VISION ON NETWORKING IN THE AGE OF AI

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I only have 15 minutes and certainly the deck is long

- I will go through some slides quickly
- We can always engage in a conversation off-line juanj@nvidia.com

You will notice throughout the presentation we are transmission media agnostic

- Fiber, copper, wireless... not really relevant
- Each media has its place and time

Whenever I say “Currently it is like this, but it will be like that” - that is a research line that requires efforts
DATA PROCESSING UNIT VISION

NVIDIA’s DPU (Data Processing Unit) are the smallest DC you can have

- A DPU is
  - A network interface
  - A SoC for programmability
  - A GPU
  - An acceleration engine...
A LITTLE BIT OF BACKGROUND:
THE DATA CENTER IS THE NEW UNIT OF COMPUTING

Accelerated Disaggregated Infrastructure (ADI)

Accelerated Computing
GPU: AI & machine learning
GPU critical for AI & machine learning
Every workload will become AI Accelerated

Software defined, Hardware-accelerated
DPU (data processing unit)
DPU essential to disaggregate resources & make composable ADI

NVIDIA Networking

You can do 3 things with data: transport it, processed it, use it. As of 2020, NVIDIA covers these three pillars with the incorporation of Mellanox Technologies.
DISAGGREGATION & COMPOSABILITY

All Resources Become Virtualized and Composable

The NVIDIA Network is the Backplane of the Data Center | Dynamically Compose the Computer You Need!
BLUEFIELD-2X
DATA PROCESSING UNIT

AI-Powered DPU

200 Gbs BlueField-2 augmented by Ampere GPU

A dedicated GPU for networking functions

Enhanced the DPU with AI capabilities

Scale out computing performance with GPUDirect and CUDA

Tighter security across the PCIe bus

Apply AI to real time network traffic
- Anomaly detection & automated response
- Traffic shaping/steering
- Dynamic security orchestration
THE DPU
Pushing reconfigurability and processing down to hardware

From Hardware Appliances

To Software Defined Infrastructure on CPU

To Software Defined Infrastructure on DPU

NVIDIA NIC

Acceleration Engines

Software-defined Networking
Software-defined Security
Software-defined Storage
Infrastructure Management

NVIDIA DPU with Arm Cores & Accelerators

Software-defined Networking
Software-defined Security
Software-defined Storage
Infrastructure Management
Acceleration Engines
WHEN YOU ACCEPT THIS PARADIGM, THEN EVERYTHING IS A DATA CENTER

End-to-End, Open Platform

COLLECT DATA | TRAIN MODELS | SIMULATE | DRIVE AV | DRIVE IX | DRIVE RC

Your data center can be the backbone of the cloud, or can be supporting edge computing, or it may be shipped in a car...as far as everything is interconnected, you are fractally seeing the world.
CLOUD
It is there to stay
THE SOFTWARE DEFINED CLOUDED DATA CENTER

**Virtualize-as-you-go**

**Features**

- Resource virtualization & disaggregation
  - Virtual instances comprise of physical ingredients
- Efficient services, Container & VM friendly
- Tenant isolation & security
- Visibility and telemetry
- Edge ready
- AI powered
THE VIRTUALIZED DATA CENTER

Network & Storage Baseline Services

- Software Defined
- Scalable
- Secure
- Efficiency & Performance

VM/Container

Hypervisor

NIC Hardware
BARE METAL PLATFORMS EMERGENCE ➔ SMARTER NIC

Driving Forces

- Performance
- Security and Isolation

Trust shifts into the DPU

- Cloud managed

R&D
SOFTWARE DEFINED NETWORK, STORAGE, SECURITY TRANSITION

You have many flavors - and they may even coexist within the same infrastructure.
SDN AND NFV DATA PATH NEEDS AND ACCELERATION

Accelerating SDN by moving it from Software to Hardware

SDN Dataplane

NFV

VNF

VNF Logic

vSwitch

Hypervisor

VNF Packet Processing

Encap/Decap vSwitch vRouter Crypto/Security Firewall NAT...

VNF Send Receive

vSwitch Packet Processing

Encap/Decap vSwitch vRouter Crypto/Security Firewall NAT...

Hypervisor Send/Receive

ACCELERATE

ACCELERATE

10X PPS @ 0% CPU

5x BW @ 80% lower CPU%
SDN NEEDS HARDWARE PERFORMANCE
ASAP2 = Accelerated Switching And Packet Processing (Hardware Acceleration in NIC ASIC)

OVS over DPDK VS. OVS Offload

<table>
<thead>
<tr>
<th>Test</th>
<th>ASAP2</th>
<th>OVS DPDK</th>
<th>Benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Flow VXLAN</td>
<td>66M PPS</td>
<td>7.6M PPS (VLAN)</td>
<td>8.6X</td>
</tr>
<tr>
<td>60K flows VXLAN</td>
<td>19.8M PPS</td>
<td>1.9M PPS</td>
<td>10.4X</td>
</tr>
<tr>
<td>10K flows VXLAN, CT, NAT</td>
<td>11.3M PPS</td>
<td>146.5K PPS</td>
<td>77.1x</td>
</tr>
</tbody>
</table>

Significant Performance Boost @ Zero CPU resources
SD SECURITY NEEDS HARDWARE PERFORMANCE

Hardware acceleration of next-generation firewalls - the *only* path to scale

- **VM/Container**
- **Bare Metal Server**

**Application Throughput During DoS Attack**

- **Attack 1**: No Mitigation
- **Attack 2**: Software mitigation
- **Attack 3**: Hardware mitigation

**Security Apps**

- **DOCA**
- **Connection Awareness SDK**
- **Introspection SDK**
- **DPI SDK**
- **Crypto and Firewall SDK**

**DPU HW**
DPUS MAKE SECURE CLOUD POSSIBLE

Perimeter security is broken

Foundational NICs – Perimeter Security Only

Mellanox’s DPUs – Secure Cloud

Traditional Security Model

Security Everywhere

Vast majority of cyber-attacks on cloud servers aim to mine cryptocurrency
Cyber-attacks on cloud systems spiked 250% from 2019 to 2020.
MODERN DATA CENTER

Internet

North-South

Security Services

IDS

NGFW

Anti-Malware

VPN

DPU

Bare Metal Servers

Web Servers

Public Cloud Servers

East-West

North-South

Edge
5G
Ramping up
**Computing Requirements for 5G**

5G use cases require a 100x increase in traffic demand.

- **Extreme Compute**: CPU-only infrastructure becomes obsolete.
- **Extreme I/O**: Data ingestion requirements increase exponentially.
- **Cloud Native/COTS**: Decrease CAPEX and R&D investments.
- **Programmable**: Tailored to specific use cases; evolve as demands change.
- **ML Capable**: Implement ML as workloads necessitates.
5G RAN IS CLOUD-NATIVE & RUNS MANY WORKLOADS

Paves the Way to Creation of New Business Models

VOICE  DATA  AR / VR  ROBOTICS  IoT  AV

CLOUD NATIVE

Virtualized and Centralized RAN (COTS)
15-75X PERFORMANCE IMPROVEMENT IN 4 YEARS

AI and Graphics

75x in 4 years

AI/DL/ML
- Training
- Inference
- Tensor Core

15x In 4 years

Graphics
- DL SuperSampling
- Ray Tracing

??

Aerial 5G
- HPC Phy
- Instructions / HW
- Dynamic Precision
- AI for PHY
- MAC Scheduler
- E/M Ray Tracing
5T FOR 5G FOR O-RAN DU (CONNECT-X)

AERIAL developer kit - 5G v-RAN
Roadmap for enterprise and massive-MIMO scenarios

O-RAN 7.2 Split support
100Gb/s eCPRI Tx and Rx
Support up to 64 APs (Anthea Ports)
Any number of cell
Grand-Mast in every DU
GPU-Direct for efficient base-band processing

5T for 5G - Time-Triggered Transmission Technology for Telco
AERIAL DEVKIT

- Aerial DevKit 1.0 announced at GTC 2020
- Jumpstart performance evaluation
- Included with DevKit
  - Pre-installed Aerial SDK and software environment
  - Test scripts based on the latest Aerial SDK release that demonstrate KPIs
  - Logged results of DevKit configuration including hardware, environment, SDK, and sample test execution
  - Ability to exercise specific or all test cases included

![Architecture Diagram]

DevKit 1.0

- Aerial BBU
  - Gigabyte E251-U70
- Traffic Injector
  - Gigabyte E251-U70
WRAP UP

What can one extrapolate from all this in terms of R&D?

**General**
- Disaggregation of resources
- Continuum cloud-to-edge
- Software to (reconfigurable) hardware migration
- Secure communications from crypto to postquantum

**Cloud**
- Telemetry, hypervisors, crosstalk
- Security, deep packet inspection, regular expressions
- From perimeter security to secure cloud

**5G**
- Over the air control, data channels
- Massive MIMO (pre-coding, number of layers)
- Channel interpolations
Thanks!

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https://www.braine-project.eu/