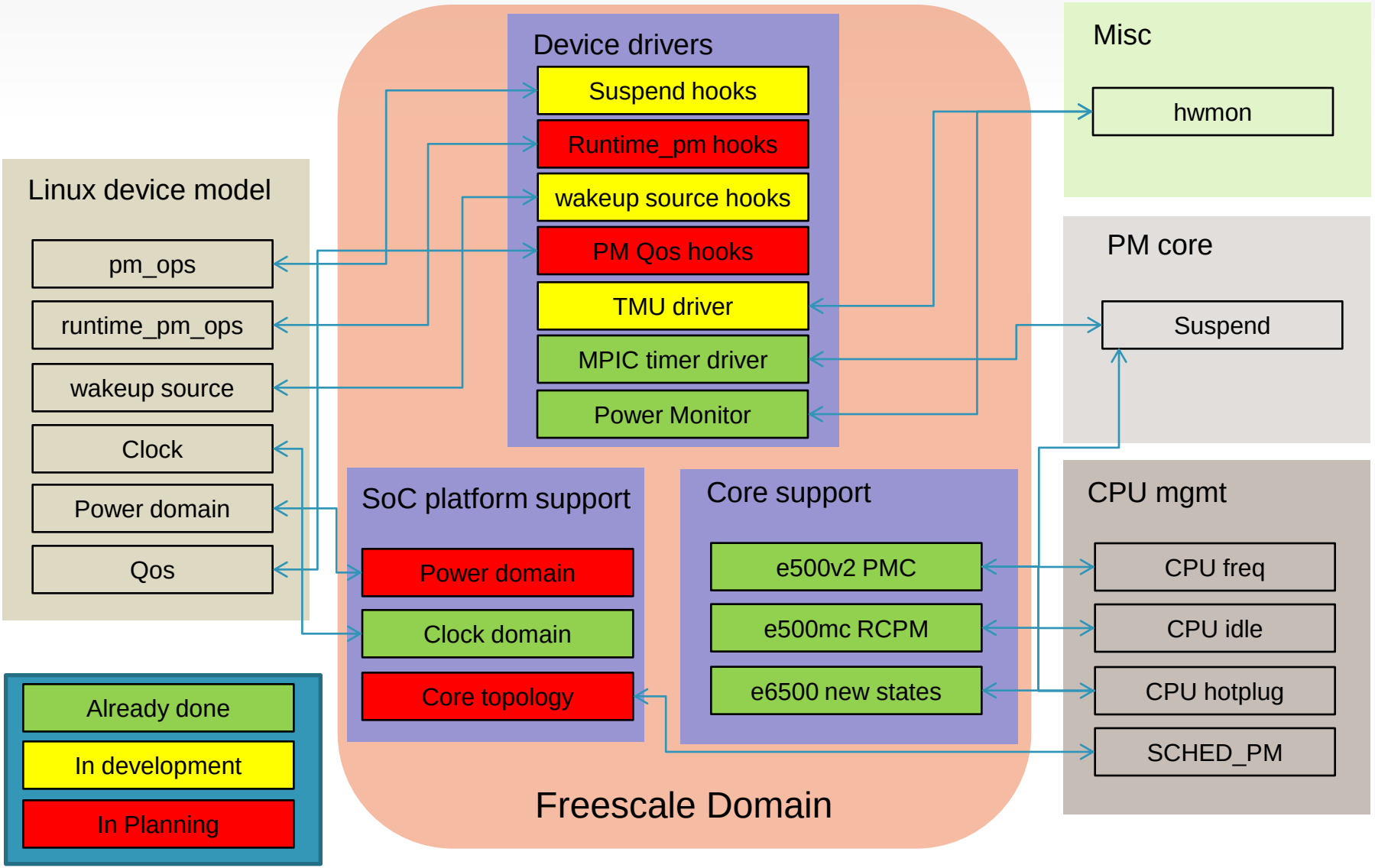
Feature	Description	Hardware applicable	Availability
wake on GPIO	Wake on changes of level on GPIO pins.	P1022, P3-P5, T4/B4	T4/B4: SDK1.4 Other: SDK1.3
wake on external interrupts	Wake on external interrupts. Other devices can wake the system by sending signal to IRQ[0:11] pins. Such as the EVENT button and RTC on board.	P1-P5, T4/B4	T4/B4: SDK1.4 Other: SDK1.3
cpu idle	W T cl		
lossless deep sleep	D S pl		
Altivec drowsy	E b		
power monitor	M v		
thermal monitor(on-chip TMU)	It cl		
thermal monitor(on-board chips)	It b		
Cascade power management	R fu p		

Feature	Description	Hardware applicable	Availability
Driver compatibility	Drivers in the system need to be tested and updated to work with low power modes. Basically the driver need to stop the hardware properly before entering low power mode, and start the hardware on resume.	P1-P5, T4/B4	SDK1.4
Auto-response	Automatically respond to certain types of network traffic in Deep Sleep in order to stay longer in low power state. Need to update Fman microcode.	T1040	SDK1.4+
Deep Sleep (chassis v2)	To meet the tough power consumption requirement for Print & Image use case deep sleep is designed for the chassis v2. It is totally different from deep sleep used on P1022 and much more complex.	T1040	SDK1.4+
Benchmarking	Measure and document the power saving and wakeup latency for various PM states and features	All	SDK1.4+
Optimization			
Demos and solutions			
Autosleep			
CPU topology and SCHED_PM			

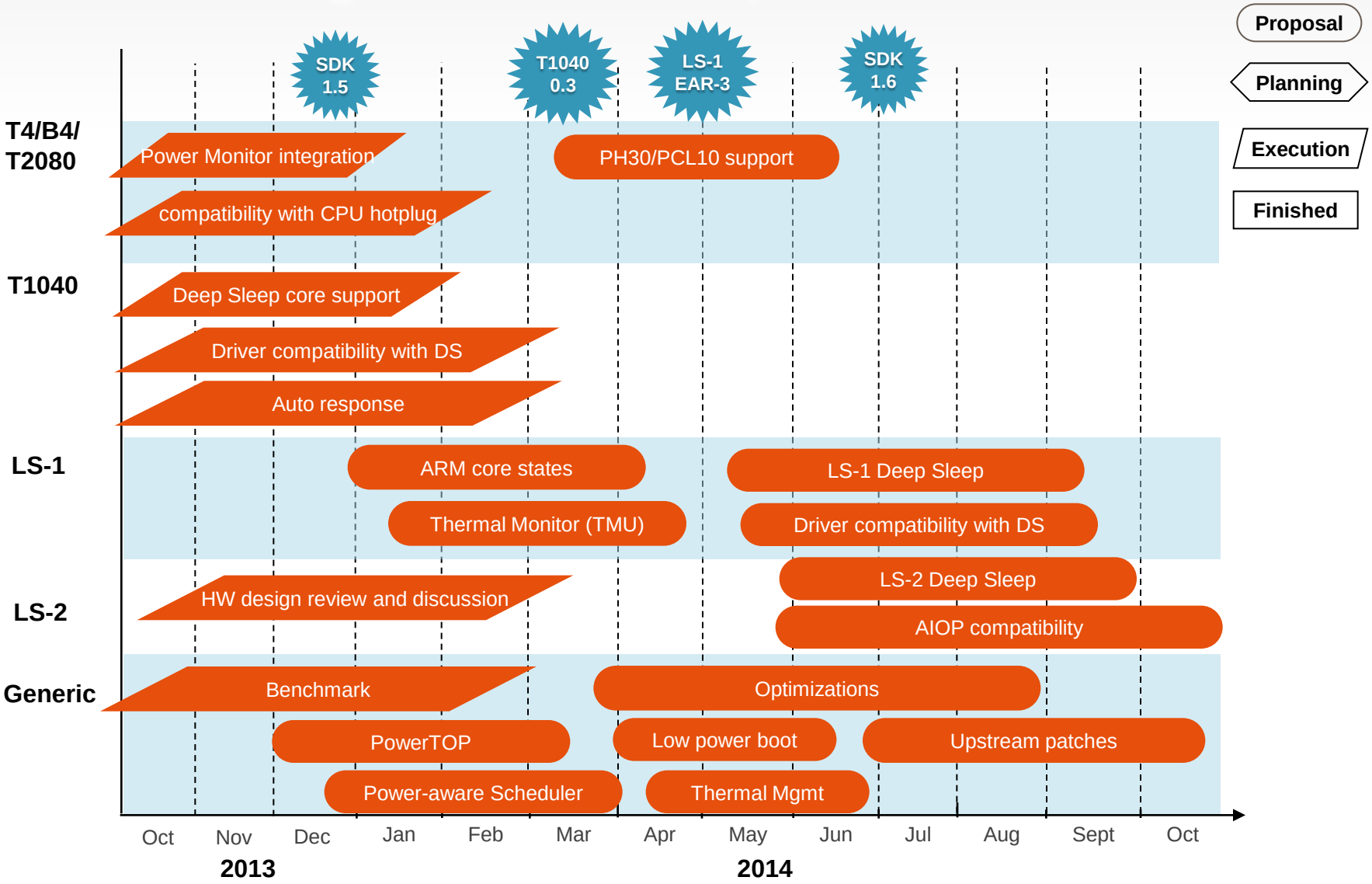
Feature	Description	Hardware applicable	Availability
DEVDISR support	Provide friendly interface in u-boot/kernel to disable unused IP blocks in the SoC.	All	SDK1.4+
Runtime PM	Disable specific device when it is not used, and enable it automatically when it is used later.	All	SDK1.4+
PowerTOP	Tool to measure how efficient the Power Management features are used to save power. Useful for tuning software on system level.	All	SDK1.4+
PM QoS	Provide interface to set application specific QoS expectation on latency and throughput, so that devices can enter proper states that guarantees the QoS requirement.	All	SDK1.4+
Device PM states	Add or make use of the PM feature for device which has it's own PM states like PEX, USB, SATA, Ethernet, and etc.	All	SDK1.4+
FLIB support	Provide library code for PM features that can be used not only in Linux but also bareboard environment and other Oses.	All	SDK1.4+

Feature List with priority

Freescale software components

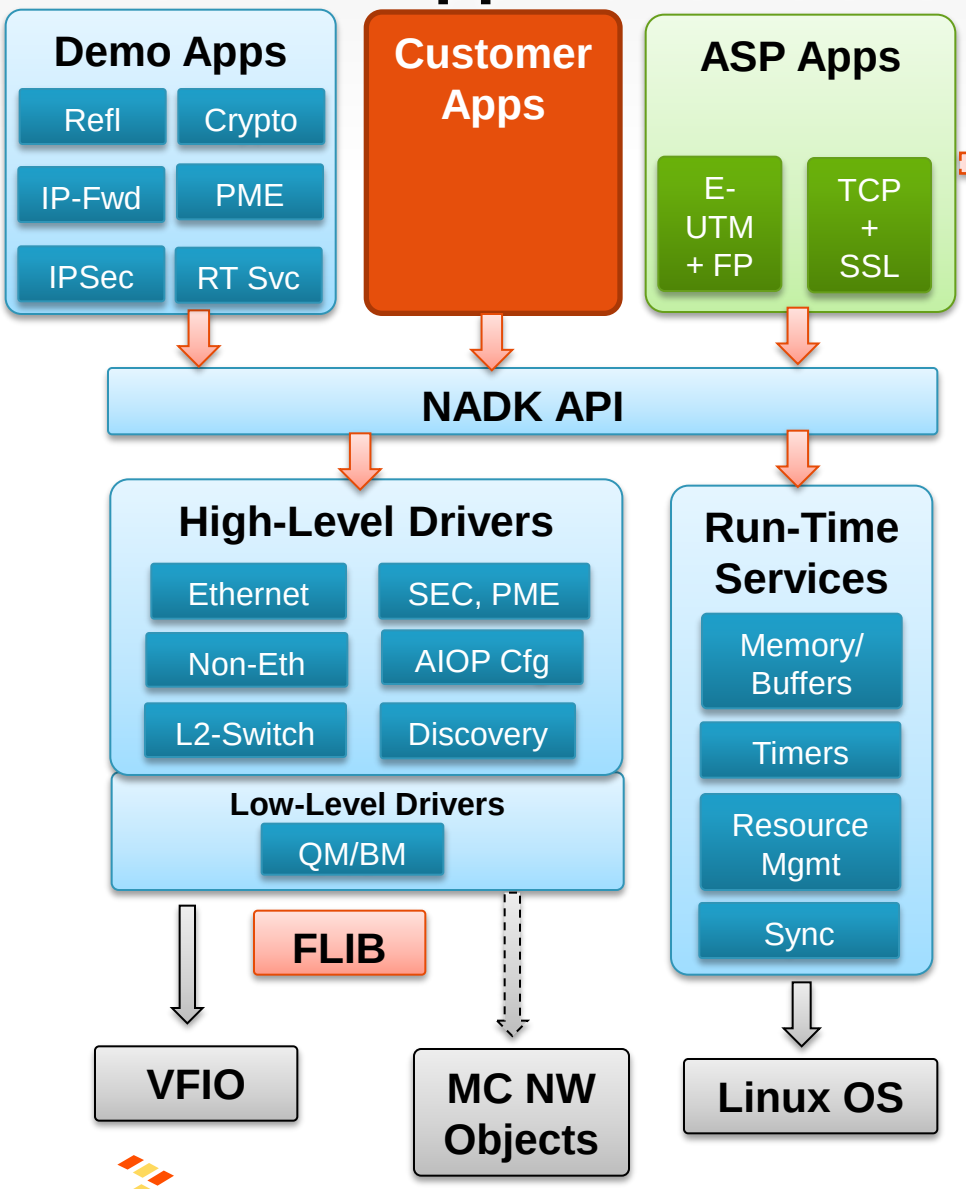


Power Management Roadmap



Networking Application Development Kit

Network Application Development Kit



- Targeted for NW Application development
  - Specific customers willing to use new API/env for licensing, debug or performance concerns
- Restructure USDPAA & PSP
  - USDPAA
    - Low-level driver for data I/O only.
  - PSP
    - Separate out NW services as optional middleware
    - Separate applications and change to library mode
  - High-Level drivers
    - New high-level drivers based on MC NW objects
- Distribution
  - Support is chargeable

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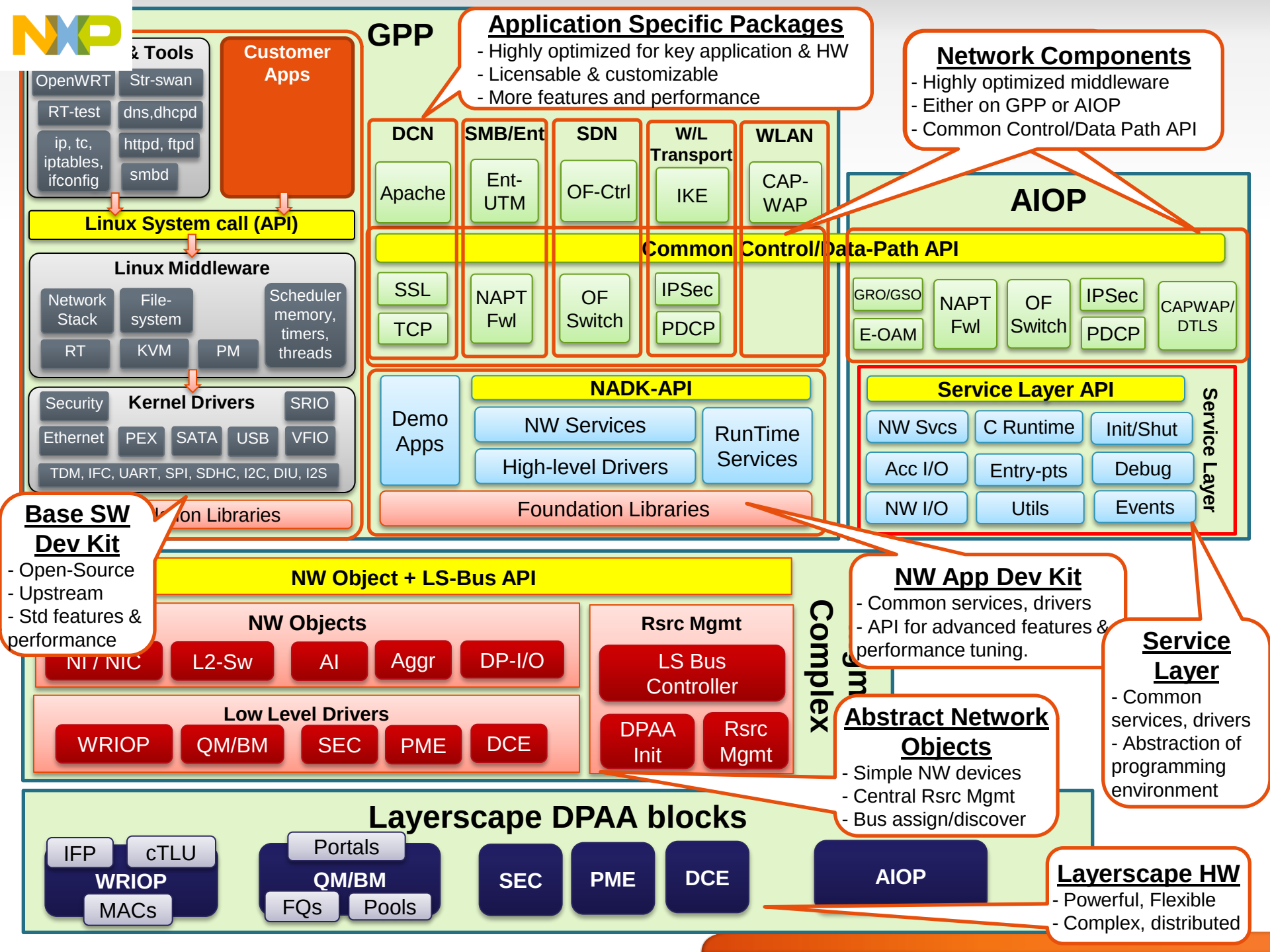
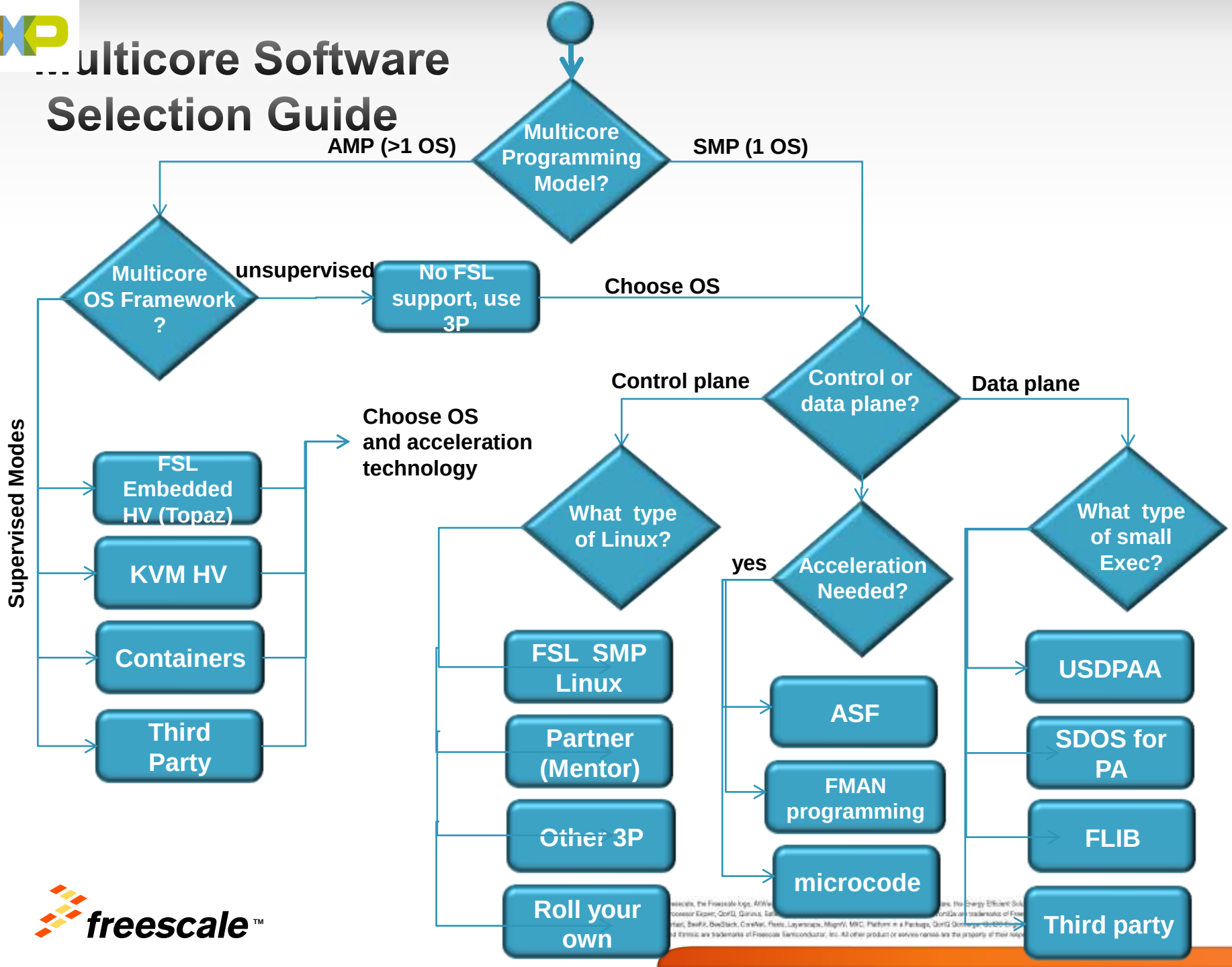

GPP
Application Specific Packages
- Highly optimized for key application & HW
- Licensable & customizable
- More features and performance
Network Components
- Highly optimized middleware
- Either on GPP or AIOP
- Common Control/Data Path API
& Tools
OpenWRT
Str-swan
RT-test
dns,dhcpd
ip, tc, iptables, ifconfig
httpd, ftpd
smbd
Customer Apps
Linux System call (API)
Linux Middleware
Network Stack
File-system
Scheduler memory, timers, threads
RT
KVM
PM
Kernel Drivers
Security
SRIO
Ethernet
PEX
SATA
USB
VFIO
TDM, IFC, UART, SPI, SDHC, I2C, DIU, I2S
DCN
SMB/Ent
SDN
W/L Transport
WLAN
Apache
Ent-UTM
OF-Ctrl
IKE
CAP-WAP
SSL
TCP
NAPT Fwl
OF Switch
IPSec
PDCP
Common Control/Data-Path API
AIOP
GRO/GSO
E-OAM
NAPT Fwl
OF Switch
IPSec
PDCP
CAPWAP/ DTLS
Demo Apps
NADK-API
NW Services
High-level Drivers
RunTime Services
Foundation Libraries
Service Layer API
NW Svcs
C Runtime
Init/Shut
Acc I/O
Entry-pts
Debug
NW I/O
Utils
Events
Service Layer
Base SW Dev Kit
- Open-Source
- Upstream
- Std features & performance
NW App Dev Kit
- Common services, drivers
- API for advanced features & performance tuning.
Service Layer
- Common services, drivers
- Abstraction of programming environment
NW Object + LS-Bus API
NW Objects
NI / NIC
L2-Sw
AI
Aggr
DP-I/O
Low Level Drivers
WRIOP
QM/BM
SEC
PME
DCE
Rsrc Mgmt
LS Bus Controller
DPAA Init
Rsrc Mgmt
Complex
Abstract Network Objects
- Simple NW devices
- Central Rsrc Mgmt
- Bus assign/discover
Layerscape DPAA blocks
IFP
cTLU
WRIOP
MACs
Portals
QM/BM
FQs
Pools
SEC
PME
DCE
AIOP
Layerscape HW
- Powerful, Flexible
- Complex, distributed

Multicore Deployment Use Cases

...ulticore Software Selection Guide



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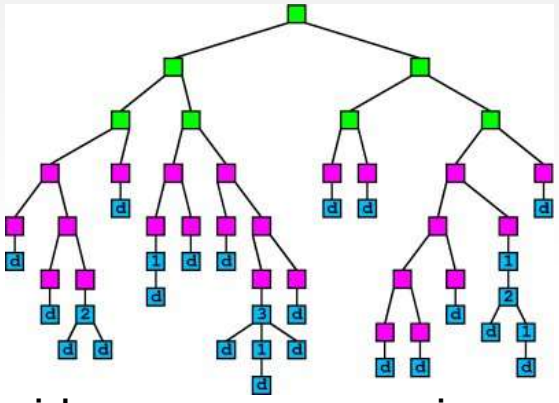
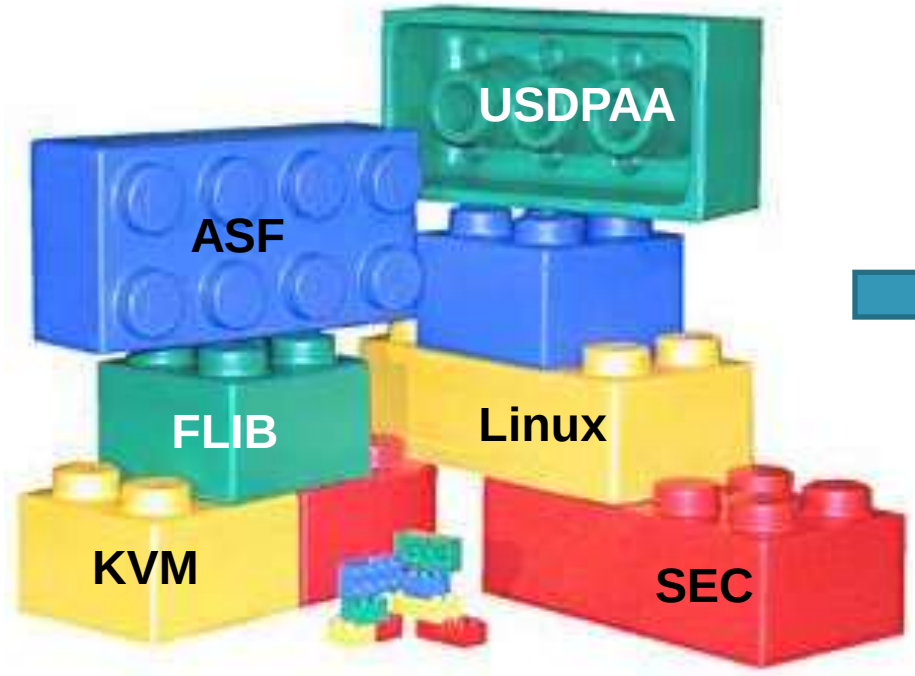
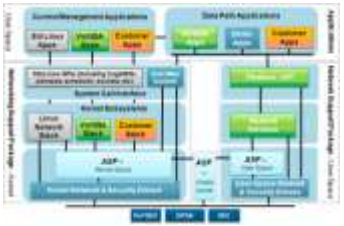
Leggo Brick mentality



Decide on a programming model

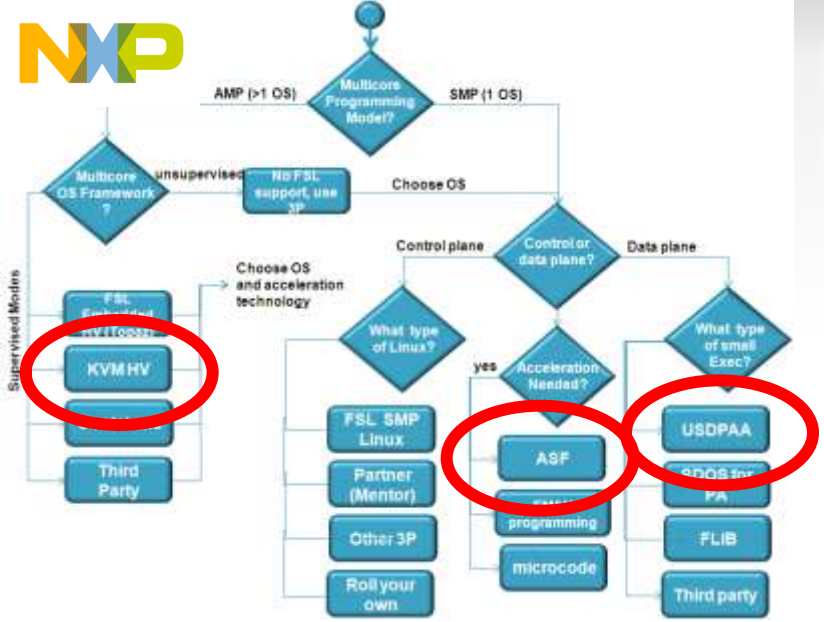


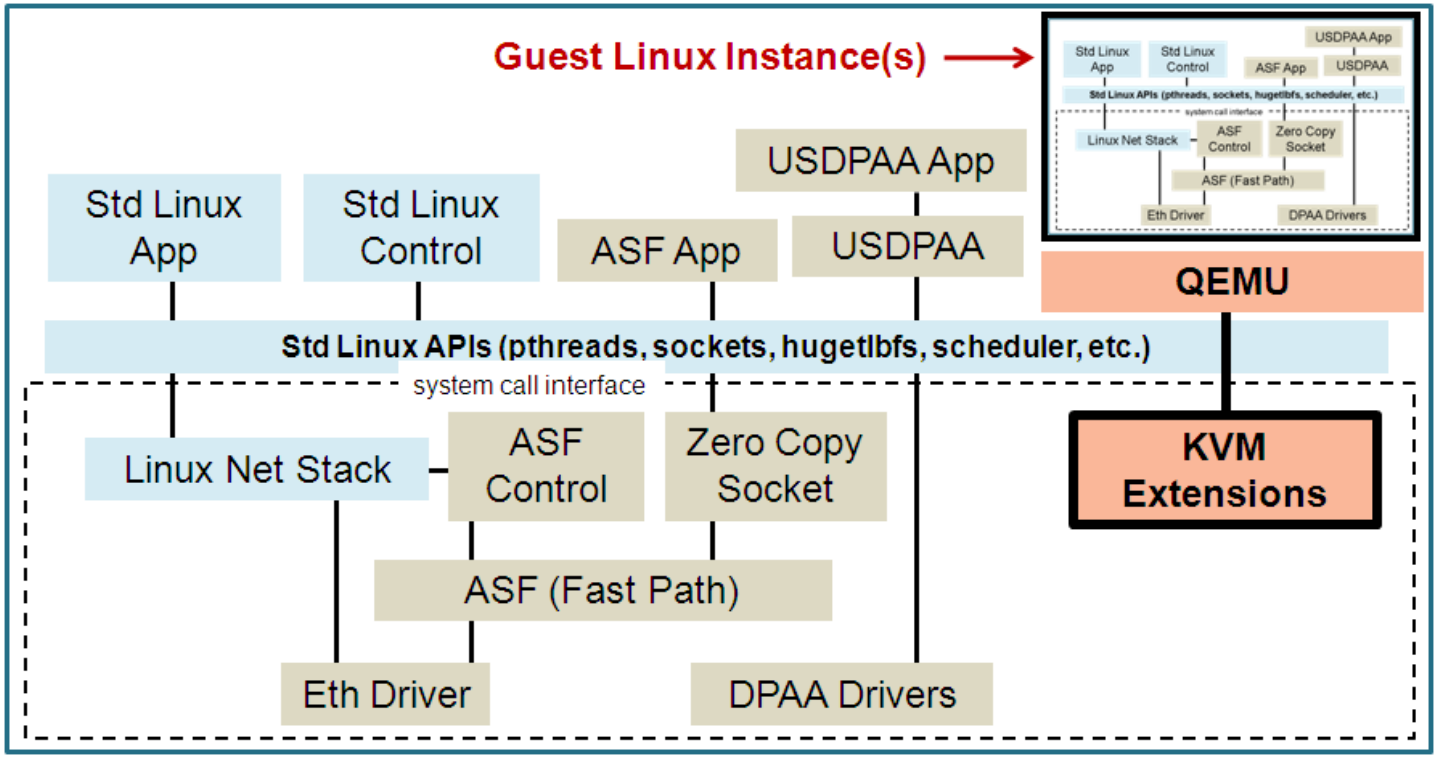
…that's composed from a set of MC leggo bricks



…to select a MC SW solution….

Example 1: KVM with USDPAA and ASF Software Reference Architecture





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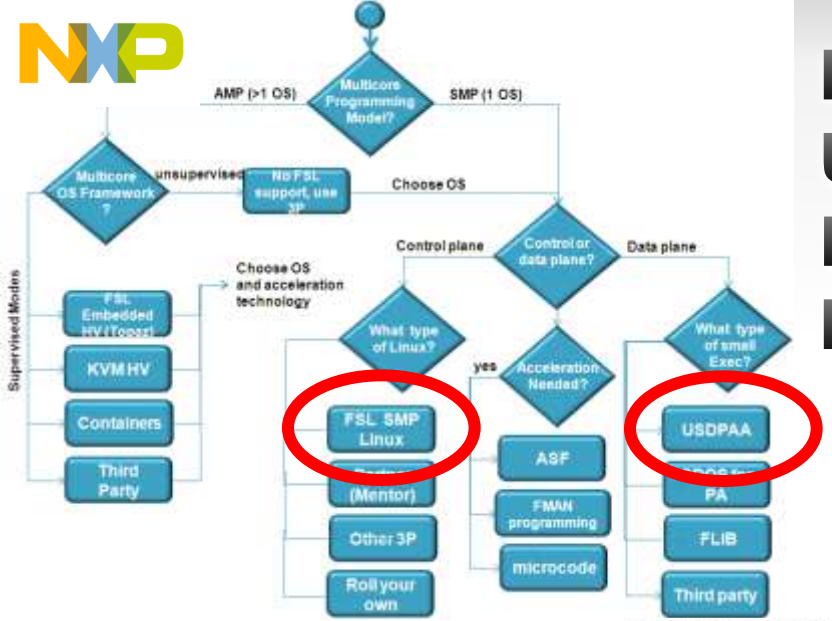
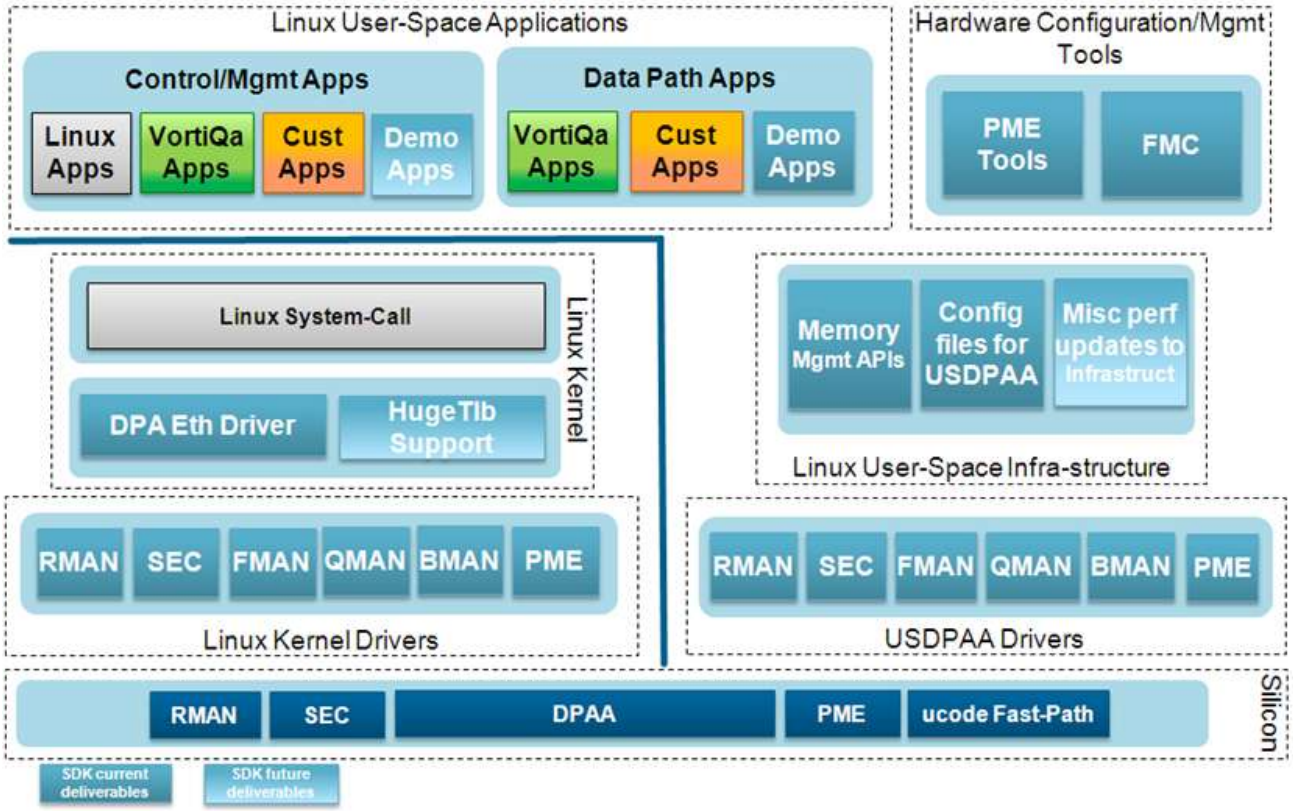
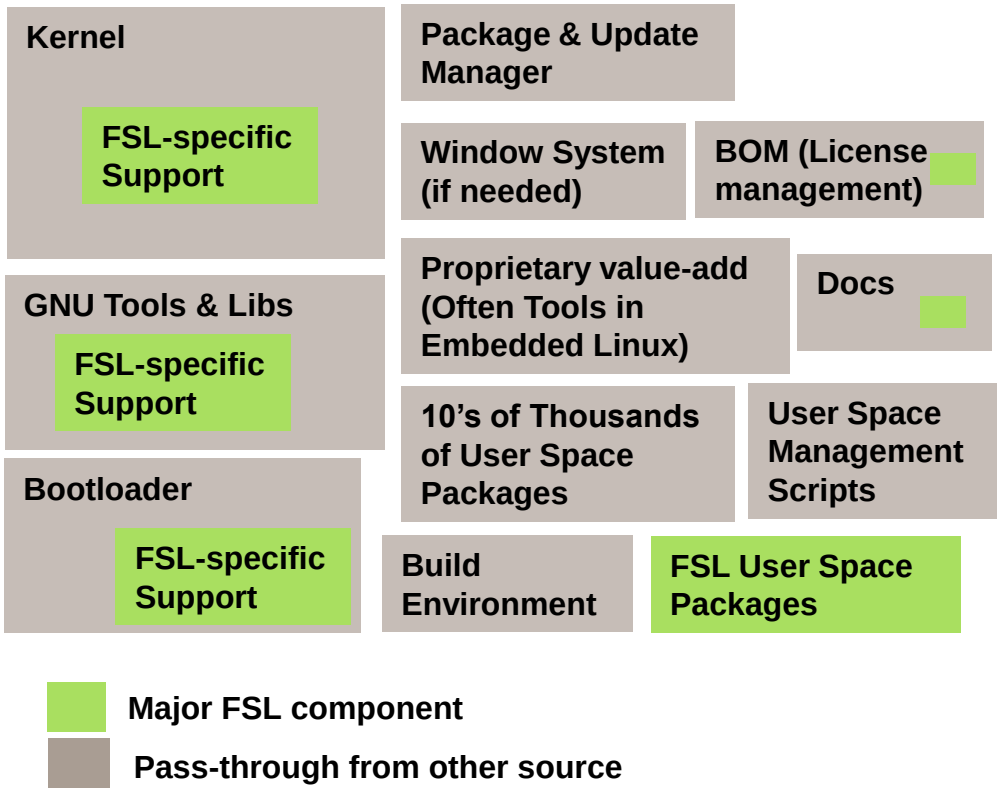
Example 2: USDPAA Running on FSL Linux Software Reference Architecture



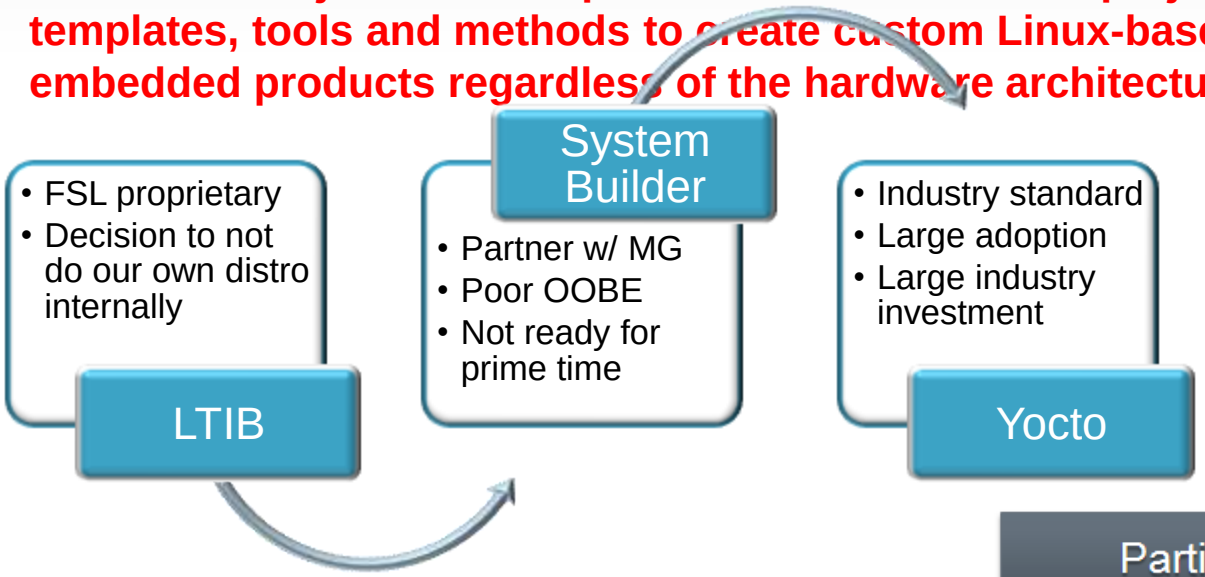


A Linux Distribution (Distro): A Complete Linux Kit

- Linux is an open-source integration of many components from many sources, most of which are architecture-independent and don't originate with Freescale.
- Customers (and FSL internally) cannot use Linux without a complete kit.
  - Many distros exist.
  - Some customers create their own.
  - Major FSL SW must be usable with arbitrary distros.
  - But FSL also must use and ship one.
  - FSL choice: Yocto



- **The Yocto Project™ is an open source collaboration project that provides templates, tools and methods to create custom Linux-based systems for embedded products regardless of the hardware architecture.**



- ❑ **Engaged in Yocto community since June**
- ❑ **MG also moving to Yocto (working jointly)**
- ❑ **Field team transparency and feedback**
- ❑ **Beta version by end of 2011**
- ❑ **Full incorporation into SDK 1.2 in April 2012**

Participating Organizations

- Cavium Networks
- Dell
- **Freescale Semiconductor**
- Intel
- LSI
- **Mentor Graphics**
- Mindspeed
- MontaVista Software
- OpenEmbedded eV
- Panasonic
- NetLogic Microsystems
- RidgeRun
- Secret Lab Technologies
- Sakoman, Inc.
- Texas Instruments
- Tilera
- Timesys
- **Wind River**

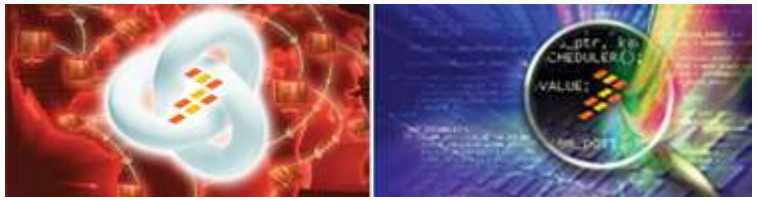
Distributing Linux: Three Primary Models

Model	Approach	When to Use	Attributes
Native on Eval Board	Provide evaluation boards with complete native GNU Tool environments right on the board.	Desire zero "getting started" effort to building and running FSL and standard OSS	Easy to use.
Yocto (Complete)	This embedded distribution helps customer create entire Linux system. Package both as ISO image and also in virtual machine.	Need a tool to generate a complete Linux environment including tailored file system.	Complex, but very flexible and powerful.
A la Carte	Simplify customer access to just the major Freescale-created Linux components. Perfect for integration into Linux distributions from other sources, home-brew or 3rd party. Supports fast delivery of patches.	Desire to integrate Freescale Linux components into a Linux development environment that the customer already has.	Simple when the customer is also the integrator.

Software Services

Networking Software and Services Group

- ***Accelerate*** **Customer Time to Market**
  - Speed Adoption of Multicore / new technologies
  - Dedicated expert staff with access to software and SoC teams



- ***Deliver*** **Commercial Software, Support, Services and Solutions**
  - Commercial Software: VortiQa, CodeWarrior, Processor Expert
  - Packaged and Customized services

- ***Simplify*** **Software Engagement with Freescale**
  - Consolidate Freescale software and solutions
  - Streamline business processes

- ***Create*** **Success!**
  - Partner with customers
  - Leverage *your* strengths, add *our* capabilities

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Networking Software and Services Group

Software Products and Custom Services

Development Tools	Runtime Products	Solutions Reference	Linux® Services	Integration Services
• CodeWarrior – IDE – Debug – Compiler – Trace • QorIQ Optimization Suite – Scenarios Tools – DDrV	• VortiQa Software Products – Application Identification Software (AIS) – Open Networking Switching Framework – Platform Services Package (PSP) – Mobile Transport	• Storage Controller • SDN Switch • Wireless LAN • Data Concentrator • Smart Converged Gateway • Digital Signage	• Commercial Support • Frozen Branch • Application Specific Hardening • Feature Acceleration	• Systems Consulting • Design Services • Porting • Migration
CodeWarrior QorIQ	VortiQa			

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Segment Solutions

CSL: Differentiated Segment Solutions – Enterprise AP Gateway

- Market Aligned
- Differentiated High Performance Segment-Specific Solutions
- Near market ready designs – leverage R&D efforts
- Feedback to internal teams, improve future NPIs performance

Turnkey, Market-Ready

Time-To-Market

- Provide Level2/level 3 support on turnkey solutions

Differentiated System Performance

- Solution Performance with low CPU utilization
- Evaluate Wi-Fi, SSL/DTLS/VPN performance
- Tradeoffs - x1 vs x2 cores,, DDR size, speed
- Tradeoffs on CPU clock, platform clock speed & power consumption

Enterprise Cloud

AP Gateway

Multi-Service Gateway

- Storage Server (NAS, SAN)
- Video Media Server
- ISR (Integrated Service Router)
- Universal Communication Gateway
- BSC9131 Femto-WLAN Gateway

Differentiated Platform Solutions (DPS)

- Converged IOT Gateway –Wi-Fi, 3G/4G, sensor network (IOT)
- Scalable, Portable open-source Platform runs on any QorIQ, Qonverge, PowerPC devices

(e.g. P101x, P1020x P1022,/1013, P1023 /P1017, P1025 etc)

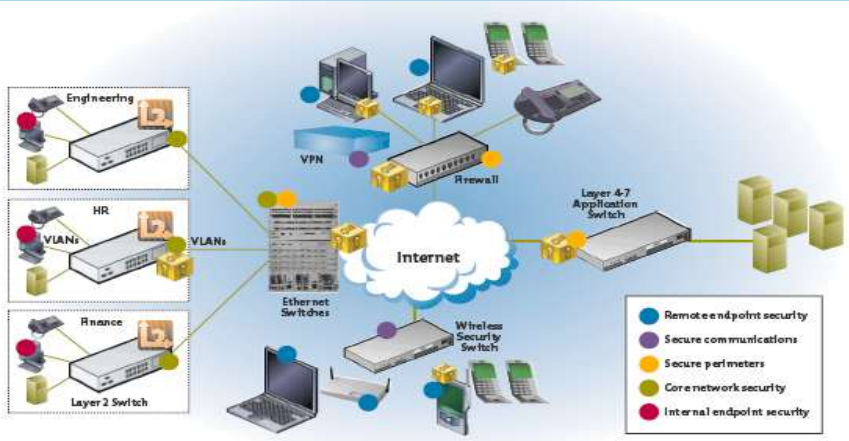
- Winner of 2012 Australian and New Zealand Smart Metering Conference – “Best Networking and Communication Product Award”
- Winner of 2011 Broadband World Forum: Infovision Award – Smart multi-core, multi-service Business Gateway
- 2012 Innovator of the Year by ECD Magazine for the core agnostic platform approach to Wireless Smart Gateways

Network Applications

VortiQa Application Identification Software (AIS)

Market Driver - *The need for identifying and controlling web applications traffic at the edge of business network*

- Trends
  - Application Identification becoming a key component of security appliances.
  - Explosive adoption of smart devices in business.
  - Need for device & application recognition as Application usage increases substantially.
  - Need for right policy enforcement for effective utilization of network bandwidth in businesses.



Highlights:

- User space Network Application using PSP middleware
- Configurable detection schema for full deep packet inspection or partial inspection for higher performance
- In-house Signature development & distribution infra.
- Nearly 1700 application features detection – Social Networking, P2P, Business Apps, Games, Streaming etc

Status:

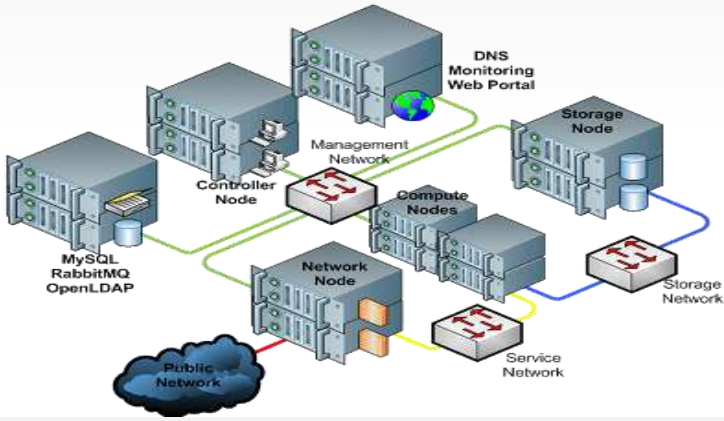
- Released on QorIQ T4240, P4080, P2020, P1020
- Traffic Characterization and Encrypted traffic detection in progress.
- Release v3.0 scheduled for Sept, 2013

Network Function Virtualization using Open Stack Neutron

Market Driver - *The need for an elastic expansion of virtual network services on dynamic demand*

- Trends
  - Virtual network appliances replacing legacy hardware
  - Enterprises are adopting Cloud Computing technologies
  - Elasticity - Dynamic scale in and scale out of virtual network appliances based on Network Traffic Load.
  - Reduction of CAPEX & OPEX
  - Cloud orchestration for OpenFlow/Software Defined Networks

openstack™



Highlights:

- Freescale QorIQ platforms work as Compute Nodes.
- Brought up Web Proxy and Open Cart virtual network function on Open Stack Grizzly compute node.
- Active participation in the OpenStack forum. Proposing new ideas blue prints & sharing software with the community
- Demonstrated at the ONS-2013, China Roadshow

Status:

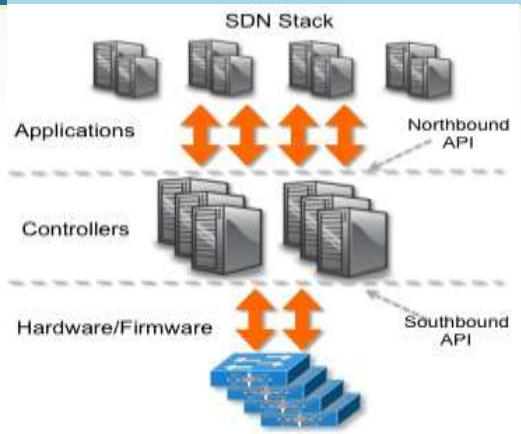
- OpenFlow Controller Integration with OpenStack - Neutron
- Cloud Resource Discovery Service development for OpenFlow/SDN Network deployments
- Next release on Dec,2013

Network Applications Development

VortiQa ONSF
(Openflow Networking Software Framework)

Market Driver - *Data center and clouds embracing this promising and disruptive new technology to improve network manageability and reduce operational cost*

- Trends
  - Enterprises are fast moving to cloud for network services.
  - Cloud operators adopting network virtualization for scalability, flexibility and cost reduction.
  - General purpose switch market reducing considerably in favor for SDN based switches for better manageability and improved cost.



OPEN NETWORKING FOUNDATION

OpenFlow

InCNTRE

Highlights:

- Support for Openflow 1.3 protocol
- Plugfest validated for Interoperability
- Application extensions for L3-L7
- Integration with Open Stack and VXLAN
- Customer demos in China & Taiwan Road shows

Status:

- North Bound APIs published for application integration
- Release-1 targeted for Q1 2014 (IP Fwd, IPSec)
- Final release targeted for Q4 2014 (Firewall, QoS)

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Tools

Freescale's Developer Tools Organization - DevTech

- History
  - 1985: Origins as Metrowerks, recognized as Gold Standard for Mac/Desktop Development Tools
  - 1996: Entered embedded development market
  - 1999: Acquired as an independent subsidiary of Motorola's Semiconductor Products Sector
  - 2002: Acquired Embedix (Lineo), established Linux Solutions Group
  - 2002: Acquired Applied Microsystems Corporation, expanded product offering to add board bring-up and code analysis capabilities
  - 2005: Fully integrated as part of the TSO organization, focused on enablement tools and software
- **CodeWarrior Development Studio®**
  - Complete Development, Debug and Analysis Suite
- Linux and Run-time Technology
  - Development Tools (kernel & application)
- Reference and evaluation boards
- Customer Support, Product Maintenance

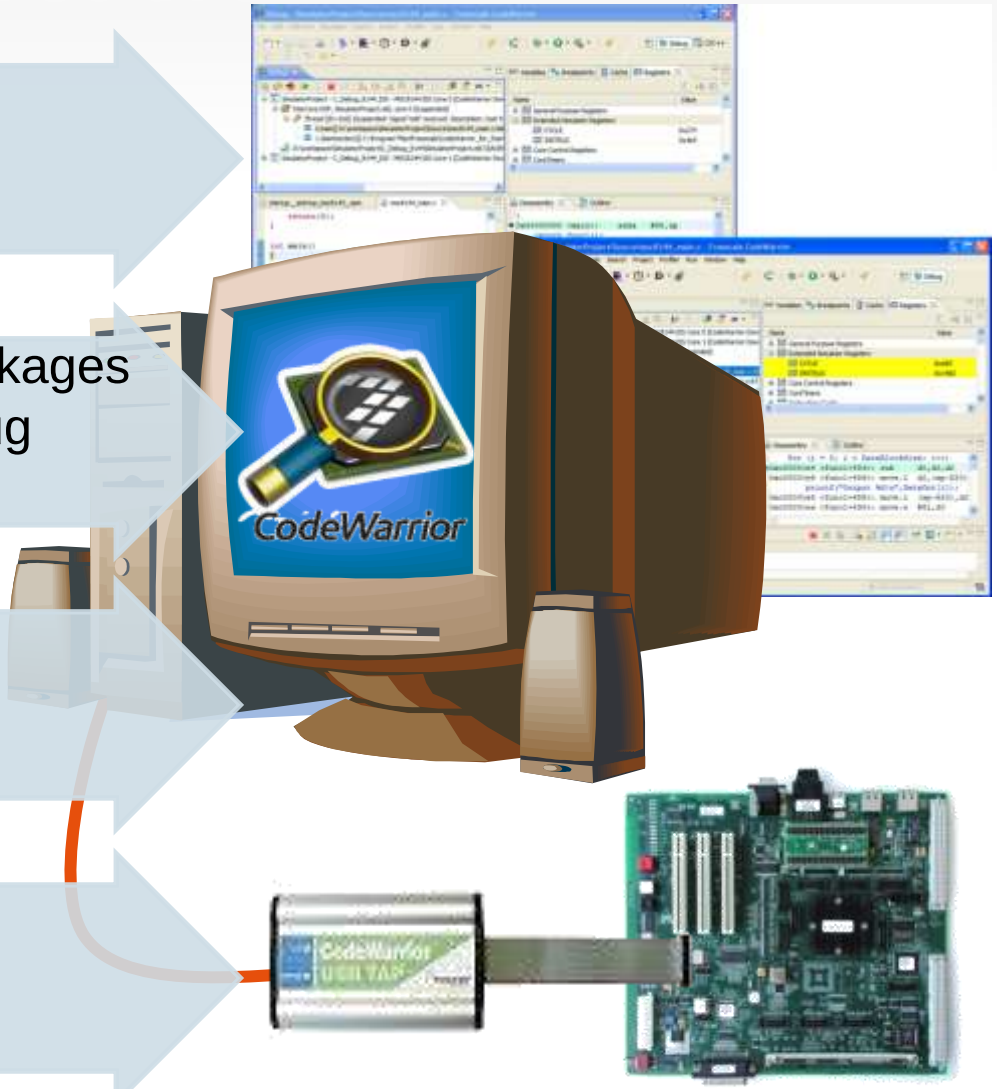
Complete Development Solution

Algorithms
- IDE
- Build
- Simulate

OS & Drivers
- OS & Driver Packages
- Stop Mode Debug
- Trace

Applications
- Debug Agents
- Trace
- SDKs

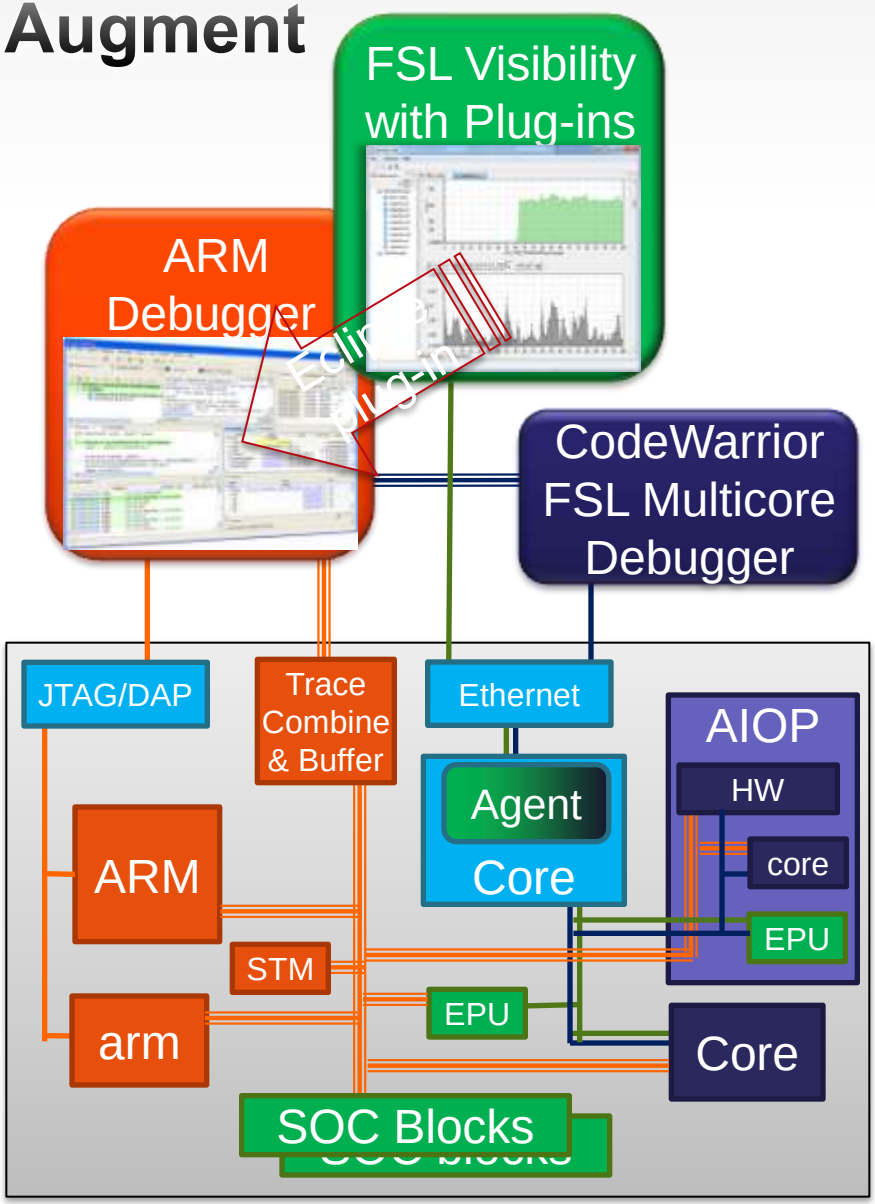
Test & Refine
- Test Server
- Profiling
- Code Coverage



Freescale Development Tools

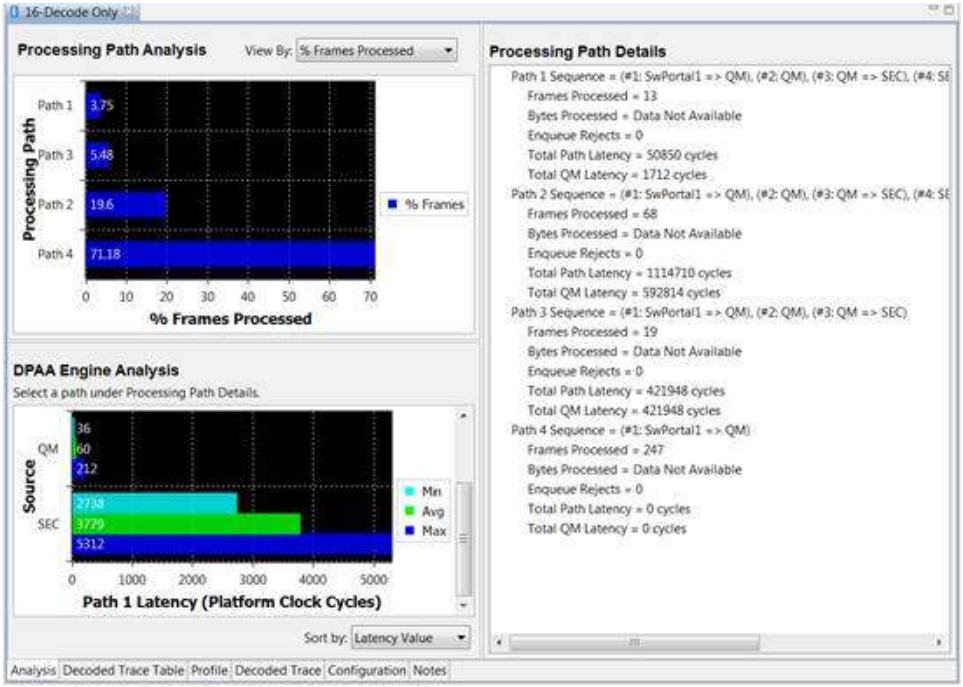
Layerscape Tools: Leverage the Ecosystem & Augment with Freescale

- Off-the-shelf ARM tools
  - ARM DS-5 or any ARM Coresight-Aware tools “just work”
- Augment ARM tools with Freescale plug-ins and stand-alone tooling
  - ARM tools act as a pipe for Freescale trace and debug
- CodeWarrior enables debug of Freescale cores
  - AIOP & Accelerators
  - Fit within ARM Coresight



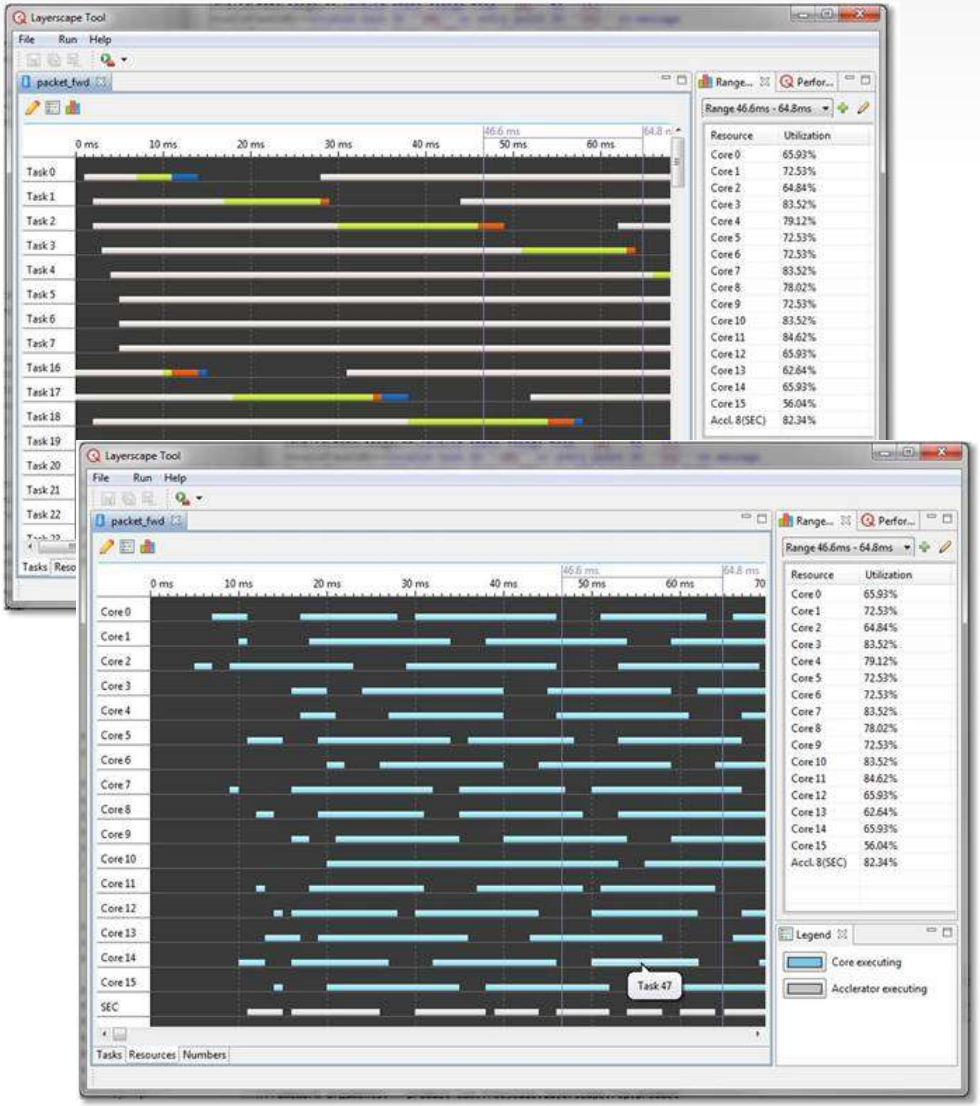
Packet Analysis Tool

- **Customer Benefits**
  - Complexity abstraction and ease of use
  - Enables key use cases:
    - Packet-Oriented System Level Performance Analysis
    - SoC Data Plane Configuration Debug
    - Packet Processing Latency Analysis
    - Packet Processing Critical Resource Monitoring
- **Target areas:**
  - SoC debug/analysis feature enablement
  - Linux Systems
  - Analysis data interpretation and visualization
- **Users**
  - External Customers
  - Freescale internal developers



Layerscope AIOP Scheduler Analysis Tool

- **Customer Benefits**
  - Customer can see a time line of AIOP Program execution.
  - Visualizes task timelines
  - Provides resource centric visualization for both cores and accelerators.
  - Presents task statistics
  - Customer can select time ranges and the viewer presents utilization statistics over the selected range.
- **Technology**
  - Today built on top of the simulator
  - Will be moved to Emulator
  - Linux Systems
  - Analysis data interpretation and visualization
- **Users**
  - Freescale Designers and validation team
  - Freescale internal developers
  - External Customers



We have a prototype today


freescale™