KVM on Embedded Power Architecture Platforms

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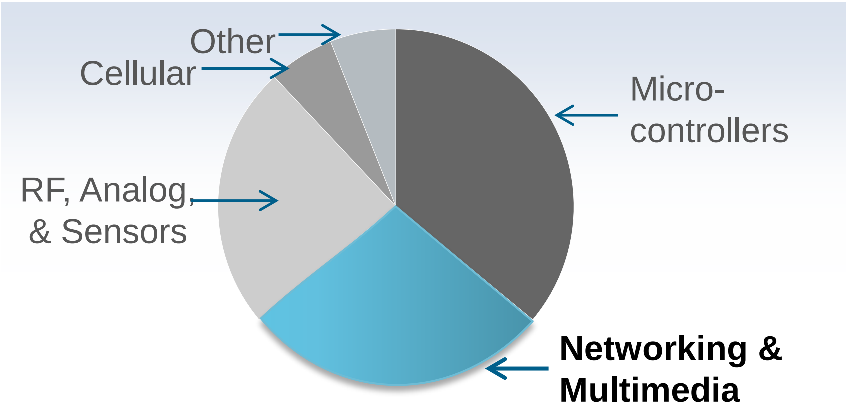
Agenda

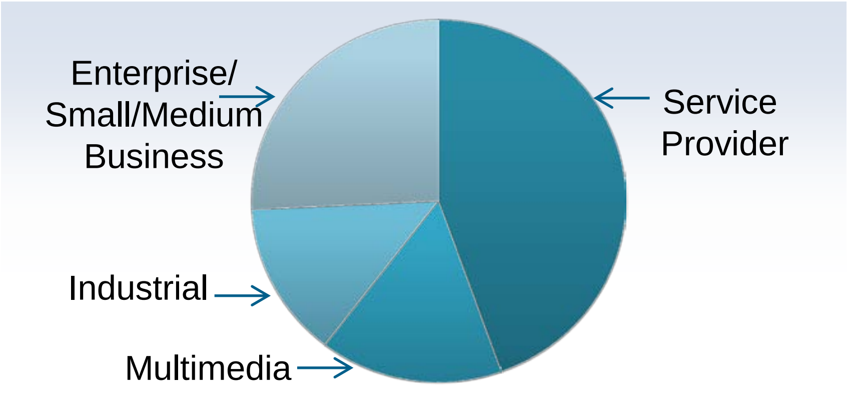
- Background
  - Freescale / Networking
  - Embedded Systems
  - Use Cases
- KVM on Embedded Power
  - New requirements
  - Status
- Future / To Do

Freescale: Networking & Multimedia Group

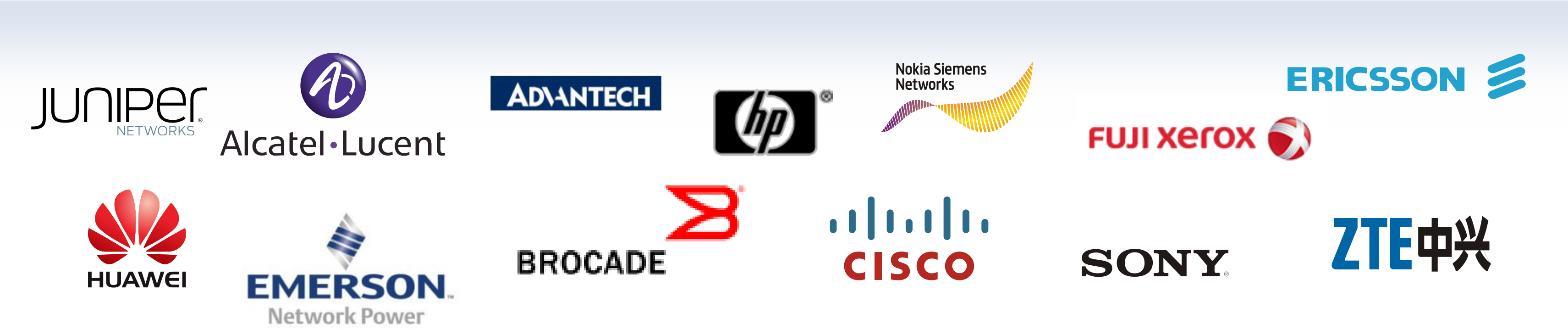
2010 Freescale Revenue



NMG Revenue by Market

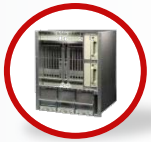
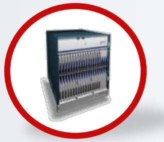


Key Networking Customers

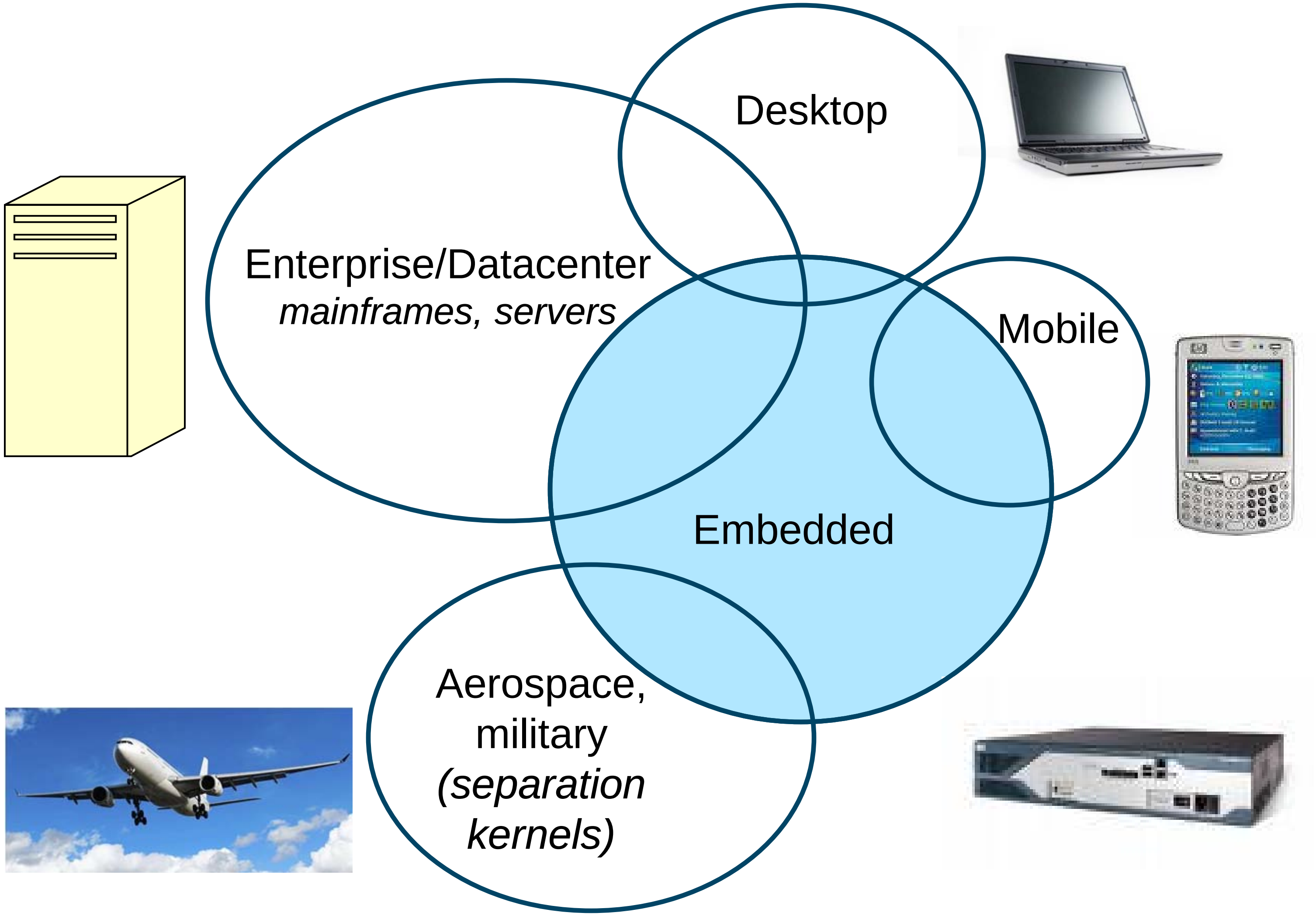


Freescale is #1 in the network/communications processor market
(300+million units shipped since 1989)

QorIQ Processing Platforms

QorIQ P5 **P5020, P5010**	64-bit High End Up to 2.2 GHz	 Service Provider Routers	 Network Admission Controls	 Storage Networks	 Switching
QorIQ P4 **P4080, P4040**	4 – 8 Cores Up to 1.5 GHz	 Metro Carrier Edge Router	 IMS Controller	 Radio Network Control	 Serving Node Router
QorIQ P3 **P3041**	2 – 4 Cores Up to 1.5 GHz	 Converged Media Gateway	 SSL, IPSec, Firewall	 Access Gateway	
QorIQ P2 **P2040, P2020, P2010**	1 – 2 Cores Up to 1.2 GHz	 Unified Threat Mgmt	 VoIP Carrier-Class Media Gateway	 Wireless Media Gateway	 Base Station
QorIQ P1 **P1010, P1011, P1012, P1013, P1014, P1015, P1016, P1017, P1020, P1021, P1022, P1023, P1024, P1025**	1 – 2 Cores 400 MHz to 1 GHz	 Integrated Services Router	 Network Attached Storage	 Home Media Hub	 Enterprise WAP

Virtualization — Trends



Desktop

Enterprise/Datacenter
mainframes, servers

Mobile

Embedded

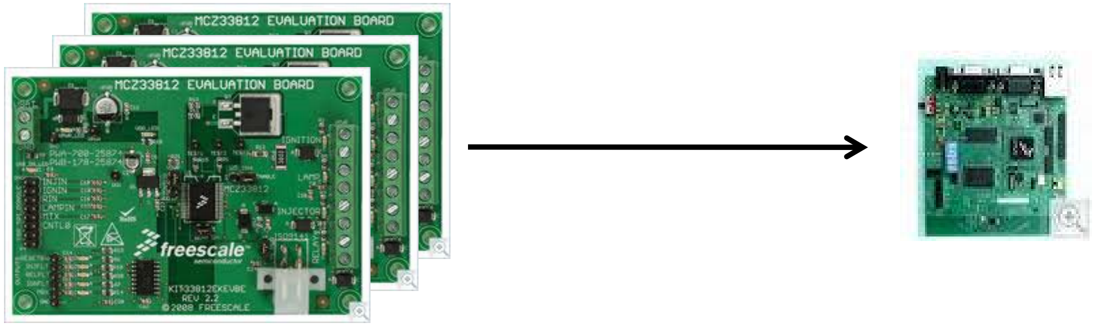
Aerospace,
military
*(separation
kernels)*

Embedded Systems

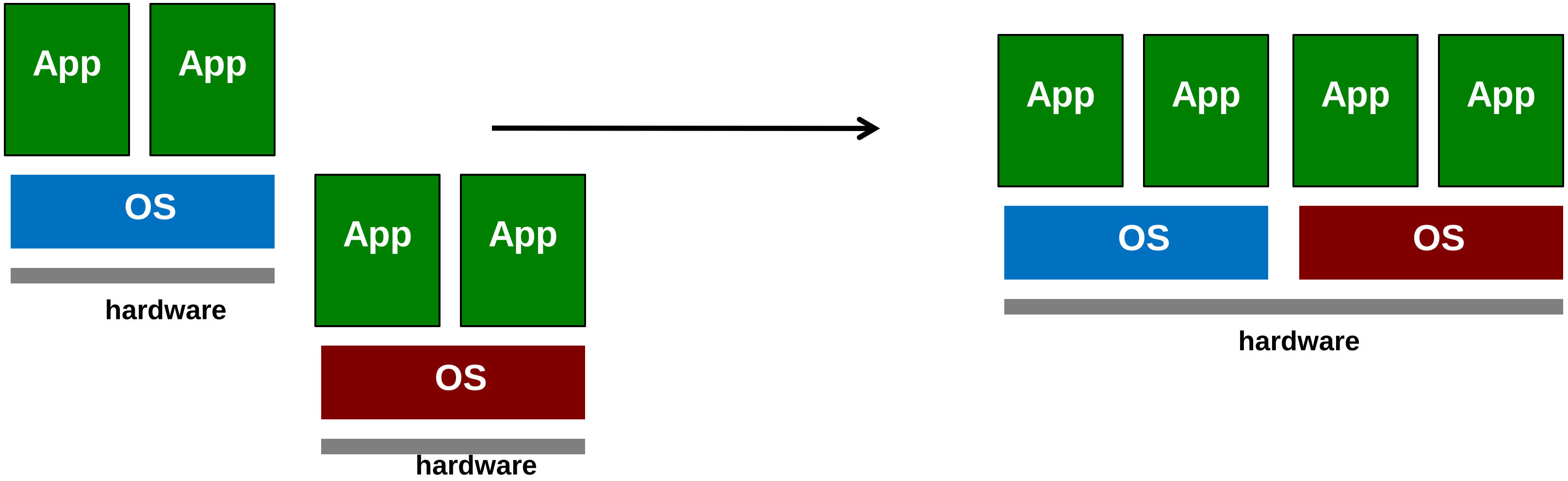
- ▶ How is embedded different?
  - Fixed function devices– not general purpose
  - Huge variety of hardware platforms
    - No standard platforms (no BIOS, ACPI, UEFI)
  - Real time constraints
  - Large variety of operating systems
    - VDC Research (2011 report)
      - About 50% of devices shipped by survey respondents had no formal OS or an in-house developed OS

- ▶ Trend: move to multi-core SoCs, but SMP with a single OS will not be the only usage model

Trend: Consolidation on Multicore Processors



Benefit: Cost/power savings


App App
OS
hardware
App App
OS
hardware
App App App App
OS OS
hardware

Use Cases/Examples

- Control-plane / data-plane – split into partitions
- Migration — move to new hardware, preserve investment in software
    - Run legacy software alongside new software
    - Add Linux® to a system
- Sandbox — isolate untrusted software

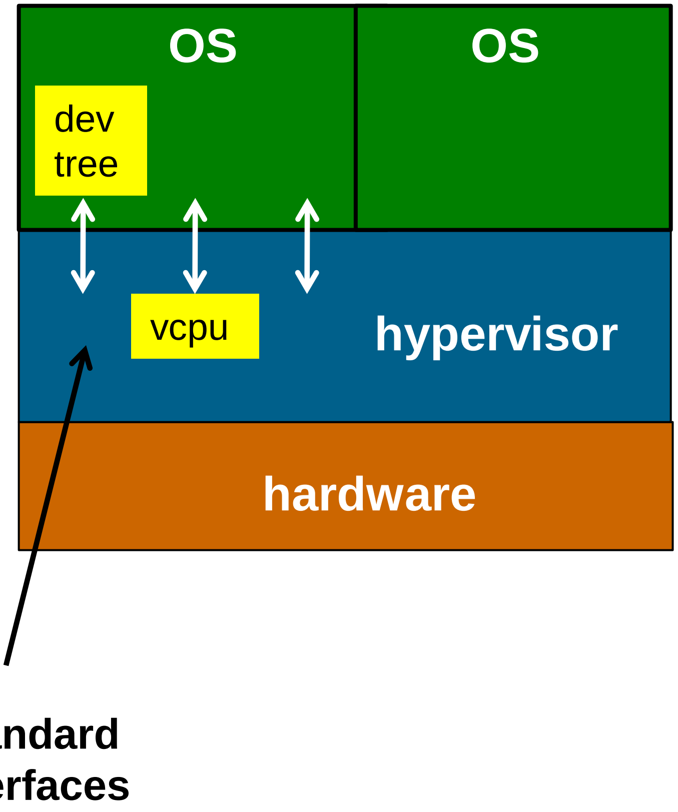
Use Cases/Examples…continued

- High availability — active/standby configuration without additional hardware
- In-service upgrade
- Many more possibilities…

Standards

- power.org ePAPR
  - Resource discovery (device tree)
  - Multi-CPU boot
  - v1.1 includes virtualization extensions
    - ABI
    - APIs (hcalls)

- Power ISA 2.06B
  - Virtualized implementation notes



Why KVM for embedded Power Architecture?

Our customers are asking for it.

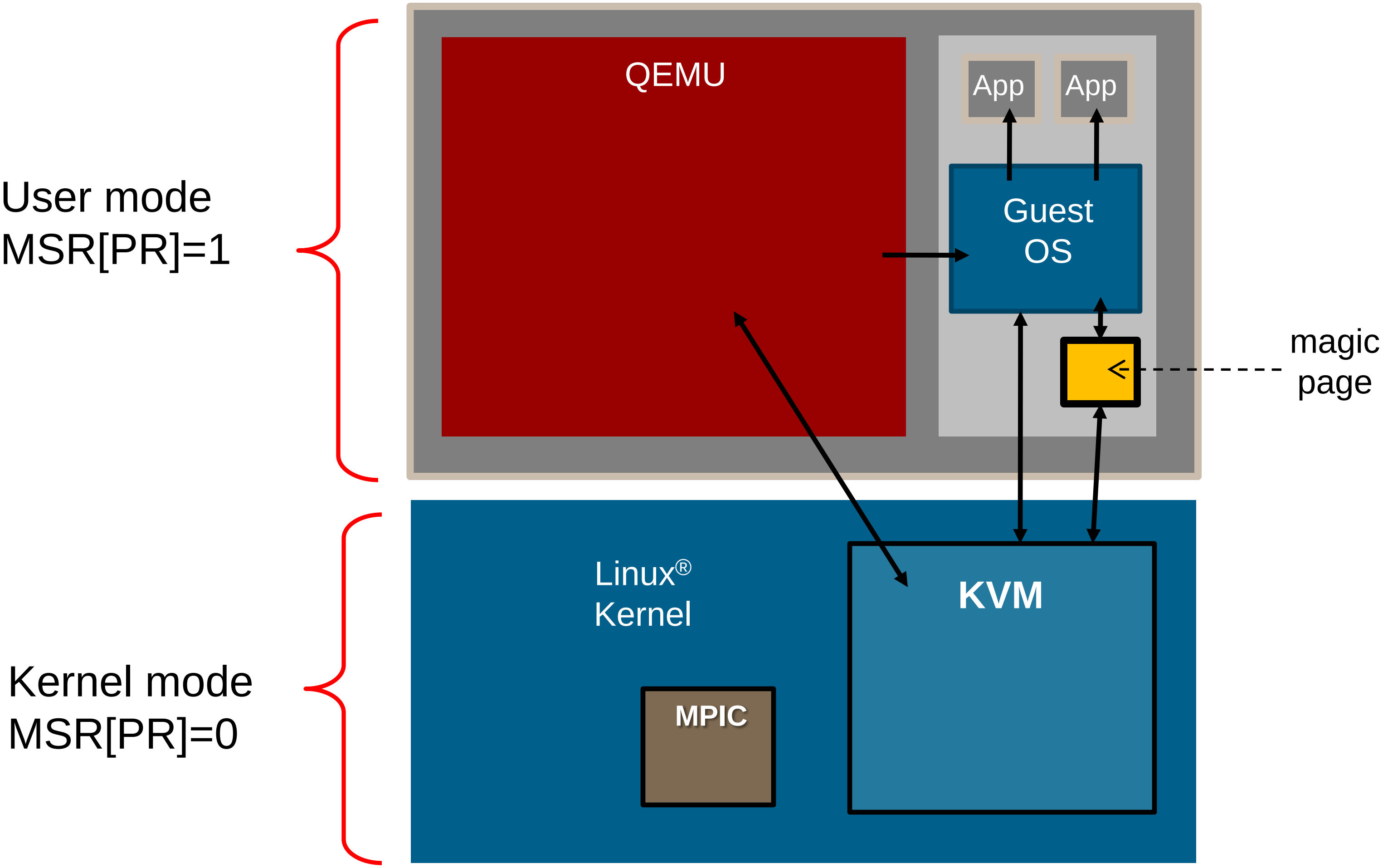
KVM on Power -- History

- 2007-2008:
  - IBM developed 4xx processor (Book-III E) support (Hollis,Christian)
- 2009:
  - Freescale did preliminary port to e500v2 (Yu Liu)
- 2009
  - Port to server Book III S (Alex Graf)
- 2010-2011
  - In progress: port to e500mc, improve/consolidate e500v2 work

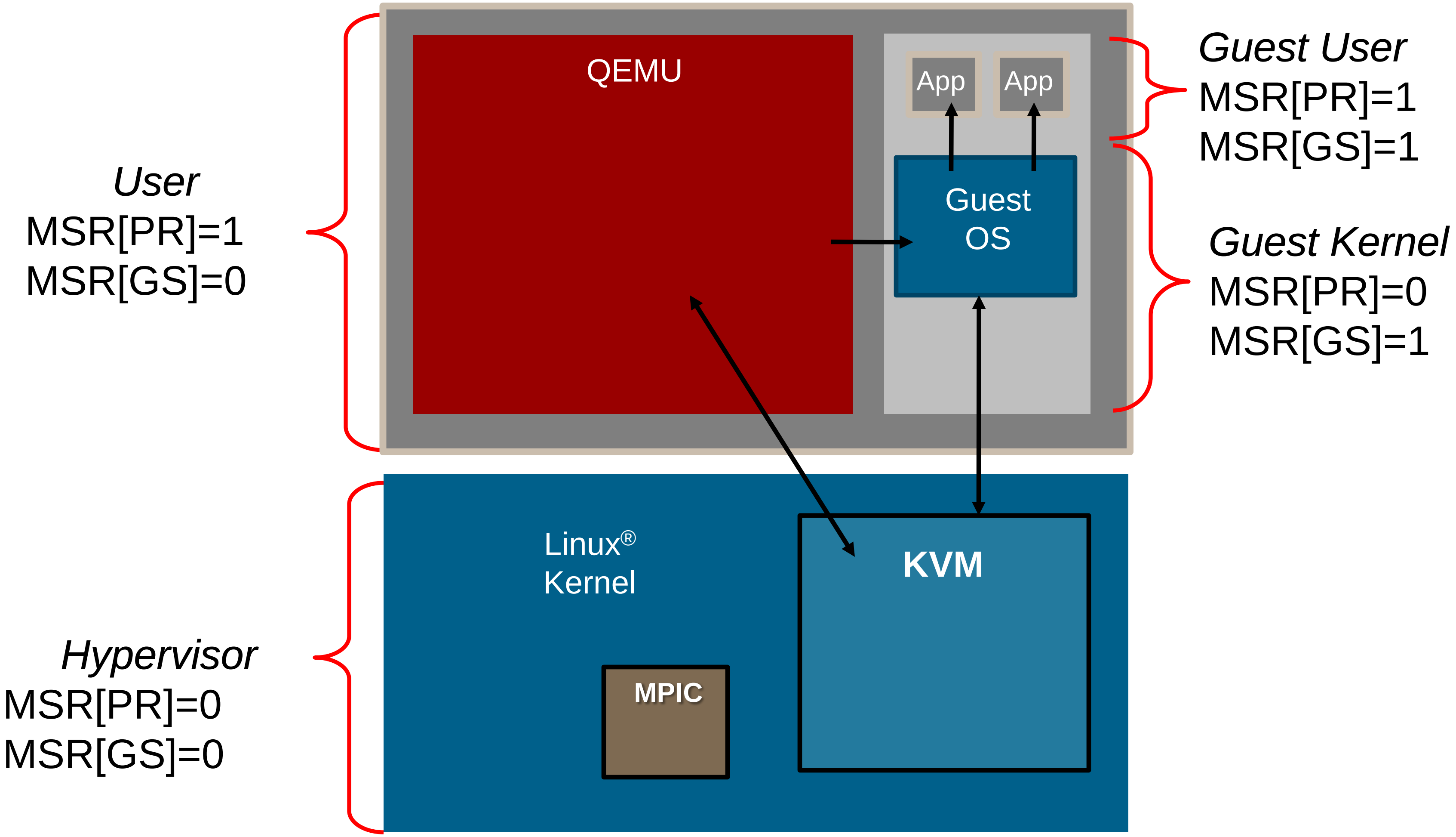
New Mechanisms we need

- ►Assign guests physically contiguous memory
  - e500 MMU – software managed
    - TLB0 – 4KB mappings
    - TLB1 – small number of variable sized, large pages
  - Needed for performance (e.g. 80% speedup in kernel boot time)
  - Required for pass-through I/O devices to do DMA
    - Freescale IOMMU supports a small number of DMA windows per device
    - Devices with no IOMMU (e500v2-based)
- ►Pass-through of SoC I/O devices (non-PCI) to guests

KVM – e500v2


User mode
MSR[PR]=1
QEMU
App
App
Guest OS
magic page
Kernel mode
MSR[PR]=0
Linux® Kernel
KVM
MPIC

KVM – e500mc


QEMU
App
App
Guest OS
Linux® Kernel
KVM
MPIC
Guest User
MSR[PR]=1
MSR[GS]=1
Guest Kernel
MSR[PR]=0
MSR[GS]=1
User
MSR[PR]=1
MSR[GS]=0
Hypervisor
MSR[PR]=0
MSR[GS]=0

Status Summary

- ► Initial ports to e500v2 and e500mc based SoCs are complete
  - Basic features are there– sufficient to boot Linux® guest
  - e500v2 uses paravirt– shared page of memory and guest side patching
- ► Prototype direct map (pass-through) support for memory and I/O devices is working
  - Use in-kernel MPIC
- ► Upstreaming in progress

To Do

- Patches --> upstream
- Performance analysis & tuning
- Get rid of static guest device tree files
- Work out an improved mechanism to pass-through non-PCI I/O devices and physical memory
    - Hugetlbfs
- IOMMU support for SoCs with a PAMU
- Guest SMP
- 64-bit support (e5500)
- Additional VCPU features– e.g. debug, perfmon, cache locking

To Do…continued

- Error management
- Real time
- High availability
- Inter-partition communication/doorbells
- Direct hardware interrupts to guest OSes for pass-through devices
- Virtual time
- Libvirt
- Processor Roadmap
  - e6500 – has hardware threads and LRAT (logical to real address translation)

Conclusion

- Partitioning/virtualization is here to stay in the embedded space
- With some modest changes, KVM addresses many of the requirements
- Freescale sees direct customer demand for KVM and is committed to enabling this