SmartNICs: Giving Rise To Smarter Offload at The Edge and In The Data Center

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#Arm Tech Symposia
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The Cloud to Edge Infrastructure Foundation for a World of 1T Intelligent Devices
SmartNIC and Smart Offload Definition

**Smart**

- Includes application processing capable of running rich operating system (Linux) and distributed cloud stacks.

**Offload**

- Offload special purpose hw that ‘offloads’ a specific task (ex: network, storage, security) to maximize efficiency and performance.
- NIC - class of offload for ethernet controllers.
Agenda

• Evolving beyond the SmartNIC, a datacenter story

• Arm platform for smart offload and accelerated edge compute
Evolving beyond the SmartNIC, a datacenter story
Traditional server deployment

Server
- Runs all OS, virtualization and application stacks
- IO stacks for fixed function off-load

Fixed function off-load
- NIC – Network Interface Controller
- Storage – HDDs, SDDs, etc
Web and mobile traffic drove fundamental shift to IO

Global IP traffic hit 1 Zettabyte in 2016
  • Will increase to >3 Zettabytes by 2021

Direct impact on server network bandwidth
  • 10Gb Ethernet -> 100Gb Ethernet++

Orders of magnitude more storage requests
  • NVMe/SSDs - millions of operations per second

*Impact on Server: Increased CPU utilization for network/storage IO*
Storage and memory disaggregation

Pull data from anywhere, quickly
  • ‘Over Fabric’ such as NVMe-oF

Software defined network/storage (SDN/SDS)
  • Reconfigurable virtual networks

RDMA – fast path to remote memory requests
  • RDMA - Remote Direct Memory Access

Impact on Server: SDN, SDS, RDMA CPU utilization and increased east/west traffic
Rise of cloud computing

New business models built on ‘as a service’
• SaaS, IaaS, PaaS, FaaS

Required new management and security
• Virtual machine orchestration, management
• Virtual machine switching
• Protecting shared resources from guest applications

Impact on Server: More CPU cycles devoted to VM/container management and security
### Significant overhead cost for offload and management

$3.5B lost revenue opportunity per 1M servers/yr

- 16 vCPUs\(^{(1)}\) consumed for offload tasks
- Cloud CPU rate = $0.025\(^{(2)}\) per vCPU/hr
- $220/vCPU/yr
- 1M servers * 16 vCPU * $220/vCPU/year = $3.5B

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\(^{(1)}\) Estimated based on 50GbE NIC with 96 vCPU instance

\(^{(2)}\) Based on average Amazon AWS M5 and Microsoft Azure Dv3 reserved pricing per core
SmartNIC Offload Solution – a better approach

Add the ‘Smart’ in NIC
- Add compute capable of running Linux OS & offload SW stacks

But it’s more than a NIC
- Orchestration, VM management, security, storage
- Run vSwitch, SDN/SDS software stacks

Impact on Server: Frees all CPUs for applications
Smart offload becomes the datacenter orchestration point

Datapcenter orchestration:
- Decide where to deploy applications/VMs/containers
- Map/re-map storage to applications
- Map/re-map datacenter network topologies
Smart offload as a host for cloud storage

Host for disaggregated storage and memory:
- Pools of HDDs, SDDs, NVMe and DRAM memory
- Operates cloud object, file and block storage
Smart offload as a host for cloud acceleration

Accelerator platform as a service

CPU/Server

Storage/NVMe/Memory

GPU

TPU

FPGA

Smart Offload

Datacenter Network

Datacenter Network

Datacenter Network

Datacenter Network
Challenges of moving compute to smart offload

10x efficiency gain required

Servers:
- 100W~200W processors focus on compute perf
- Large footprint, large heat sink, sophisticated cooling

Offload devices:
- ~20W-35W ASIC budget for mainstream
- Attached via PCIe slots or Mezz card
- Smaller footprint, smaller heat sink, much less sophisticated cooling

The path to 10x efficiency gain

Arm = better Perf/W

Move functions from server CPUs to more efficient accelerators

Customize with ‘secret sauce’
From smart offload in the datacenter to accelerated edge compute
Today’s compute model

Central Data Centers

Create & Distribute

Media Content

Billions of people

Consume

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New infrastructure to unleash the brilliance of 1T Arm devices

The New Infrastructure Will Be Designed from the Edge In

1 Trillion
Autonomous Machines & Smart Devices
New infrastructure to unleash the brilliance of 1T Arm devices

1 Trillion
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Central Data Centers
CPU, GPU, TPU, Smart Offload

Cloud Tiers
CPU, GPU, TPU, Smart Offload

Edge Clouds
CPU, GPU, Smart Offload

Smart Offload
Network, Storage, Security

100GbE
## Arm compute and IO subsystem for Smart Offload

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**Common Software Platform, SBSA, SBBR, Arm ServerReady**

*Arm Architecture v8.x-A, AMBA*
Custom accelerator integration

Arm CPU
- A72, A75, Ares CPUs
- A55, Helios CPUs

Arm SoC Backplane
- CMN Coherent Mesh Network
- GIC, MMU Virtualization
- Power Control Kit
- Cryptolsand Secure Enclave

Memory
- DDR4
- DDR5
- HBM

IO
- PCIe
- CCIX
- GbE

3rd Party or Custom Accelerators
- RDMA
- De-dupe
- Bulk Crypto
- ML Processor
- Packet Inspection
- Compression
- IPSec
- A/V transcode
- TCP/IP offload
- NVMe-OF Offload
- 4G/5G Wireless
- GPU
- FPGA

Common Software Platform, SBSA, SBBR, Arm ServerReady
Arm Architecture v8.x-A, AMBA
Smart offload requires scalability

Platform Scalability from fully integrated SoC to multichip modules to fully disaggregated

Edge HW Platform

Arm Compute Subsystem

IO Accelerators Memory
Accelerated edge cloud stack

- Test suites to ensure major OS vendor compatibility
- SBSA: Server Base System Architecture
- SBBR: Server Base Boot Requirements

Foundation for cloud deployments
Accelerated edge cloud stack

Orchestration and installation
- Automated deployment, discovery, management

Edge stack blueprints
- Network management, NFV
- Vertical deployments (ex: IIoT)
- Smart City and edge cloud
Arm powering smart offload and the accelerated edge

- Scalable, secure, virtualized compute subsystems
- Combine with custom acceleration for target offload functions
- Ready for scale-out deployments in the datacenter and at the accelerated edge
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