History of Hypervisor

April 19, 2018  |  Xen ARM open source software focused

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    Demo to show two Linux OS running and how to protect smartphone against hacker’s attack
Origin of virtualization

• Virtual machine monitor? Type-1 virtualization? Hypervisor?

• IBM developed Hypervisor first, for migration of bank transaction service without interrupt of the service in 70s.

• Hypervisor for server massively adopted in data center from 2008.

• On the other hand, development of Hypervisor for mobile devices on ARM CPU started from around 2005.
Virtualization at 2008

Virtualization is the construction of an isomorphism between a virtual system and a real system [Virtual Machines] James E. Smith/Ravi Nair, 4p

Theory: simple  
Practice: complexity of design & implementation comparable to that of Linux kernel

**Ex: Vendors and open source software projects**

- **Hypervisor**
  - Application virtualization
  - OS kernel virtualization

Components: DRAM, Flash/HDD

For server system side  
For mobile system side
Why hypervisor in the past?

Consolidation

HW consolidation \(\rightarrow\) SoC BOM cost saving

Decoupling

Between OS and HW

Decoupling & live migration

Live migration from old OS to latest OS \(\rightarrow\) Zero down-time of service

Decoupling

Between OS and HW

Data center: IT industry since 2008~

Bank service: IBM since 70s~
Hypervisor Evolution (1/2)

Guest OS CAN NOT run on hypervisor, without modifying source code of guest OS.

Past
No Hardware support

Today
Simpler, stronger Hypervisor by ARM/ x86 SoC hardware assist

After SoC Architecture reflecting virtualization requirements of customers:
- CPU/MMU Virtualization
- I/O Virtualization

- Thin Hypervisor
- High Performance

Guest OS runs on hypervisor, without modifying source code of guest OS.

Guest OS

Hypervisor

Legacy H/W

VCPU
VMMU
Virtual I/O

Guest OS

Guest OS

Guest OS

H/W
with Virtualization Extension
Hypervisor Evolution: Xen case (2/2)

CPU/MMU Virtualization Overhead Reduces

2003
- Xen-1.0 (PV) for server
  - Intel VT-x, AMD-v
  - CPU Virtualization Overhead reduces

2005
- Xen-3.0 (HVM) for server
  - EPT, NPT
  - MMU Virtualization Overhead reduces

2006
- Xen ARM (PV) released for mobile
  - Intel VT-d
  - Device Pass-through improves I/O performance

2007
- Xen ARM (PV)

2008
- Xen-4.3 (x86 & ARM) for server
  - ARM VTE, GICv2, MMU400
  - SR-IOV
  - NIC performance improves

2009

2012

2014

PV driver Overhead Reduces

I/O Virtualization Overhead Reduces
History of Xen ARM hypervisor

- '07: Xen ARM architecture introduced at North America Xen Summit
- '08: Xen ARM 1st Release: ARM9 Xen Hypervisor, Mini-OS
- '09: Xen ARM 2nd Release: Paravirtualized Linux kernel (v2.6.24), Xen tool
- '10: Xen ARM 3rd Release: ARM11MPCore Support
- '11: Xen ARM 4th Release: Performance Optimization
- '12: Xen ARM 5th Release: Cortex-A9 MPCore Support
- '13: Xen ARM 6th Release: Cortex-A15 MPCore Support

Xen ARM Feature
- CPU overhead: 3% on average after optimization
- Memory footprint: 1~2 MB DRAM

Supported Hardware & Guest OS

- ARM926EJ-S (i.MX21, OMAP5912)
- Xscale 3rd Generation Architecture (PXA310, Samsung SGH-i780)
- ARM1136/ARM1176(Core Only)
- Goldfish (EQMU Emulator)
- Versatile Platform Board
- ARM11MPCore (Realview PB11MP)
- Tegra250
- Linux v2.6.11, v2.6.18, v2.6.21, v2.6.24, v2.6.27 (multicore supported)
- uC/OS-II
Smartphone prototype based on Xen ARM: Two Linux OS running on Xen ARM with mandatory access control, guaranteeing enhanced security.
Thank you!

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