

## Semiconductors

### Cloud Instance Analysis - Aug'20: Graviton (ARM) and Inferentia Ramp

September 23, 2020

#### Key Takeaway

We analyze cloud instance availability at the top 4 Cloud Services Providers (CSPs). Key takes for August: 1) In CPUs, AWS's ARM CPU, Graviton, increased by 20% MoM and now has 3% share, 2) In Accelerators, AWS's Inferentia is up to 5% of instances. NVDA has started shipping A100, but those are not yet publicly available. AWS is one of the few capable of creating an ecosystem, and while still small we will track Graviton and Inferentia share closely.

**Graviton 3% of CPU Instance Availability.** Amazon's ARM-CPU, Graviton, posted a 20% MoM increase in Aug after 53% MoM in July, and it now accounts for 3% of CPU instance availability across the four CSPs we track. INTC based instances grew 8% MoM in Aug after growing 12% MoM in July. AMD based instances grew 8% MoM after 7% growth in Jul. We continue to expect AMD to take share from INTC in servers, but now think that Graviton could take share from INTC as well.

**Graviton Now 10% of AWS CPU Instance Availability.** We think AWS instance deployments are instructive given how disruptive AWS has been. Since July-2019, INTC CPU Instances have declined to 70% from 88%, while AMD has increased to 20% from 10% and Graviton has increased to 10% from 1%. AWS is targeting Graviton at HPC, open-sourced data base, micro services and web servers.

**NVidia Continues to Dominate Accelerator Instances.** In the month of Aug-20, NVDA's share declined to 84% from 87% as no new GPU-based instances were deployed and Amazon significantly increased deployment of its in-house acceleration chip "Inferentia"-based instances, increasing its share to 5% from 2% in Jul-20.

Our sample set currently shows no instances based on NVDA's new GPU A100 which we think is driving the pause in NVDA GPU instance deployments. NVDA is already shipping A100 but those instances are not live yet. In Jul-20, GCP announced that A100 based instances are available with restricted access via a "private alpha program" and are expected to open to public access in late 2020. We expect NVDA's share to increase as A100 based instances get deployed and are publicly available.

**Inferentia Now 15% of AWS Accelerator Instances.** Since Dec-2019, Inferentia has gone to 15% of available instances from 0%. AWS is targeting Inferentia at Recommendation Engine, Forecasting and Image and Video Analysis workloads.

**Why Look at Cloud Instances?** We look at processor and accelerator instances at the top 4 CSPs (Cloud Service Providers). Available instances have grown >40% in the past 9 months, underscoring a longstanding trend of enterprises outsourcing to the cloud, so we think an analysis of Cloud Instances is instructive for assessing broader CPU and GPU share trends. Our instance analysis does have two limitations: 1) it does not account for internal CSP workloads, 2) it is not an exact measure of processors deployed. Nevertheless, we think it is a reasonable proxy for market share at enterprises, and useful for identifying trends in processor usage.

#### Links to Related Research

[NVDA + ARM = \\$50 EPS Power in 2025](#)

[Cloud Instance Analysis - Jul'20: Emergence of ARM and TPU](#)

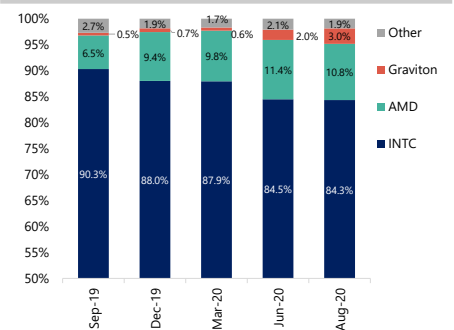
[Notes from Server CPU Expert: AMD vs INTC](#)

[A Butterfly Flaps Its Wings in 2005...](#)

[Our INTC Fabless Thesis Now a Higher Probability Event](#)

[INTC: Table Set for Change: Focus, Frugality, ...and Fabless?](#)

**Chart 1 - INTC vs. AMD vs. Graviton Share of Processor-Only Instances**



Source: Litr Insights, Jefferies

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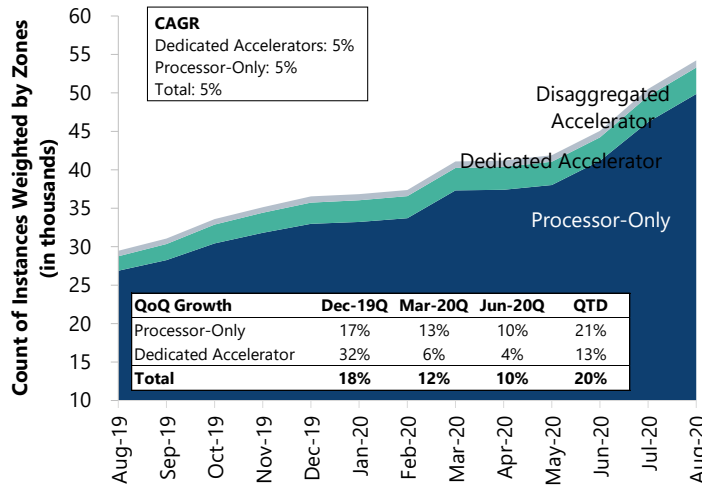
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## Instance Analysis Summary

**Chart 2 - Accelerator vs. Processor Only Instances Weighted by Zone Availability**

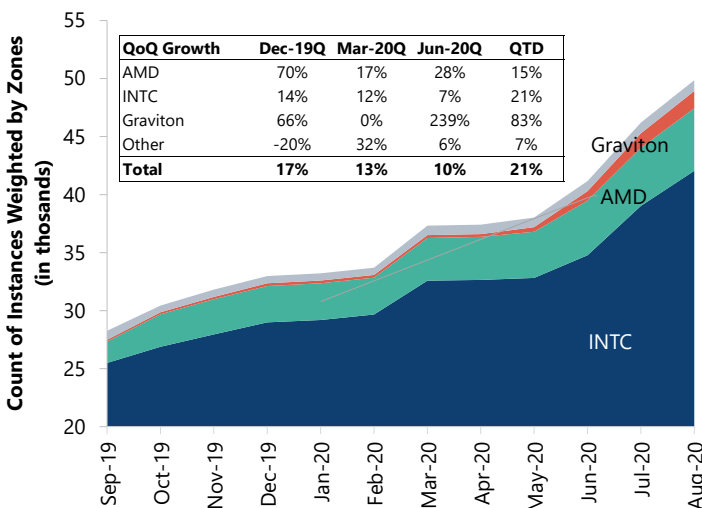


Source: Liftr Insights, Jefferies

The total number of zone-weighted instances deployed by the top 4 CSPs grew 20% QTD ending Aug-20Q. Processor-Only instances grew 21% QTD and Dedicated Accelerator instances grew by 13% QTD ending Aug-20

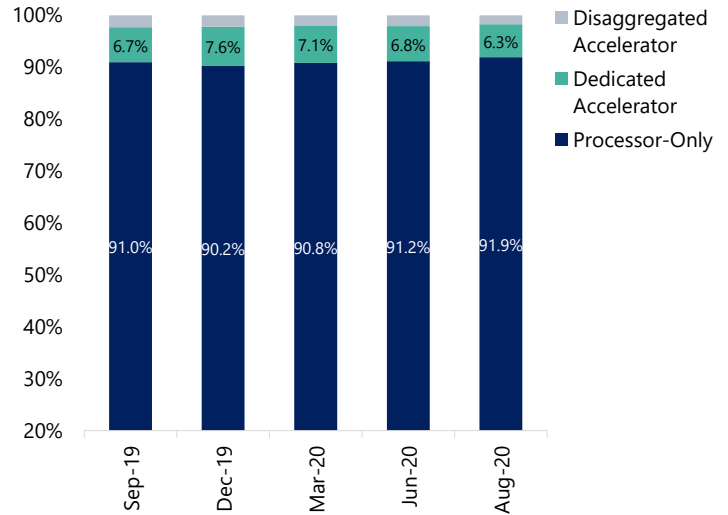
## CPU Instance Analysis

**Chart 4 - INTC vs. AMD vs. Graviton Processor Only Instances**



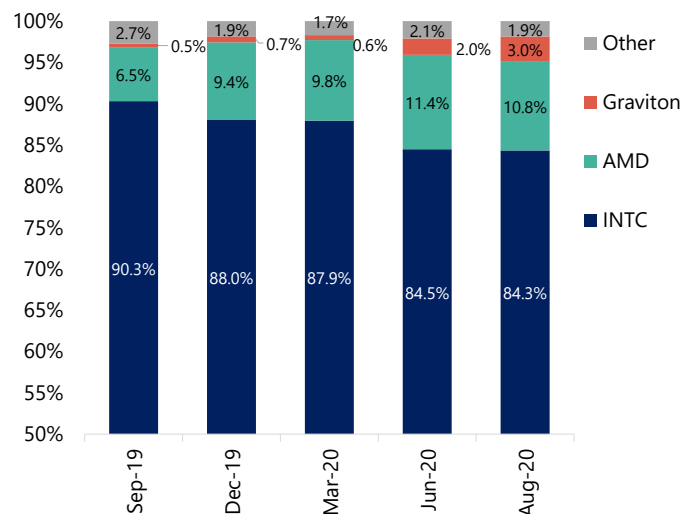
Source: Liftr Insights, Jefferies

**Chart 3 - Processor Only vs. Dedicated Accelerator Share**



Source: Liftr Insights, Jefferies

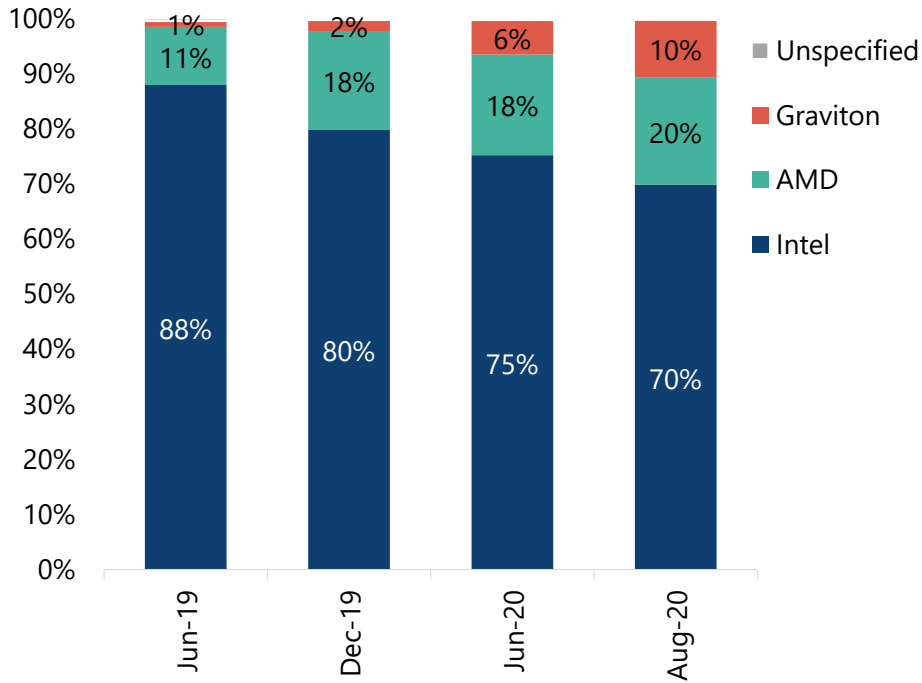
**Chart 5 - INTC vs. AMD vs. Graviton Share of Processor-Only Instances**



Source: Liftr Insights, Jefferies

AMD's share in Processor-Only instances declined to 10.8% in Aug-20 from 11.4% in Jun-20Q and INTC's processor-only instance share remained steady. QTD ending Aug-20, AMD Processor-Only instances increased by 15% and INTC's processor-only instances increased by 21%. Amazon's ARM-CPU, Graviton, increased by 83% QTD, and now account for 3%. Note that Liftr Insights calculates share of processors deployed in instance types as a product of regional availability and the number of zones in each region.

**Chart 6 - INTC vs. AMD vs. Graviton Processor-Only Instance Share at AWS**



Since June-2019, Amazon has rapidly increased deployment of its own ARM-CPU Graviton. As of Aug-20, Graviton and AMD share increased to 10% and 20% from 1% and 11%, respectively, while INTC share declined to 70% from 88%

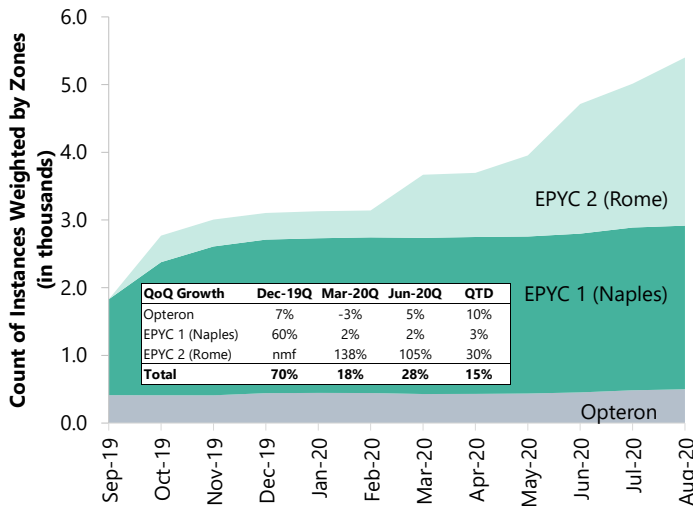
Source: Liftr Insights, Jefferies

Chart 7 - Processor Applications at AWS

Processor	Application at AWS
Graviton 2	<p><b>Compute Optimized</b></p> <ul style="list-style-type: none"> <li>- High performance computing (HPC), batch processing, ad serving, video encoding, gaming, scientific modelling, distributed analytics, and CPU-based machine learning inference</li> </ul> <p><b>Memory Optimized</b></p> <ul style="list-style-type: none"> <li>- Memory-intensive applications such as open-source databases, in-memory caches, and real time big data analytics</li> </ul> <p><b>General Purpose</b></p> <ul style="list-style-type: none"> <li>- Micro-services, low-latency interactive applications, small and medium databases, virtual desktops, development environments, code repositories, and business-critical applications</li> <li>- Applications built on open-source software such as application servers, microservices, gaming servers, mid-size data stores, and caching fleets</li> <li>- Scale-out workloads such as web servers, containerized microservices, caching fleets, and distributed data stores, as well as development environments</li> </ul>
AMD	<p><b>Compute Optimized</b></p> <ul style="list-style-type: none"> <li>- ideal for workloads requiring high vCPU and memory bandwidth such as batch processing, distributed analytics, data transformations, gaming, log analysis, web applications, and other compute-intensive workloads</li> </ul> <p><b>Memory Optimized</b></p> <ul style="list-style-type: none"> <li>- well suited for memory intensive applications such as high performance databases, distributed web scale in-memory caches, mid-size in-memory databases, real time big data analytics, and other enterprise applications.</li> </ul> <p><b>General Purpose</b></p> <ul style="list-style-type: none"> <li>- Micro-services, low-latency interactive applications, small and medium databases, virtual desktops, development environments, code repositories, and business-critical applications</li> <li>- Small and mid-size databases, data processing tasks that require additional memory, caching fleets, and for running backend servers for SAP, Microsoft SharePoint, cluster computing, and other enterprise applications</li> </ul>
INTC	<p><b>Compute Optimized</b></p> <ul style="list-style-type: none"> <li>- High performance web servers, scientific modelling, batch processing, distributed analytics, high-performance computing (HPC), machine/deep learning inference, ad serving, highly scalable multiplayer gaming, and video encoding</li> <li>- High performance front-end fleets, web-servers, batch processing, distributed analytics, high performance science and engineering applications, ad serving, MMO gaming, and video-encoding</li> </ul> <p><b>Memory Optimized</b></p> <ul style="list-style-type: none"> <li>- well suited for memory intensive applications such as high performance databases, distributed web scale in-memory caches, mid-size in-memory databases, real time big data analytics, and other enterprise applications</li> <li>- High performance databases, data mining &amp; analysis, in-memory databases, distributed web scale in-memory caches, applications performing real-time processing of unstructured big data, Hadoop/Spark clusters, and other enterprise applications</li> <li>- High performance databases, in-memory databases (e.g. SAP HANA) and memory intensive applications. x1e.32xlarge instance certified by SAP to run next-generation Business Suite S/4HANA, Business Suite on HANA (SoH), Business Warehouse on HANA (BW), and Data Mart Solutions on HANA on the AWS cloud</li> </ul> <p><b>General Purpose</b></p> <ul style="list-style-type: none"> <li>- Micro-services, low-latency interactive applications, small and medium databases, virtual desktops, development environments, code repositories, and business-critical applications</li> <li>- Websites and web applications, development environments, build servers, code repositories, micro services, test and staging environments, and line of business applications</li> <li>- Small and mid-size databases, data processing tasks that require additional memory, caching fleets, and for running backend servers for SAP, Microsoft SharePoint, cluster computing, and other enterprise applications</li> </ul>

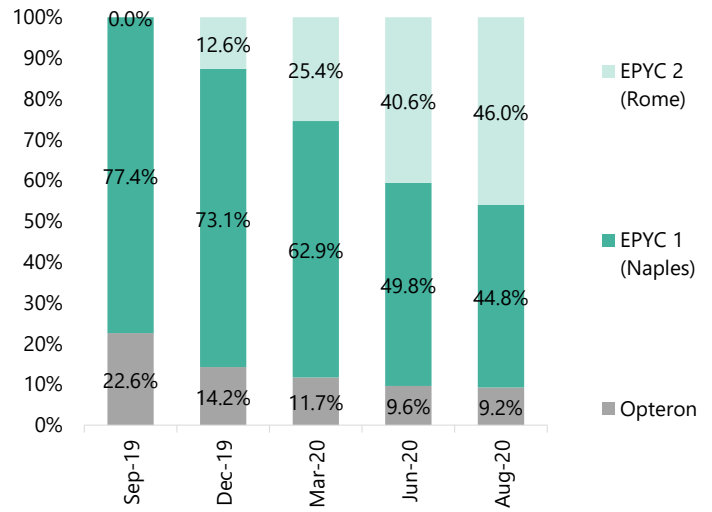
Source: Jefferies, AWS

Chart 8 - Share of AMD's Processor Versions



Source: Liftr Insights, Jefferies

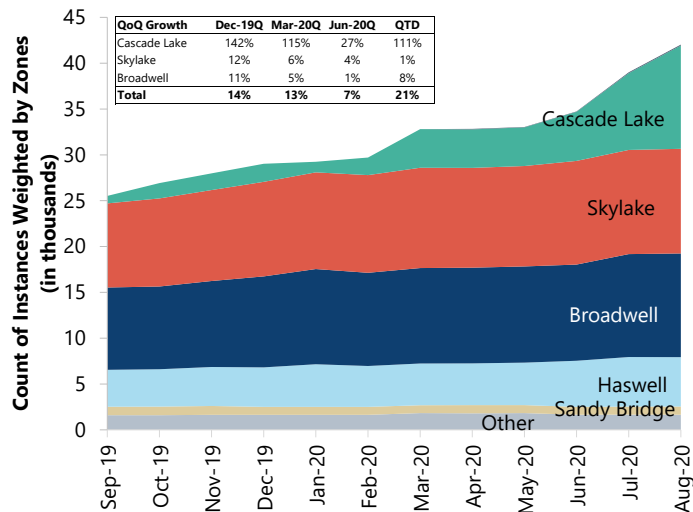
Chart 9 - AMD's Gen Share of Processor Only Instances



Source: Liftr Insights, Jefferies

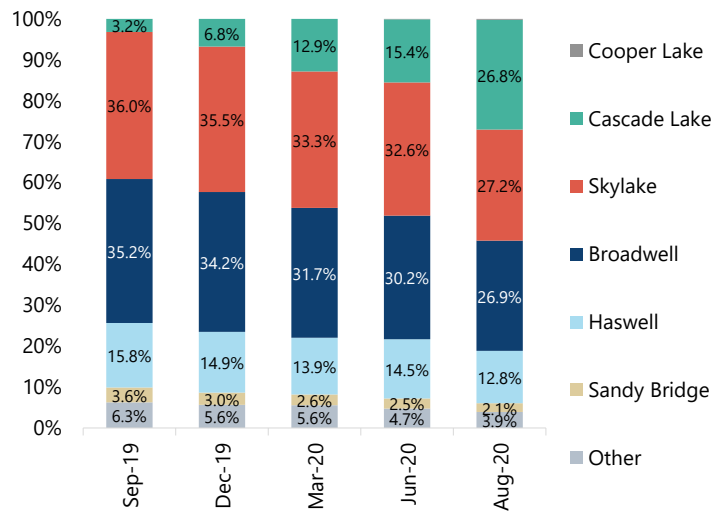
Since the launch of AMD's EPYC 2 (Rome) processor in Oct-19, the number of zone weighted instances using Rome processors has more than doubled, and represents 46% of total AMD based Processor-Only instances. AMD's Rome based instances increased another 30% in QTD ending Aug-20 after a large increase in Jun-20Q of 105%. The instance analysis supports the view that AMD is seeing increased demand for its latest generation of server CPU, Rome.

Chart 10 - Share of INTC's generation



Source: Liftr Insights, Jefferies

Chart 11 - INTC'S Gen Share of Processor Only Instances

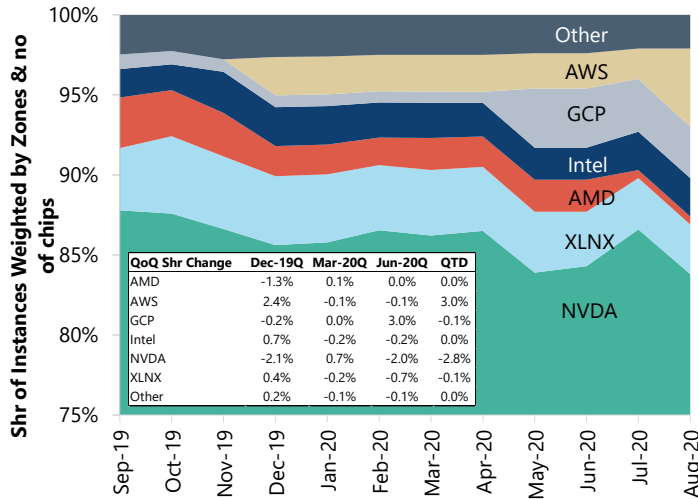


Source: Liftr Insights, Jefferies

INTC total CPU instance availability increased by 21% QTD ending Aug-20, and Cascade Lake based instances grew 111%.

## Dedicated Accelerator Instance Analysis

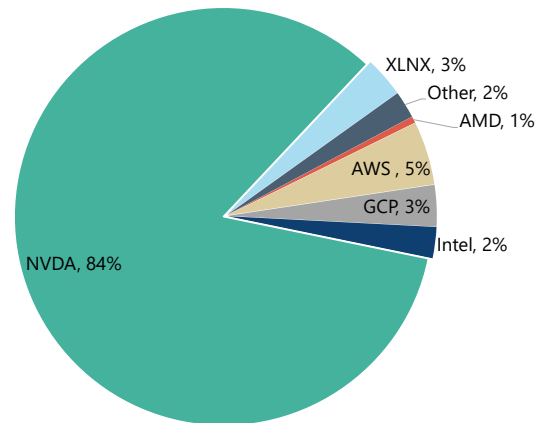
Chart 12 - Dedicated Accelerator Share



Source: Liftr Insights, Jefferies

Chart 13 - Share of Dedicated Accelerator Share

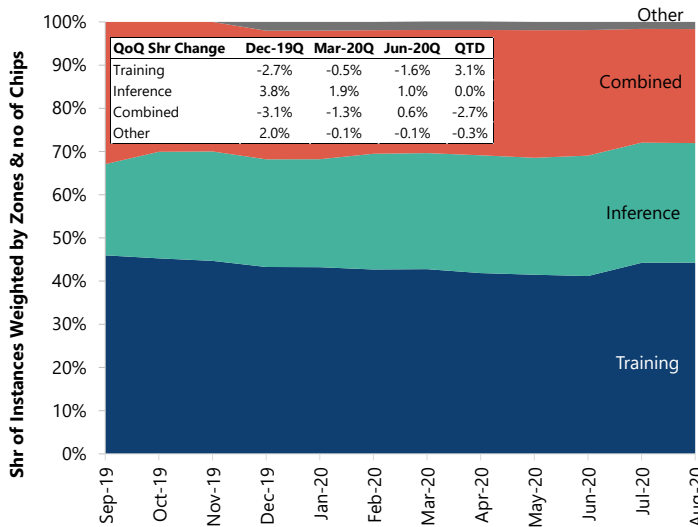
Dedicated Accelerator Share as of Aug-20



Source: Liftr Insight, Jefferies

NVDA dominates Dedicator Accelerator instances with approx. 84% share. QTD ending Aug-20, there were no material additions to NVDA based instances. In Aug-20, AWS deployed its custom inference chip "Inferentia", increasing its overall share to 5%.

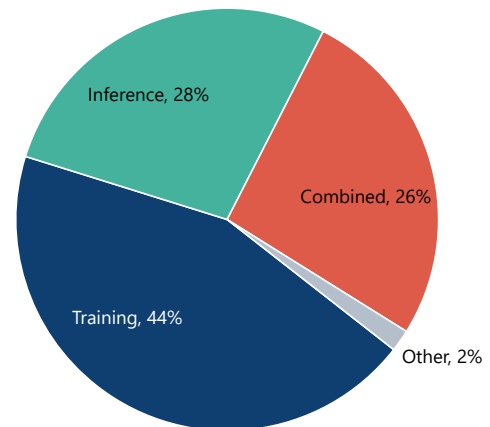
Chart 14 - NVDA's Accelerator Instances by Application



Source: Liftr Insights, Jefferies

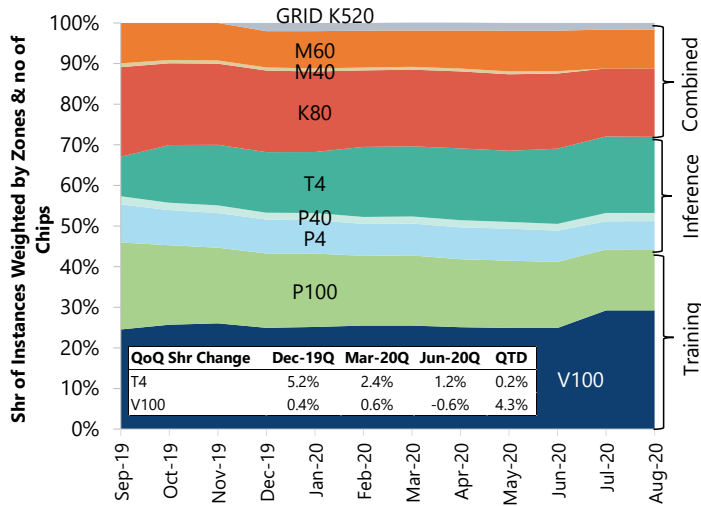
Chart 15 - Training vs. Inferencing Share for NVDA Accelerators

NVDA Accelerator Application Shr as of Aug-20



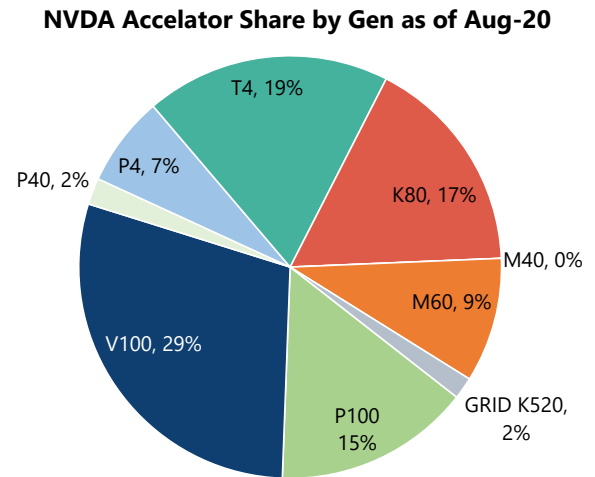
NVDA's inferencing solutions, T4, P4 and P40 GPUs, represent 28% of NVDA's dedicated accelerator instances. We expect to see NVDA's next gen acceleration platform, Ampere (A100) based instances to be deployed shortly. Since this is a solution that is designed for both inferencing and training, we would expect it to show up in the "Combined" segment.

Chart 16 - NVDA's Accelerator Instances Share by Generations



Source: Liftr Insights, Jefferies

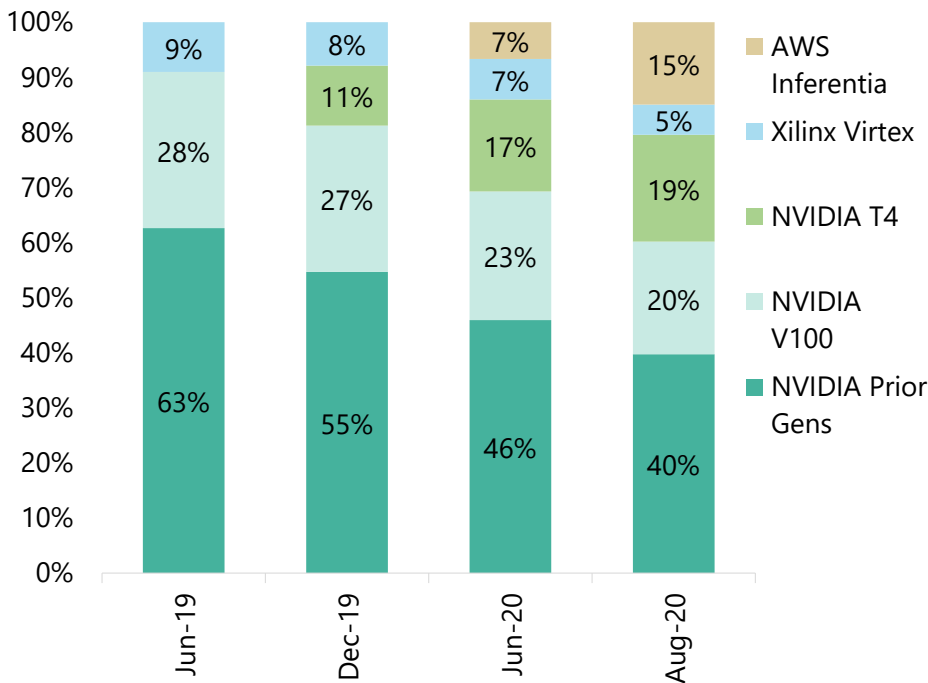
Chart 17 - NVDA Accelerator Share by Generation



Source: Liftr Insights, Jefferies

NVDA's inferencing chip, T4, share grew 0.2% QTD ending Aug-20 and training chip V100 grew 4.3%. T4 instances represents 19% share of NVDA-based accelerator instances and V100 represents 29%.

Chart 18 - Dedicated Accelerator Instances Share at AWS



Source: Liftr Insights, Jefferies

Since Dec-2019, Amazon has significantly increased deployment of its in-house designed Inferentia-based instances increasing its share to 15% from 0%. NVDA based instances represent 79% of total AWS dedicated accelerator instances.

## Chart 19 - Processor Application at AWS

Processor	Application at AWS
Inferentia	Recommendation engines, forecasting, image and video analysis, advanced text analytics, document analysis, voice, conversational agents, translation, transcription, and fraud detection
NVDA	<ul style="list-style-type: none"> <li>- Machine/Deep learning, high performance computing, computational fluid dynamics, computational finance, seismic analysis, speech recognition, autonomous vehicles, drug discovery</li> <li>- Machine learning, high performance databases, computational fluid dynamics, computational finance, seismic analysis, molecular modeling, genomics, rendering, and other server-side GPU compute workloads</li> <li>- Machine learning inference for applications like adding metadata to an image, object detection, recommender systems, automated speech recognition, and language translation. Also provide a very cost-effective platform for building and running graphics-intensive applications, such as remote graphics workstations, video transcoding, photo-realistic design, and game streaming in the cloud.</li> <li>- 3D visualizations, graphics-intensive remote workstation, 3D rendering, application streaming, video encoding, and other server-side graphics workloads</li> <li>- Genomics research, financial analytics, real-time video processing, big data search and analysis, and security</li> </ul>

Source: Jefferies, AWS

## Announcements by CSPs with no deployments

Based on information provided by Liftr Insights, we track the CSPs' announcement of new instances

### AMD:

On Nov 18, 2019 AWS announced 2 new compute optimized type based on AMD EPYC 2 processors (C5a and C5ad) expected to be available in 8 sizes. These new types have not appeared yet. On June 4, 2020 AWS announced that these instances are "coming soon".

### NVDA:

On Jul 7, GCP announced a new instance type based on NVDA's new Tesla A100 GPUs and will be available via "private alpha program" with public availability for later in 2020

On May 14, AWS announced upcoming support for NVDA's new Tesla A100 GPUs with no specific timeframe

### Xilinx:

Azure: On Oct 1, 2019, Azure planned to deploy 3 different sizes of NP instance type based on Xilinx FPGA accelerators. These have not come live yet.

AWS: On Oct 31, 2019, AWS announced it would launch F1 Xilinx FPGA based dedicated accelerator in Canada during October. This isn't live yet.

### Other Processors:

**Graphcore IPU:** On Nov 18, 2019, Azure announced ND V3 type based on Intel's Skylake processors and 16 Graphcore IPUs. This isn't live yet.



## Methodology

**What does Liftr Insights track?** Liftr Insights runs monthly scans that aggregate the **count** of instance types across 4 CSPs (Microsoft Azure; Amazon AWS, Google GCP and Alibaba Aliyun). Since instance types are defined by the processors that support them, Liftr data can track the count of instances deployed on AMD/INTC/NVDA processors, giving us granularity on the share between the vendors and the processor version. The regions with larger zone counts have more influence when calculating the share of deployed infrastructure at each CSP.

**What are Instances?** Every CSP (cloud service provider) rents out a portion of their data center (cloud) to their customers. AWS/GCP/Azure build out data centers deploying 1000s of servers and then use a software layer to partition them into virtual machines based on different configuration of compute, storage and networking. This virtual machine (VM) is called an instance.

**What are Instance Types?** Instances are optimized for certain workloads. For example, AWS groups instances into General Purpose (balance compute/storage); Compute optimized (heavy on compute); Storage optimized (heavy on storage) etc. Within each of these there are multiple instances types bifurcated based on the processor/HW supporting the instance and size of instance, specifically horsepower of the processor supporting the instance, creating an instance type with specific processor and size of processor.

### What isn't captured?

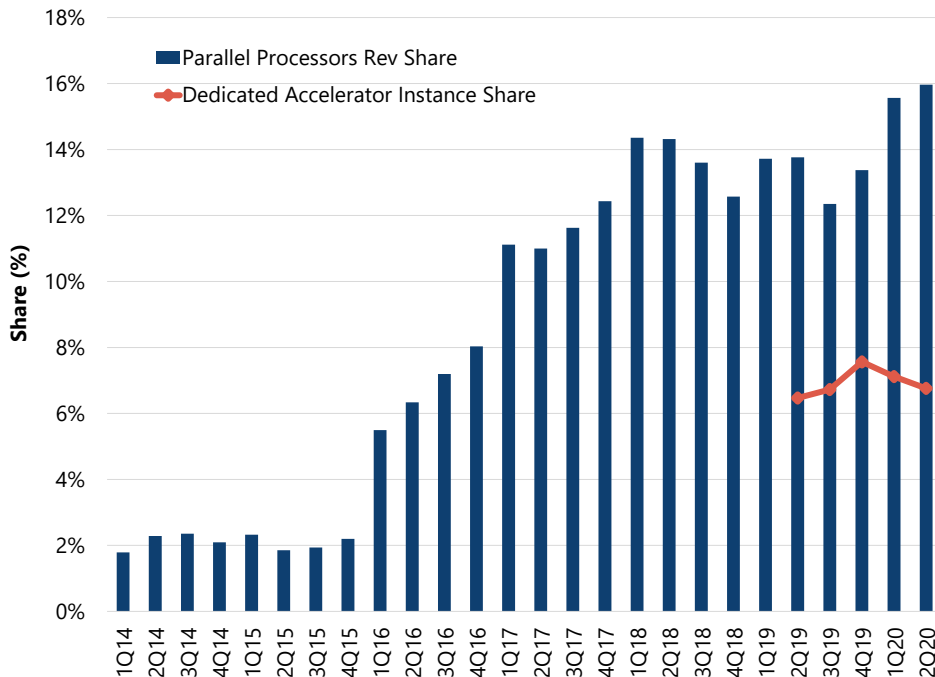
- This does not measure utilization of instances.
- Doesn't measure purchases of server CPUs/GPUs/FPGAs. The number of instances does not match up to physical servers/processors deployed, since a processor can support many VMs/instances.
- Doesn't capture internal consumption by CSPs. Many of the cloud providers purchase processors for running their internal workloads. This data doesn't capture the internal consumption

**Liftr Data Methodology for Estimating Growth and Share.** The count of instances across regions is multiplied by the number of zones in a particular region to factor in the size of instance. The regions with larger zone counts have more influence when calculating the share of deployed infrastructure at each CSP.

- Processor-only instance types explicitly exclude any accelerators from configurations, they provision only processor cores. Liftr Insights calculates share of processors deployed in instance types as a product of regional availability and the number of zones in each region.
- Accelerated instances type explicitly include accelerator chip capacity on each configuration, such as GPUs, FPGAs and other compute acceleration chips. Liftr Insights calculates share of chips deployed in instance types as a product of regional availability, the number of zones on each region and the number of accelerator chips deployed in each size offered in each region.

## Instance Analysis Compared to 10Q/Market Data

Chart 20 - Parallel Processors Rev Share vs. Dedicated Accelerator Instance Share

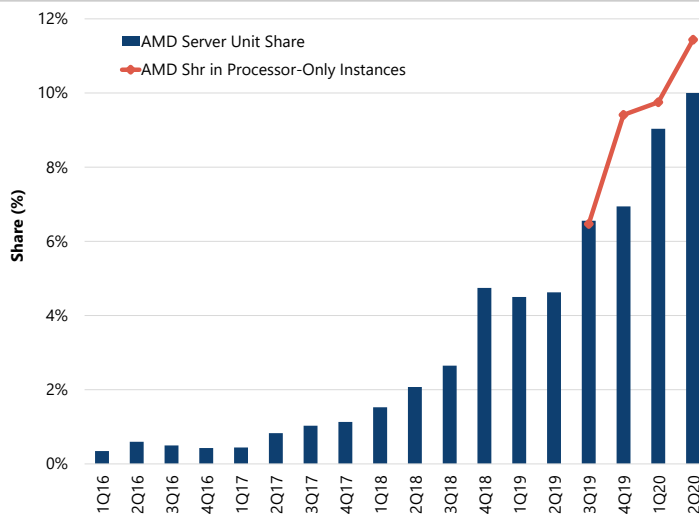


We compare the data from the Instance Analysis to data from 10Qs and income statements of INTC, NVDA, AMD and XLNX

In Chart 20, we show that according to the instance analysis in Charts 2 and 3 earlier in this note (red line here), dedicated accelerators account for about 7% of total instance availability, but on a revenue basis (blue bar), dedicated accelerators account for 15%-16%. We think this could be in part because INTC is largely selling CPUs, while NVDA is selling systems and blades. Importantly, we observe that there is a correlation with a one-quarter lag in the trendline of instances vs data center revenues reported by our sample set of companies.

Source: Liftr Insights, Company data, Jefferies \*Parallel processors rev share represents share of NVDA+XLNX+ALTR Data center revs vs. total DC processor revs (INTC+AMD+NVDA+XLNX+ALTR)

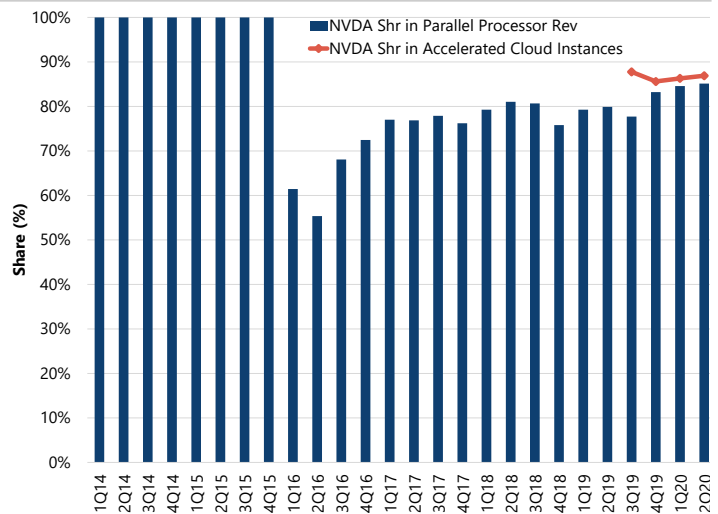
Chart 21 - AMD Server Unit Shr vs. AMD Shr in Processor-Only Instances



Source: Liftr Insights, Mercury, IHS Markit, Jefferies

AMD's share of instances (red line) as we published in Charts 4 and 5, is consistent in both magnitude and direction with its revenue share (blue bar) vs INTC in data center CPUs

Chart 22 - NVDA's Share in Parallel Processing Revs vs. Share in Accelerated Cloud Instances



Source: Liftr Insights, Company data, Jefferies \*Note: Parallel processors revenues are sum of NVDA+XLNX+ALTR DC revs

NVDA's share of instances (red line) is consistent in magnitude and in direction (with a one-quarter lag) with its relative revenue share vs data center accelerator revenues reported by AMD, XLNX and INTC/ALTR.

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I, Mark Lipacis, certify that all of the views expressed in this research report accurately reflect my personal views about the subject security(ies) and subject company(ies). I also certify that no part of my compensation was, is, or will be, directly or indirectly, related to the specific recommendations or views expressed in this research report.

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(Article 3(1)e and Article 7 of MAR)

Recommendation Published September 23, 2020 , 03:49 ET.

Recommendation Distributed September 23, 2020 , 03:49 ET.

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	Count	Percent	Count	Percent	Count	Percent
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HOLD	965	37.77%	25	2.59%	5	0.52%
UNDERPERFORM	147	5.75%	0	0.00%	0	0.00%

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