HOW TO OPTIMIZE HPC/AI INFRA W/ NVIDIA & HPE

정구형 부장 | NVIDIA Korea

NVIDIA DATA CENTER GPU HISTORY

Volta Architecture

V100

Turing Architecture

T4

RTX 6K
RTX 8K

Ampere Architecture

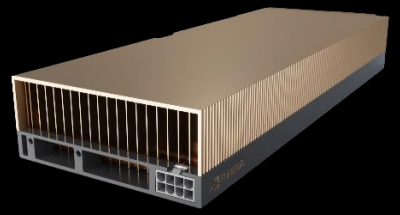
A100

2017 — 2018 — 2019 — 2020

최신 NVIDIA DATA CENTER GPU

NVIDIA **T4** 16GB

Multi-Purpose GPU for Enterprise Acceleration, Graphics, Inference

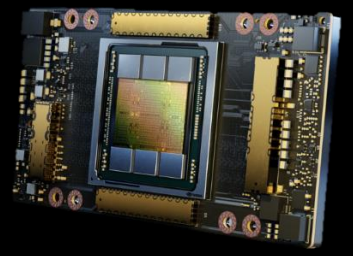


NVIDIA **A40** 48GB

World's Most Powerful Data Center GPU for Visual Computing (RTX 6K/8K Passive)

NVIDIA **A100 40GB**

World's Most Powerful Data Center GPU w/ MIG for max utilization



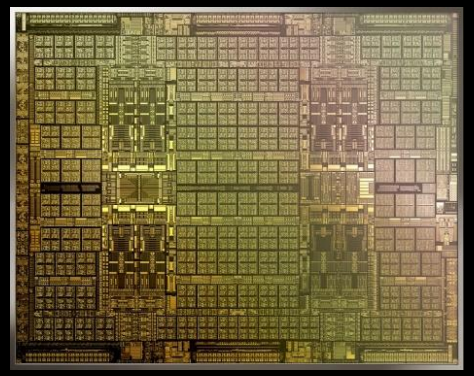
A100 80GB SXM4

World's Most Powerful Data Center GPU For Largest Workloads and Datasets

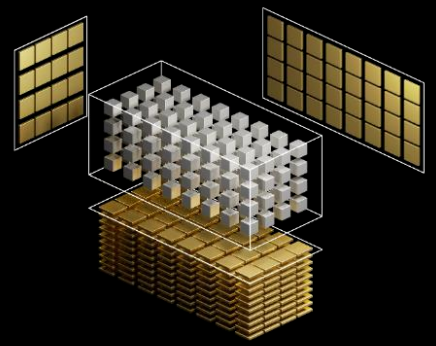
CHOOSE THE RIGHT NVIDIA DATA CENTER GPU

Workload	Description	NVIDIA A100 SXM4	NVIDIA A100 PCIe	NVIDIA T4	NVIDIA A40
Deep Learning Training	For the absolute fastest model tra ining time	• 8-16 GPUs (for new installs) 80GB: For largest models (DLRM, GPT-2 over 9.3Bn parameters in one node)	• 4-8 GPUs		
Deep Learning Inference	For batch and real-time inference	• 1 GPU w/ MIG 80GB: 7MIGs at 10GB each for large batch siz e constrained models (RNN-T)	• 1 GPU w/ MIG	• 1 GPU	
HPC / AI	For scientific computing centers a nd higher ed and research institut ions	• 4 GPUs with MIG for supercomputing cente rs 80GB: For largest datasets and high memory bandwidth applications	• 1-4 GPUs with MIG for high er ed and research		
Render Farms	For batch and real-time rendering				• 4-8 GPUs
Graphics	For the best graphics performance on professional virtual workstations*			• 2–8 GPUs for mid-range virtual workstations for professional graphics	• 4-8 GPUs for mid and high-e nd professional graphics and RTX workloads or simulation
Enterprise Acceleration	Mixed Workloads – Graphics, ML, DL, analytics, training, inference	• 1-4 with MIG for compute intensive multi-G PU workloads 80GB: data analytics with largest datasets	• 1-4 GPUs with MIG for com pute intensive single GPU w orkloads	• 4-8 GPUs for balanced work loads*	• 2-4 GPUs for graphics intens ive* and compute workloads
Edge Acceleration	Edge solutions with differing use cases and deployment location		• 1-2 GPU with MIG	• 1-8 GPUs for inference and video workloads	• 2-4 GPUs for graphics intens ive & AR/VR workloads*

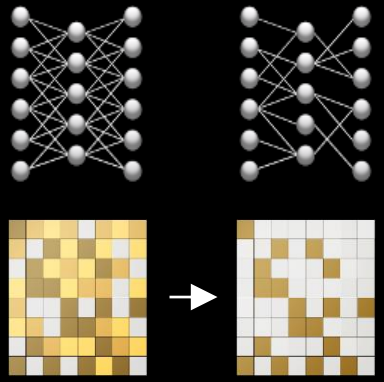
NVIDIA A100 GPU 5가지 특징



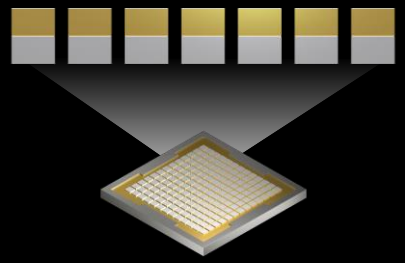
NVIDIA Ampere Architecture
World's Largest 7nm chip
54B XTORS, HBM2



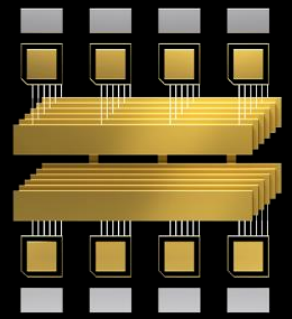
3rd Gen Tensor Cores
Faster, Flexible, Easier to use
20x AI Perf with TF32
2.5x HPC Perf



New Sparsity Acceleration
Harness Sparsity in AI Models
2x AI Performance



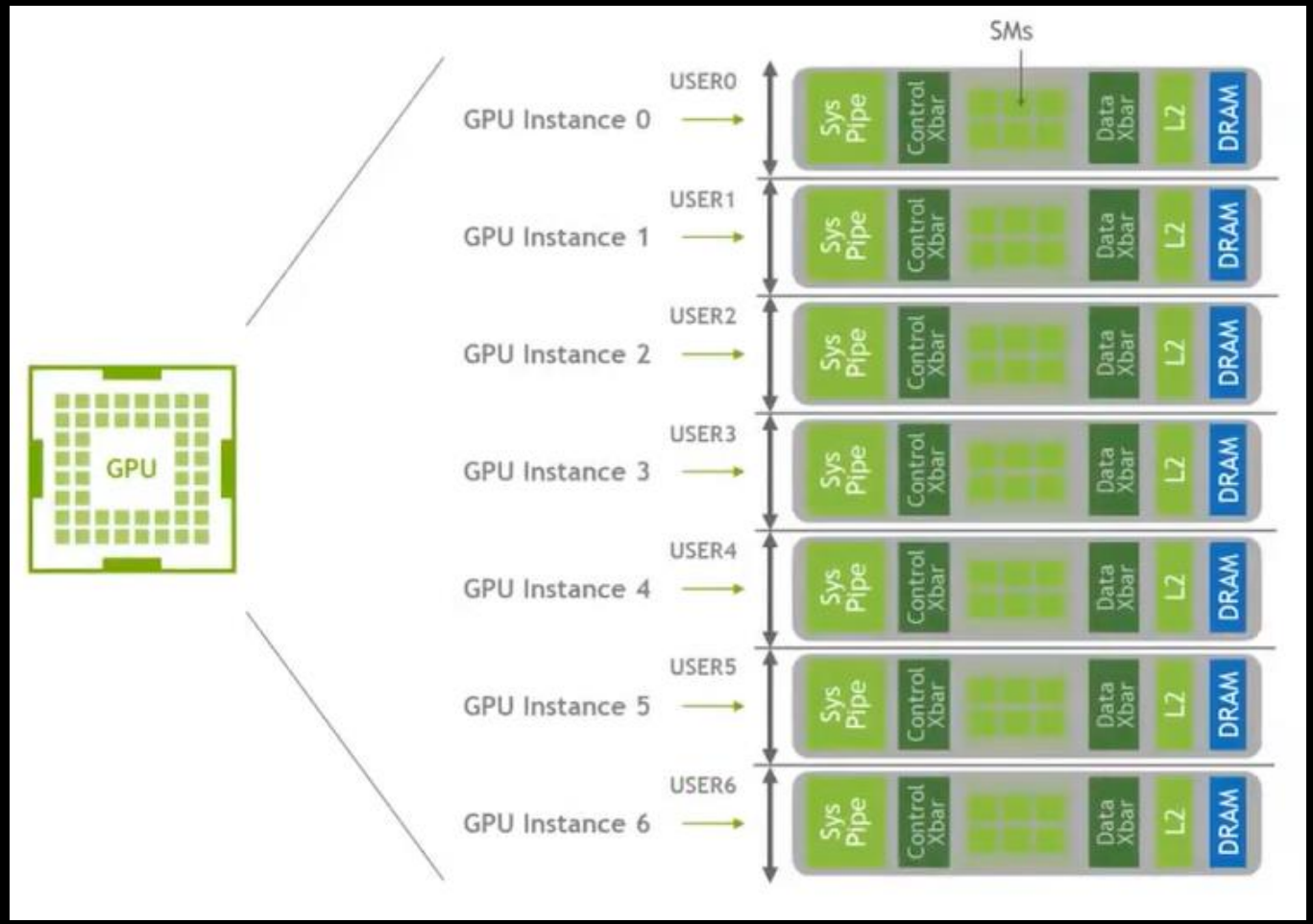
New **Multi-Instance GPU**
Optimal utilization with right sized GPU
7x Simultaneous Instances per GPU



3rd Gen NVLINK and NVSWITCH
Efficient Scaling to Enable Super GPU
2X More Bandwidth

MIG (MULTI INSTANCE GPU)

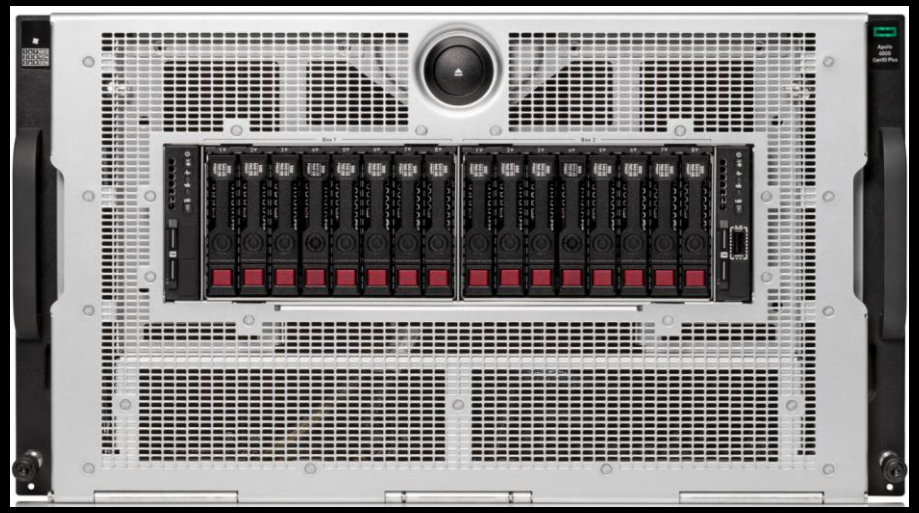
- A100 GPU, 최대 7개 GPU Slice로 분할
- 목적: GPU 사용률 극대화
- 사용 사례
  - A100 GPU 1장 미만 워크로드
  - 경량 학습, 추론, 개발, 일부 HPC
- 혜택
  - GPU 1장당 총 19가지 분할 가능
  - 분할된 MIG, H/W 독립, QoS 보장

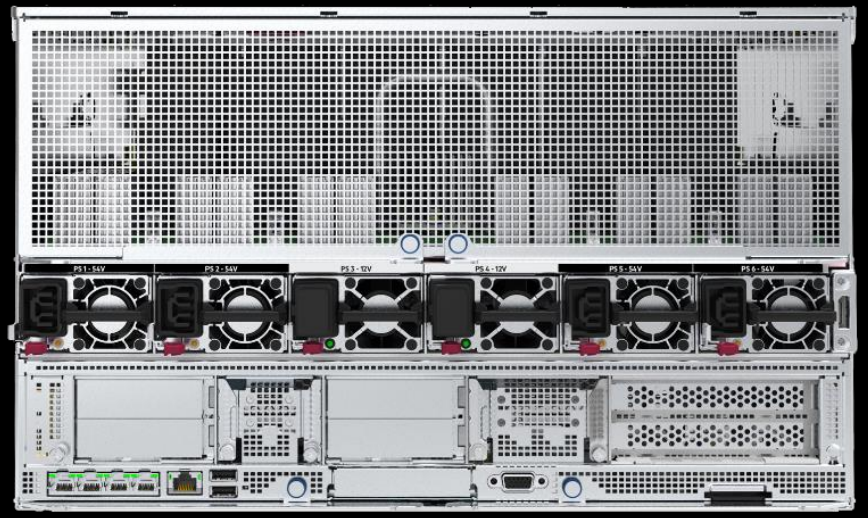


A100 GPU 1장을 MIG으로 구성할 수 있는 18가지 경우

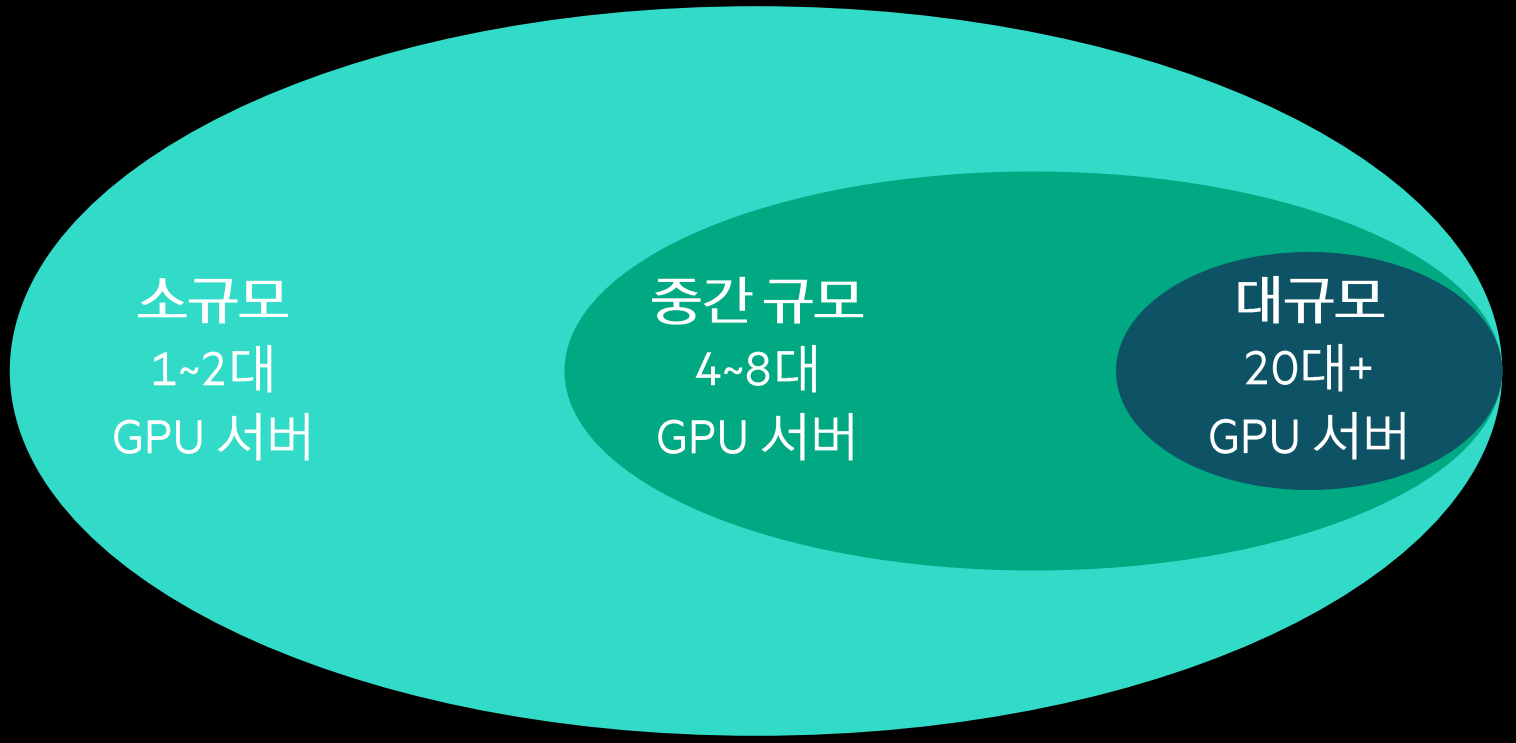
Slice #1	Slice #2	Slice #3	Slice #4	Slice #5	Slice #6	Slice #7
7						
4				2		1
4				1	1	1
2		2		3		
2		1	1	3		
1	1	2		3		
1	1	1	1	3		
3				3		
3				2		1
3				1	1	1
2		2		2		1
2		2		1	1	1
1	1	2		2		1
1	1	2		1	1	1
2		1	1	2		1
2		1	1	1	1	1
1	1	1	1	2		1
1	1	1	1	1	1	1

HPE APOLLO 6500 GEN10 PLUS



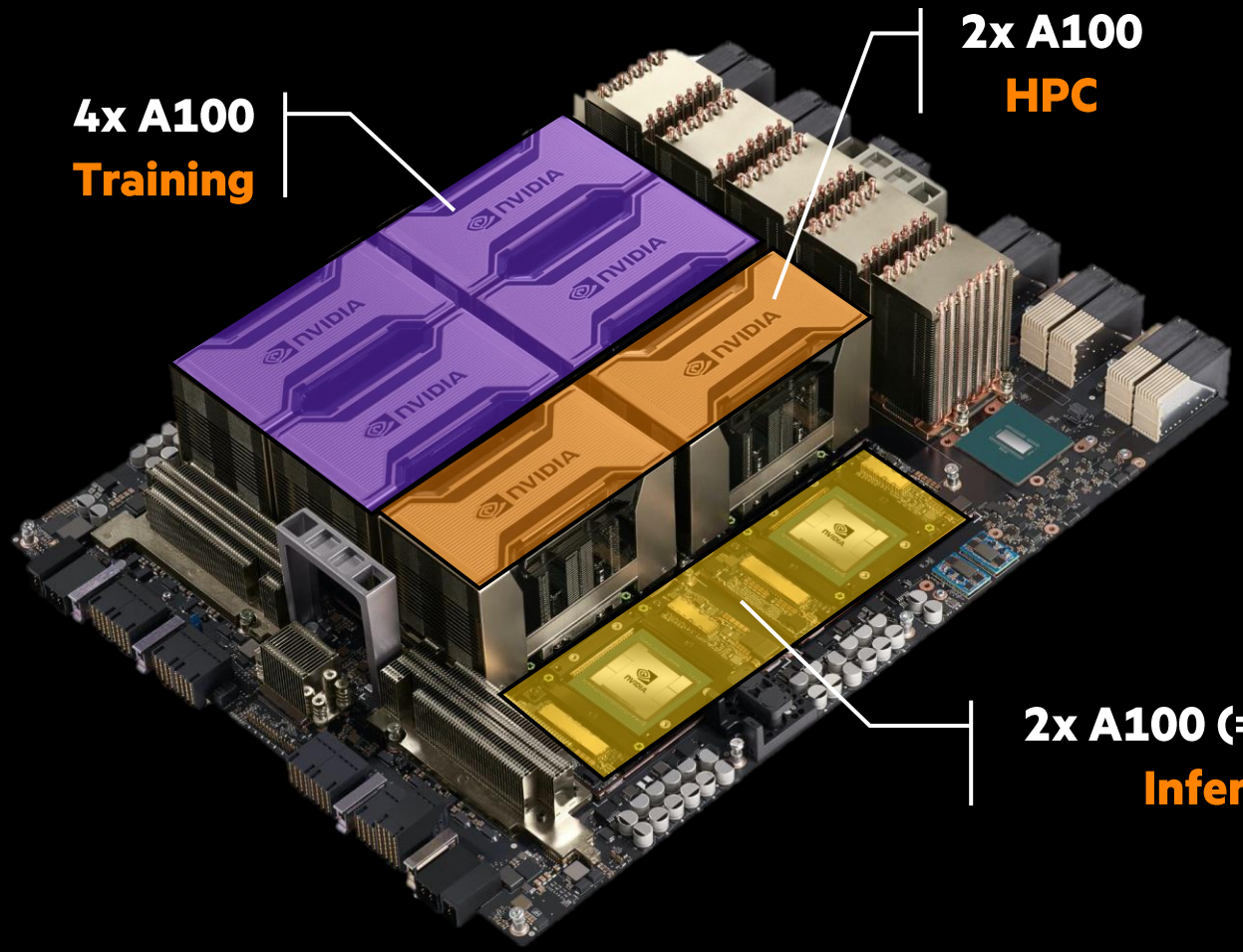


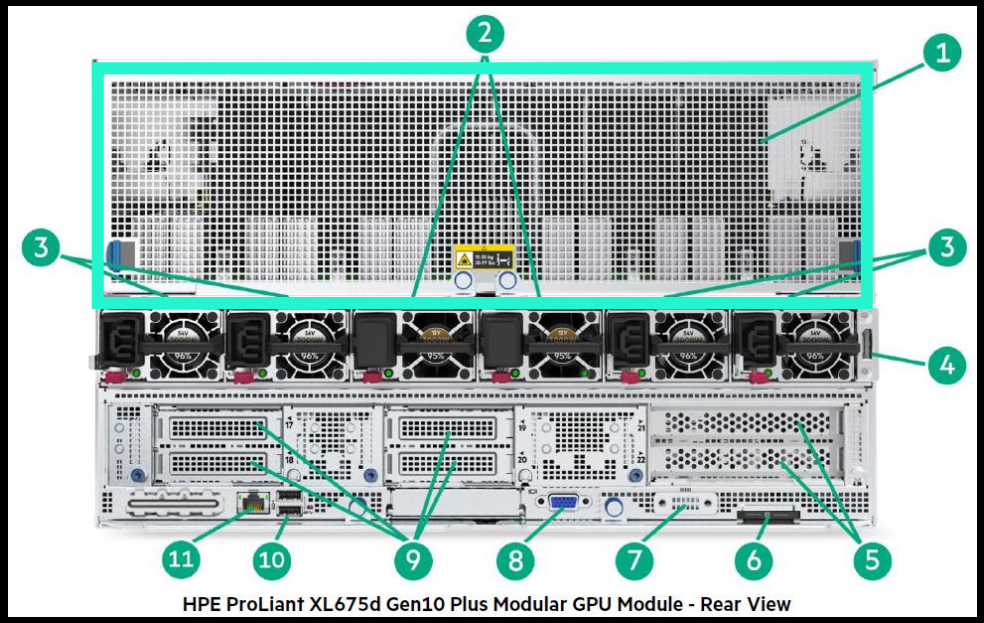
규모에 따른 GPU 서버/클러스터 구성 (예)



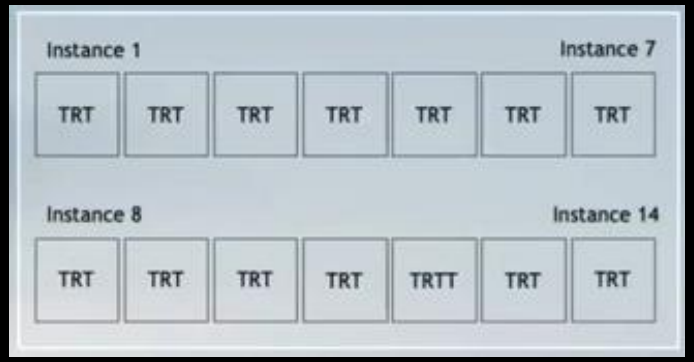
소규모 – 1~2대 GPU 서버 구성

GPU resource 분배 (예시)





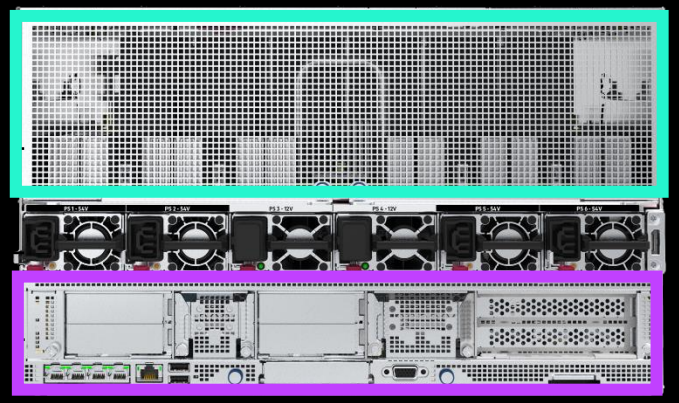
HPE ProLiant XL675d Gen10 Plus Modular GPU Module - Rear View



소규모 – 1~2대 GPU 서버 구성

서버 구분 옵션

HPE ProLiant XL675d Gen10 Plus



3U Support—Accelerator tray:

- NVIDIA HGX A100 8-GPU
- 8, 10, 16 PCIE @ 300W – 75W

2U Support—Compute tray:

- 2P AMD Rome , 280W CPU
- 4x LP PCIE Gen4 IO Slots
- 2x FH PCIE Gen4 IO Slots

HPE ProLiant XL645d Gen10 Plus

3U Support – Accelerator tray:

- NVIDIA HGX A100 4-GPU
- 4–8 PCIE @ 300W–75W

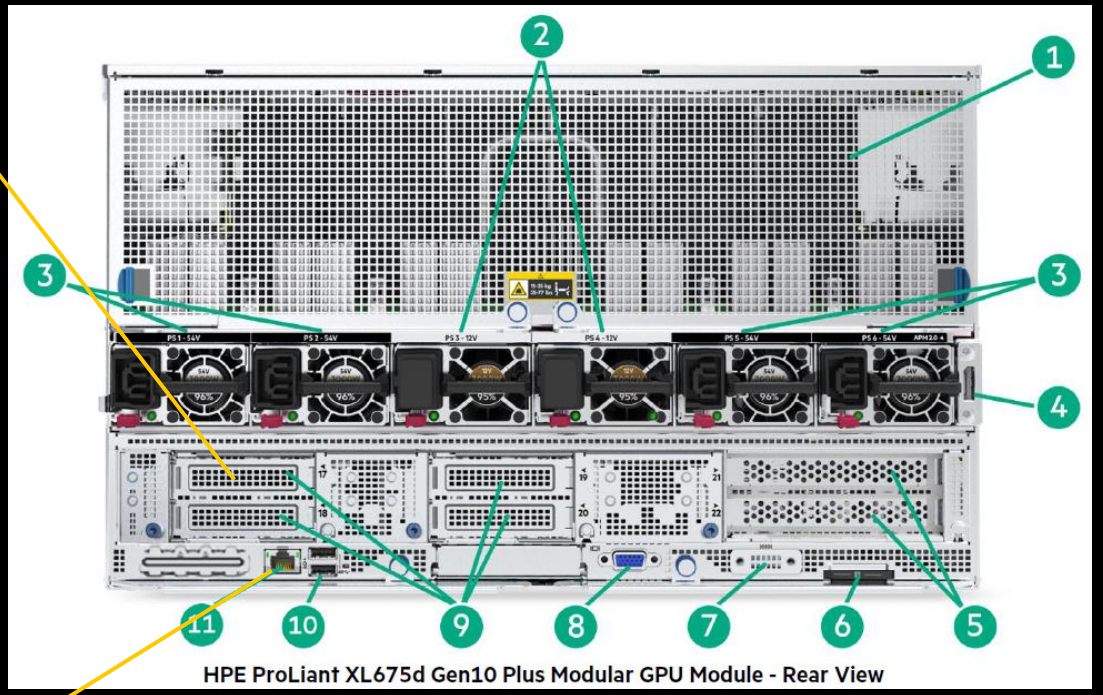
2U Support—Compute tray:

- 1P AMD Rome, 280W CPU
- 2x LP PCIE Gen4 IO Slots

소규모 – 1~2대 GPU 서버 구성

Network 구성 (예시)

Ethernet 1Gb 4-port Adapter
서비스망



HPE ProLiant XL675d Gen10 Plus Modular GPU Module - Rear View

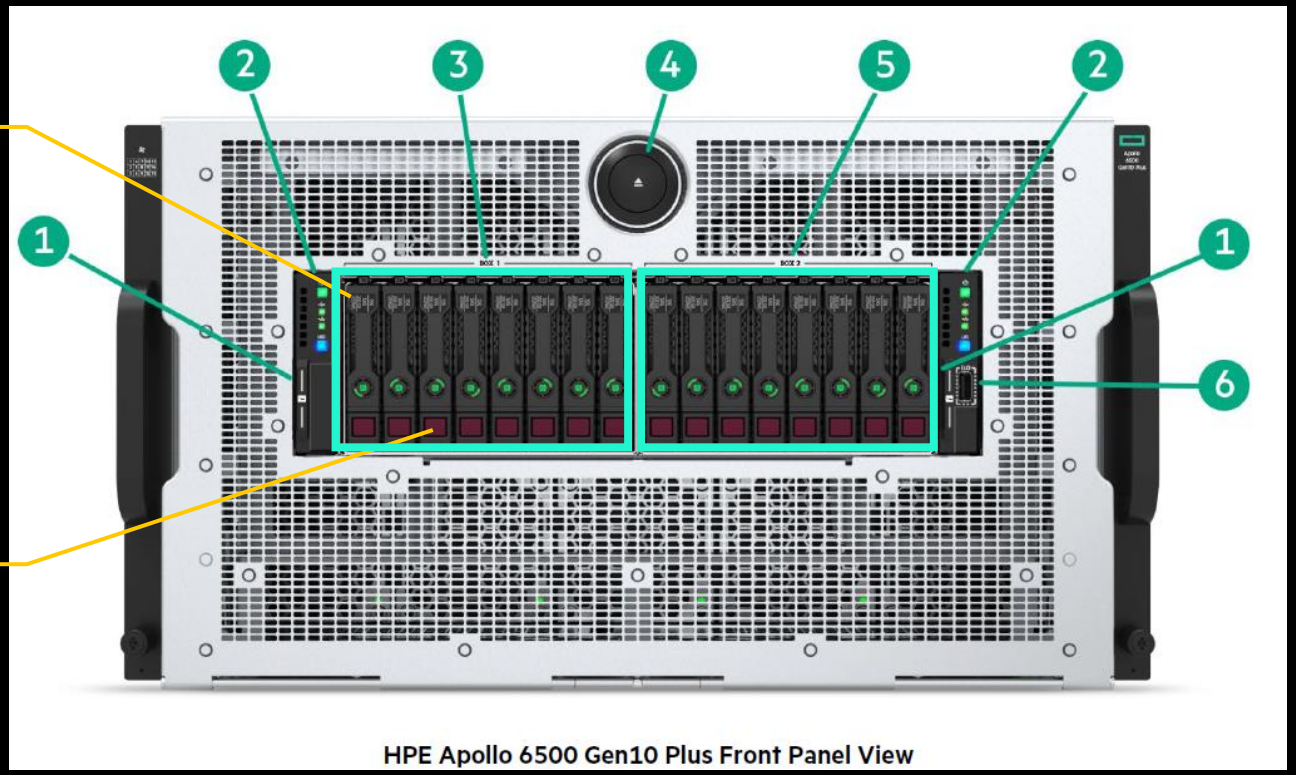
Dedicated iLO management port
관리망

소규모 – 1~2대 GPU 서버 구성

Internal Storage 외 (예시)

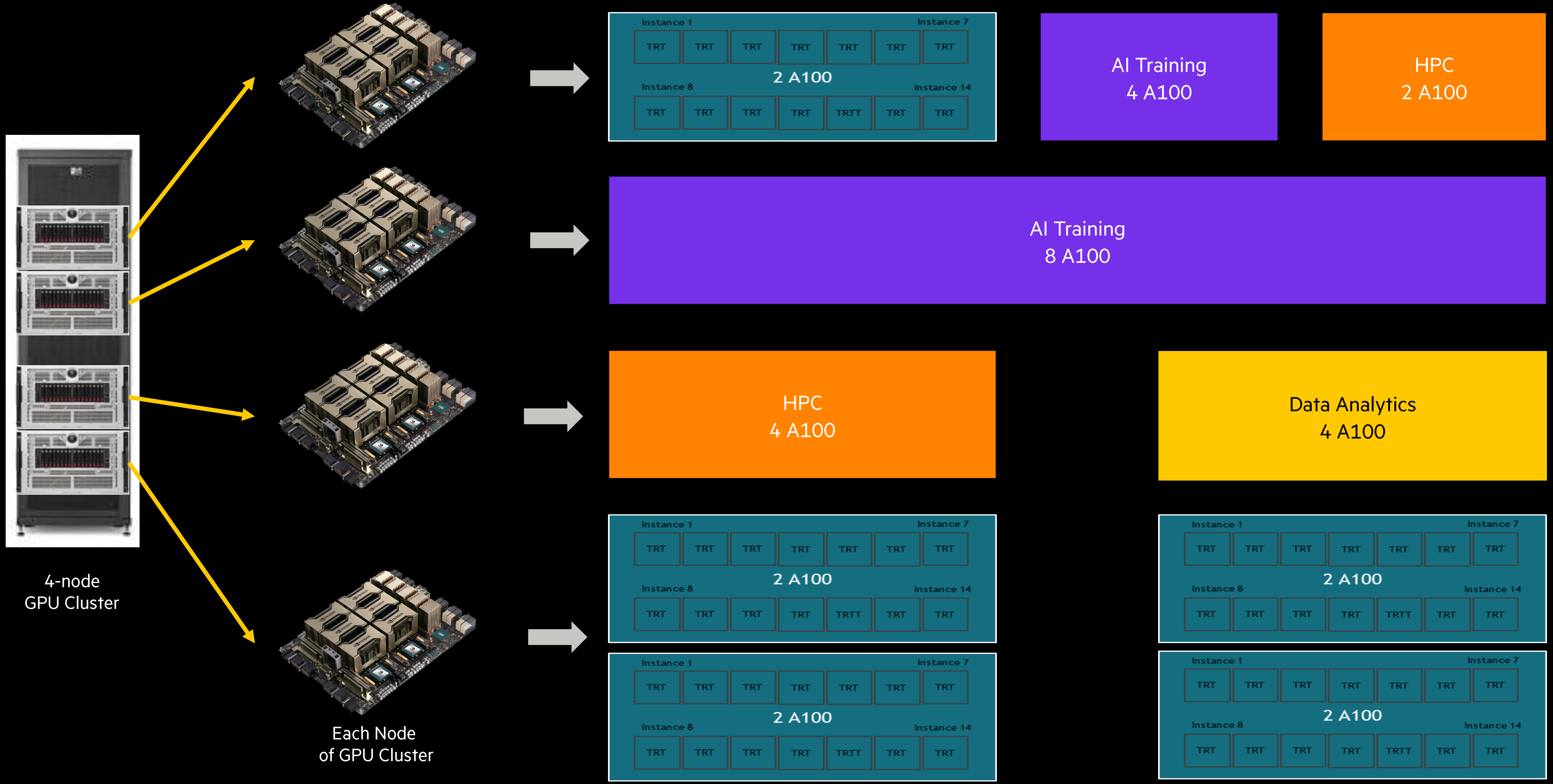
2x 1.92TB SSD
OS

?x 3.84TB SSD
Data



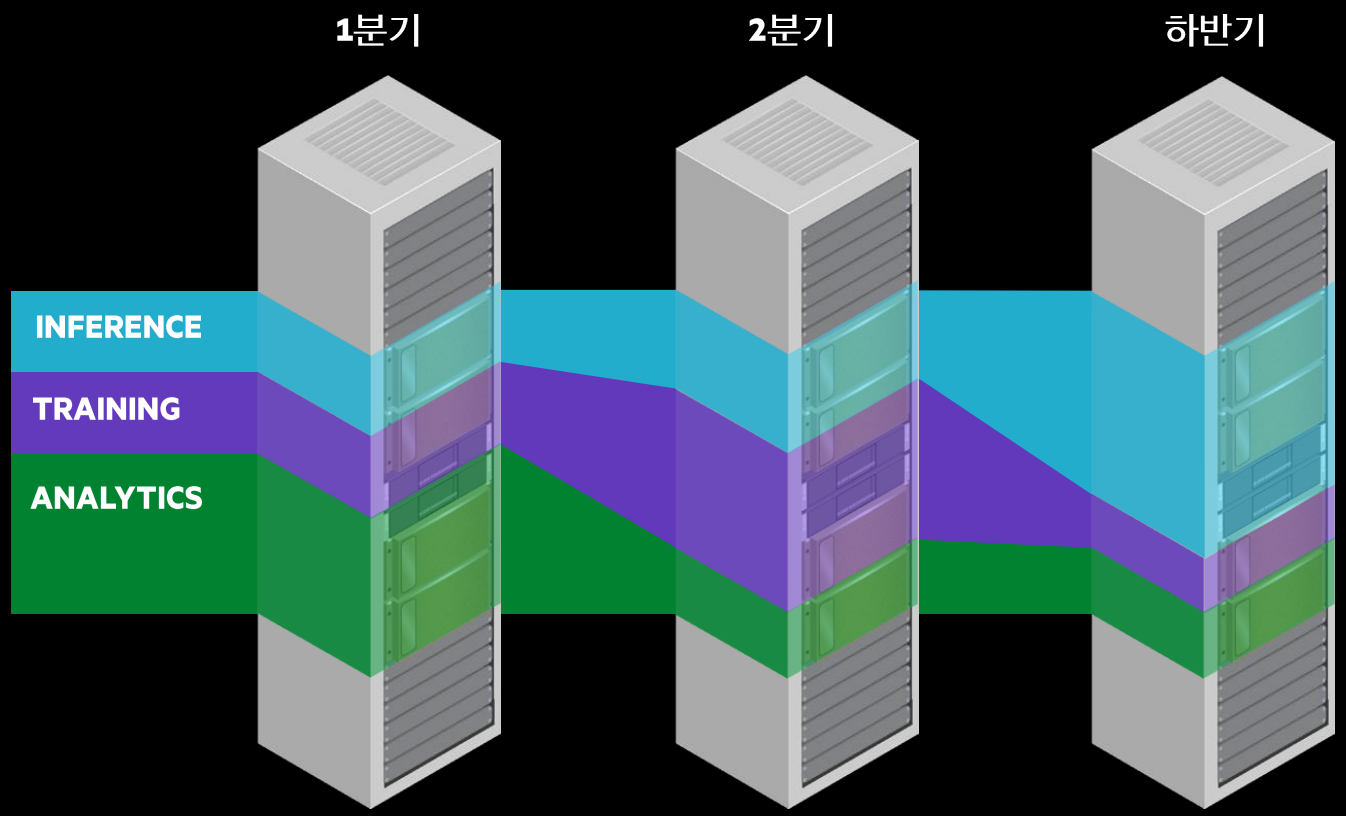
HPE Apollo 6500 Gen10 Plus Front Panel View

중간 규모 – 4~8대 GPU 서버 구성 (예)



중간 규모 – 4~8대 GPU 서버 구성 (예)

시기적 특성 있는 업무의 경우, **A100 MIG** 기능으로 유연한 시스템 구성



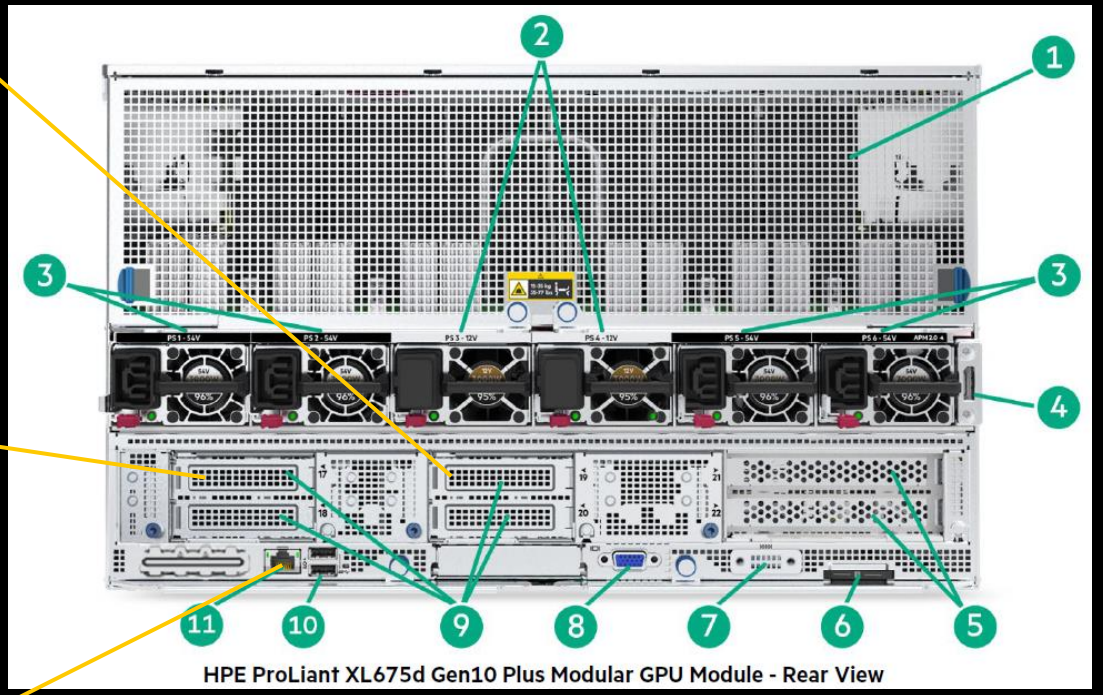
중간 규모 – 4~8대 GPU 서버 구성

Network 구성 외 (예시)

Mellanox Ethernet 10/25Gb
2-port Adapter
서비스망

InfiniBand 100Gb
1-port Adapter
Compute Fabric

iLO management port
관리망



HPE ProLiant XL675d Gen10 Plus Modular GPU Module - Rear View

대규모 – 20대+ GPU 서버 구성

GPT-3 모델이란?

- 자연어 처리 모델 (텍스트–인간의 언어-를 다루는 인공 지능 모델)

어디서 만들었나?

- OpenAI (샌프란시스코 위치 인공 지능 연구소)

GPT 시리즈

- GPT-1 (2018년; 파라미터 수 약 1억 1천 7백 개)
- GPT-2 (2019년; 파리미터 수 약 15억 개)
- GPT-3 (2020년; 파라미터 수 약 1750억 개)

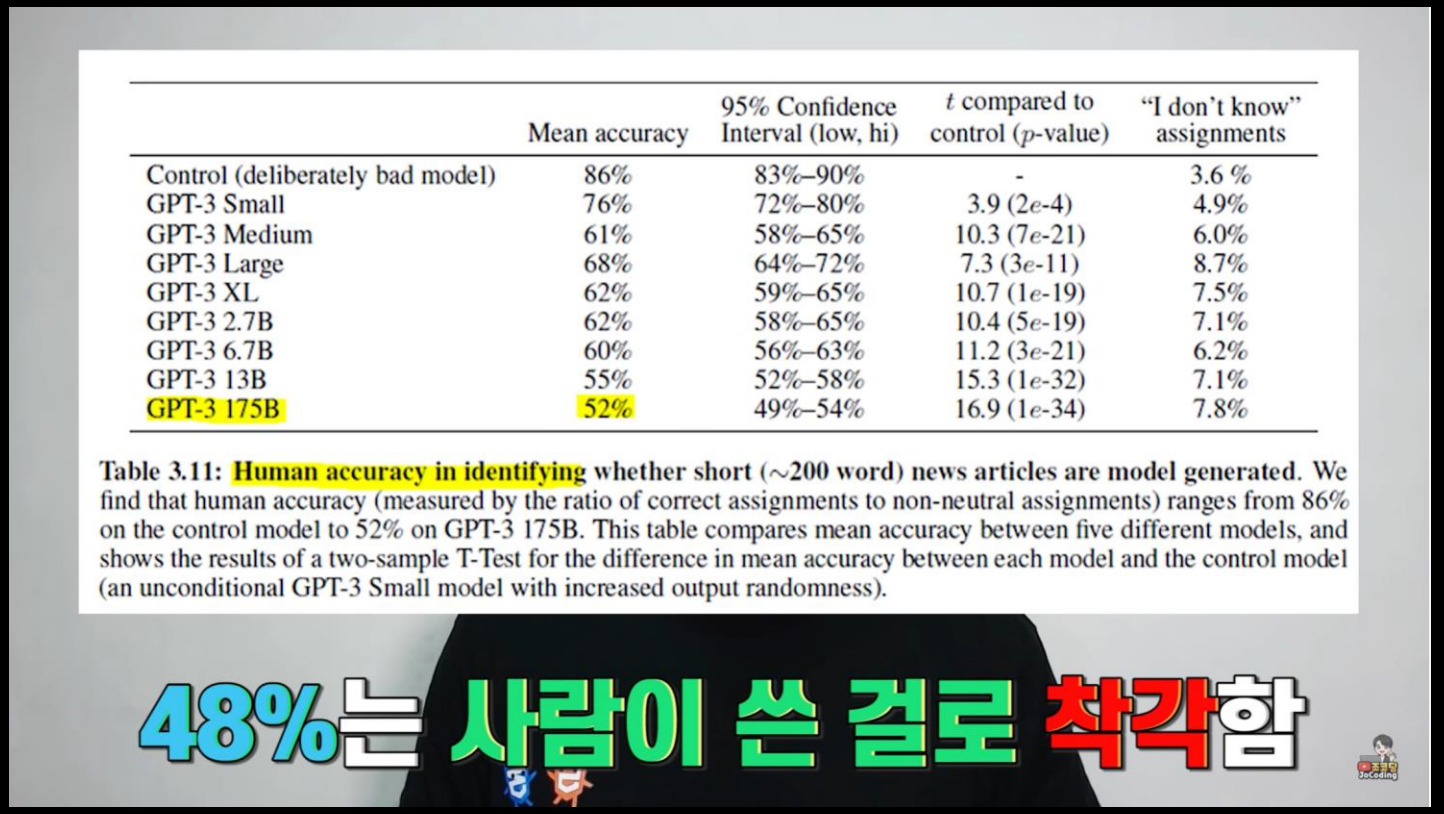
대규모 – 20대+ GPU 서버 구성

학습된 GPT-3 모델의 성능

1) GPT-3 모델이 쓴 기사를 사람이 봤을 때 48%이 사람이 쓴 것으로 착각

	Mean accuracy	95% Confidence Interval (low, hi)	*t* compared to control (*p*-value)	"I don't know" assignments
Control (deliberately bad model)	86%	83%–90%	-	3.6 %
GPT-3 Small	76%	72%–80%	3.9 (2*e*-4)	4.9%
GPT-3 Medium	61%	58%–65%	10.3 (7*e*-21)	6.0%
GPT-3 Large	68%	64%–72%	7.3 (3*e*-11)	8.7%
GPT-3 XL	62%	59%–65%	10.7 (1*e*-19)	7.5%
GPT-3 2.7B	62%	58%–65%	10.4 (5*e*-19)	7.1%
GPT-3 6.7B	60%	56%–63%	11.2 (3*e*-21)	6.2%
GPT-3 13B	55%	52%–58%	15.3 (1*e*-32)	7.1%
GPT-3 175B	52%	49%–54%	16.9 (1*e*-34)	7.8%

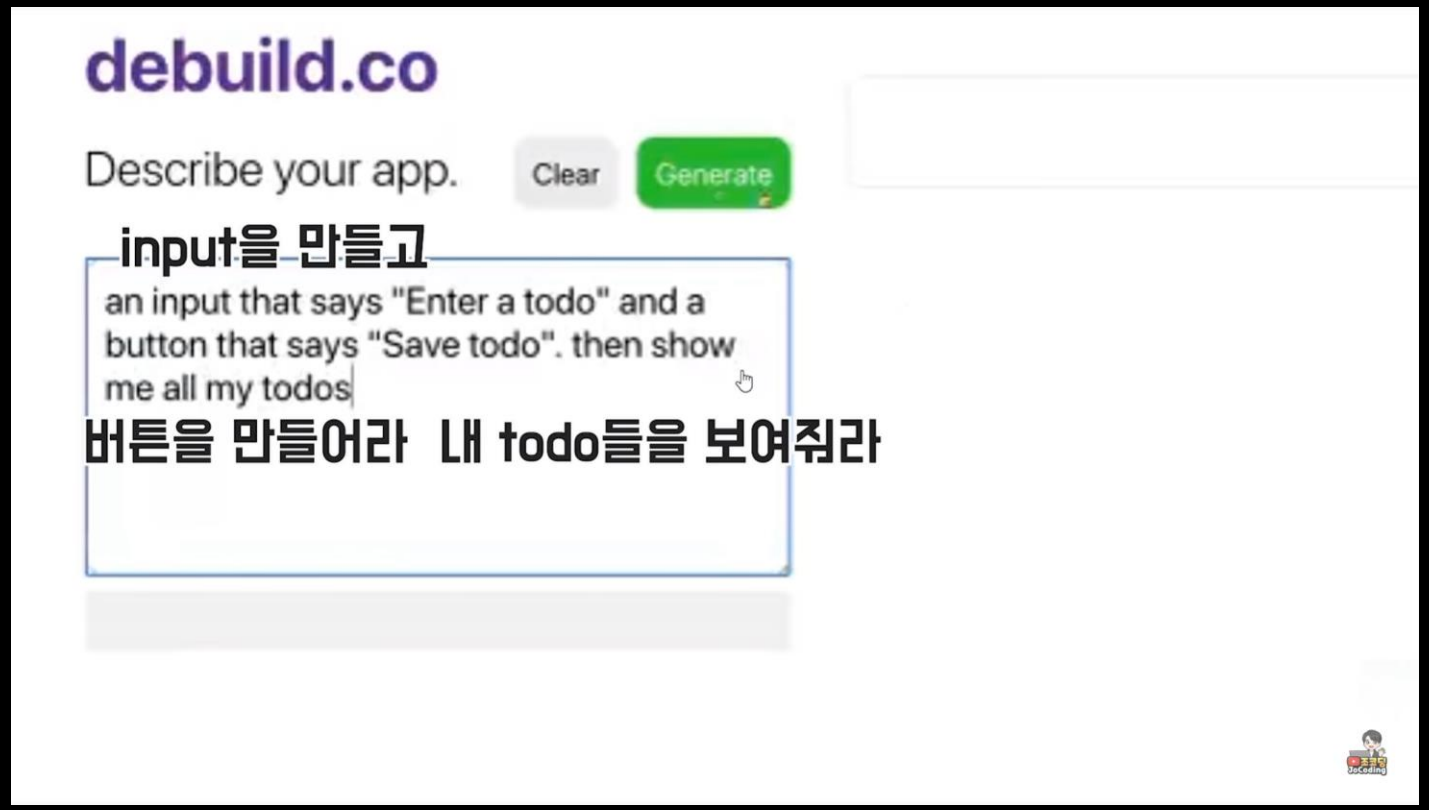
Table 3.11: Human accuracy in identifying whether short (~200 word) news articles are model generated. We find that human accuracy (measured by the ratio of correct assignments to non-neutral assignments) ranges from 86% on the control model to 52% on GPT-3 175B. This table compares mean accuracy between five different models, and shows the results of a two-sample T-Test for the difference in mean accuracy between each model and the control model (an unconditional GPT-3 Small model with increased output randomness).



대규모 – 20대+ GPU 서버 구성

학습된 GPT-3 모델의 성능

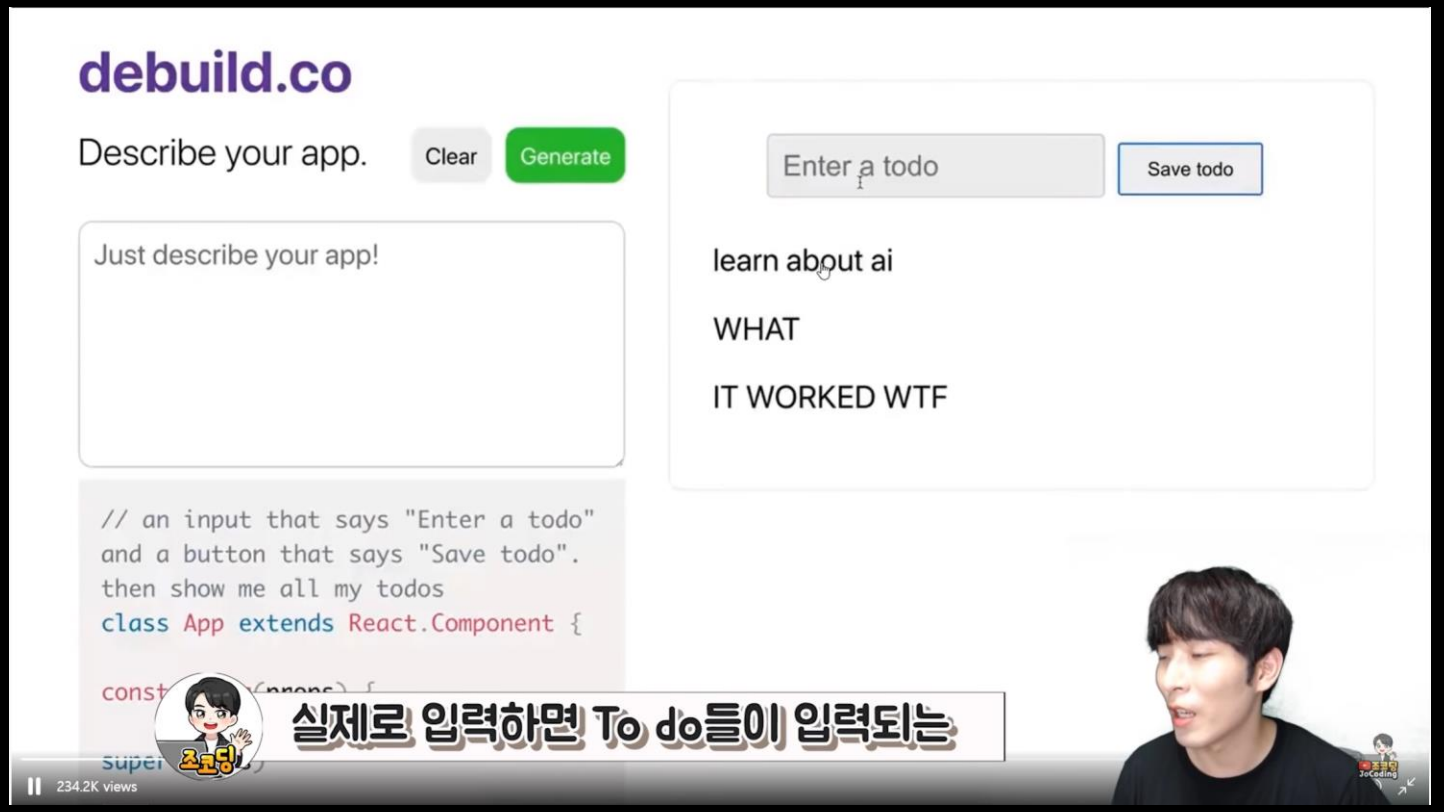
2) 텍스트로 만들고자 하는 어플리케이션을 설명하면



대규모 – 20대+ GPU 서버 구성

학습된 GPT-3 모델의 성능

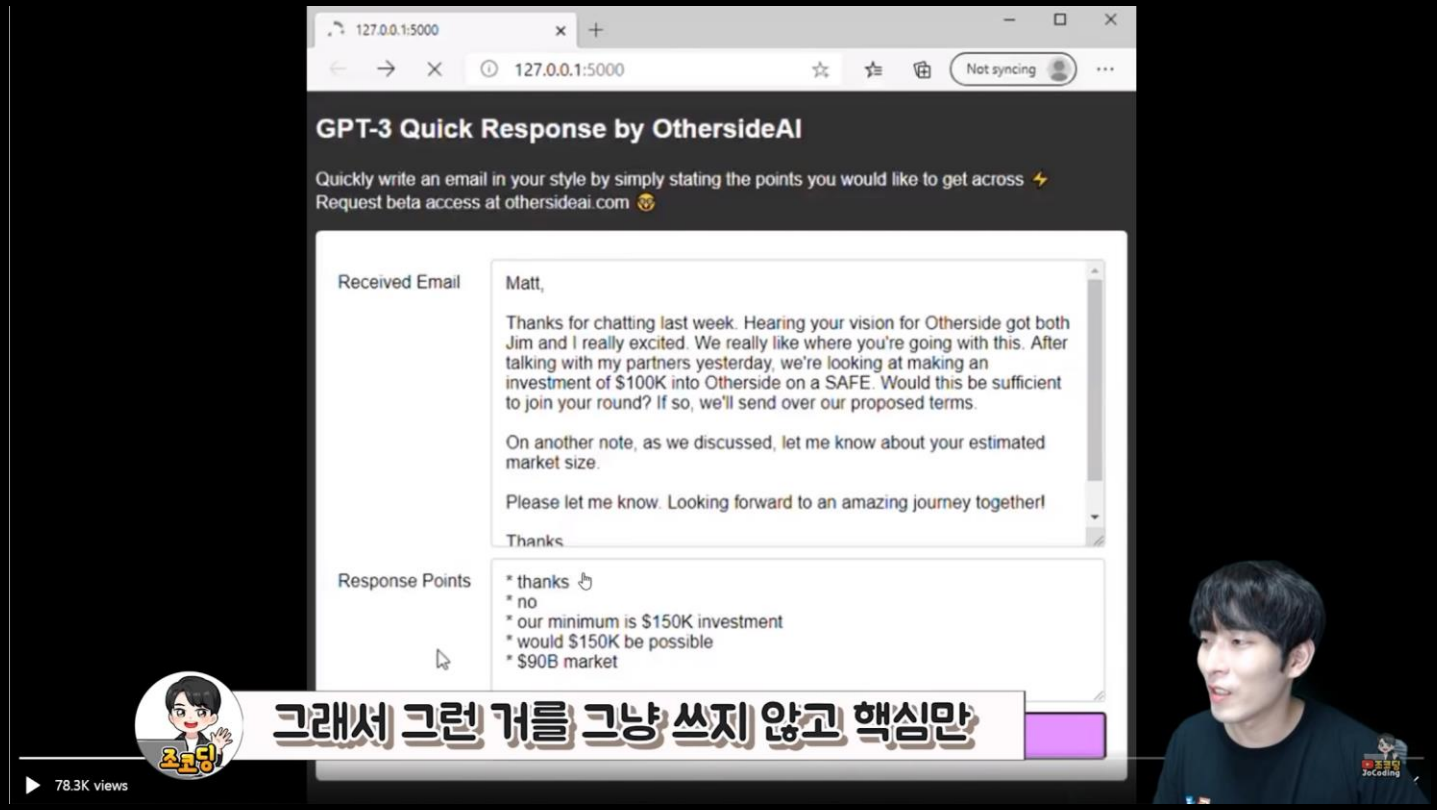
2) 텍스트로 만들고자 하는 어플리케이션을 설명하면, 스스로 코딩을 짜서 어플리케이션을 완성



대규모 – 20대+ GPU 서버 구성

학습된 GPT-3 모델의 성능

3) 이메일 회신을 하고자 할 때 핵심 키워드만 입력하면,



대규모 – 20대+ GPU 서버 구성

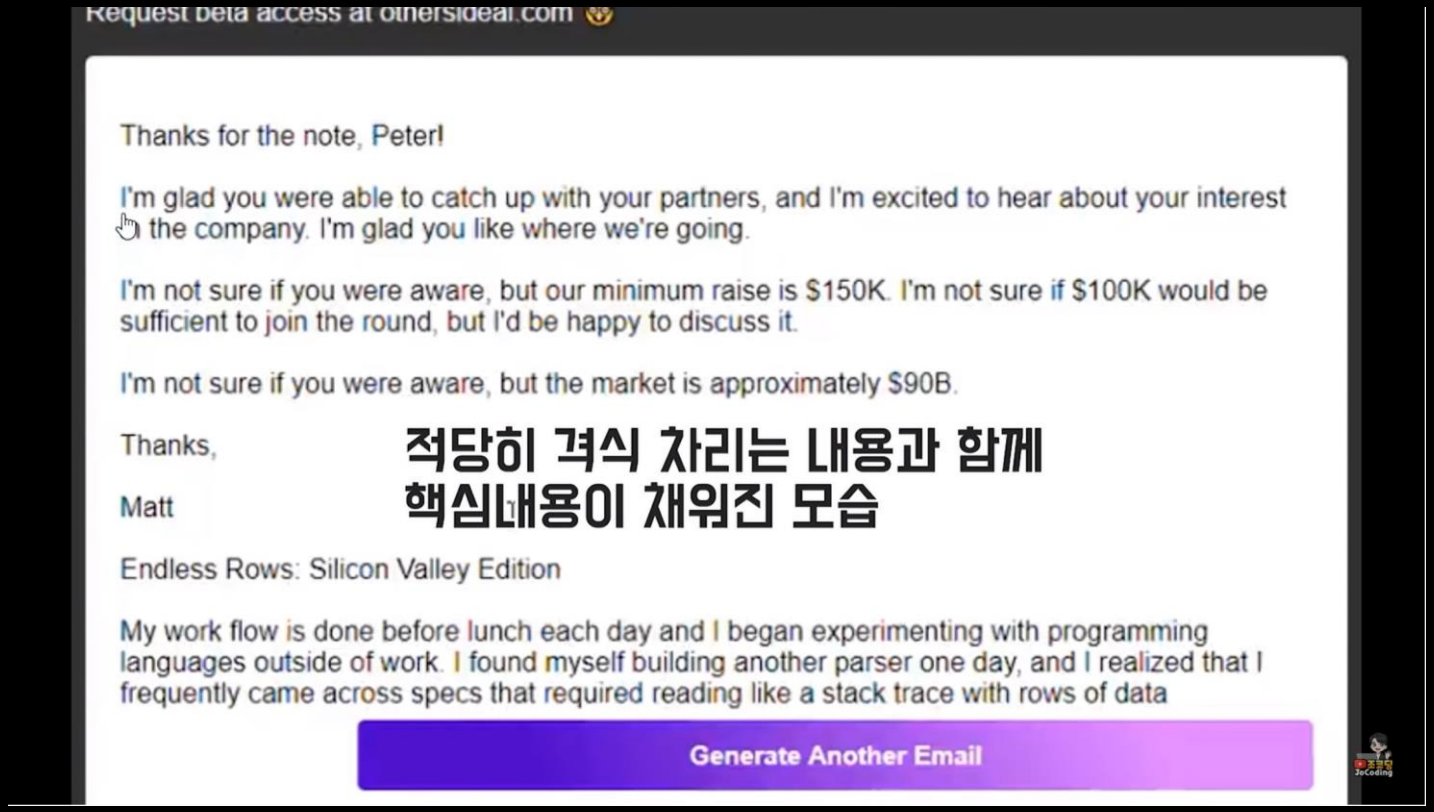
학습된 GPT-3 모델의 성능

3) 이메일 회신을 하고자 할 때 핵심 키워드만 입력하면,

대규모 – 20대+ GPU 서버 구성

학습된 GPT-3 모델의 성능

3) 이메일 회신을 하고자 할 때 핵심 키워드만 입력하면, 자동으로 격식 차려진 이메일 작성



대규모 – 20대+ GPU 서버 구성

- 지난 7월 NVIDIA 기사에 따르면, OpenAI 기관이 아래와 같은 규모의 시스템(Microsoft Azure)을 사용해서 GPT-3 모델을 훈련시키는데 성공했다고 합니다.
  - ✓ 285,000 CPU cores
  - ✓ 10,000 GPUs (NVIDIA V100)
  - ✓ 400 gigabits per second of network connectivity for each GPU server

- ZDNet의 기사에 따르면, 업계에서는 GPU 1장을 갖고 GPT-3을 훈련시킬 경우, 약 355년이 걸릴 것이라고 합니다.

- V100 GPU 1만 장일 경우, 소요 시간?
- V100 GPU가 아닌 A100 GPU일 경우, 소요 시간?

대규모 – 20대+ GPU 서버 구성

참고 문서

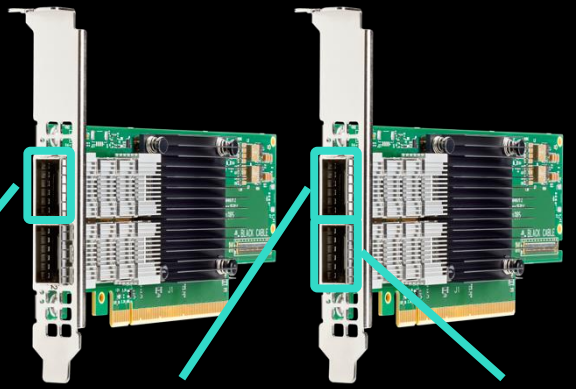
✓ HPE Apollo 6500 Gen10 Plus QuickSpecs (2020년 12월 버전)

✓ NVIDIA DGX SuperPOD Reference Architecture (2020년 11월 버전)

대규모 – 20대+ GPU 서버 구성

Network 구성 (예시)

Compute
(InfiniBand)

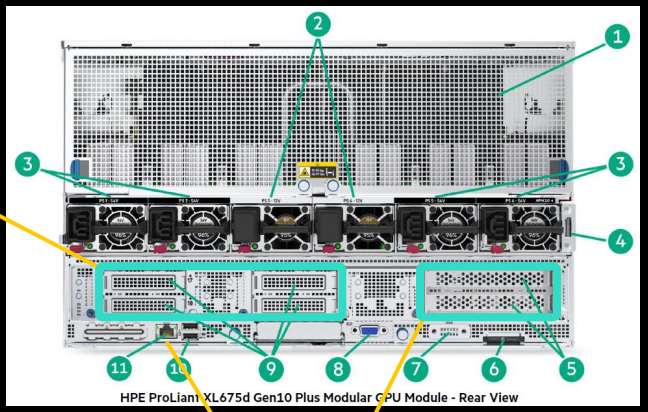


Storage
(InfiniBand)

Storage
(InfiniBand)

In-band
(100GbE)

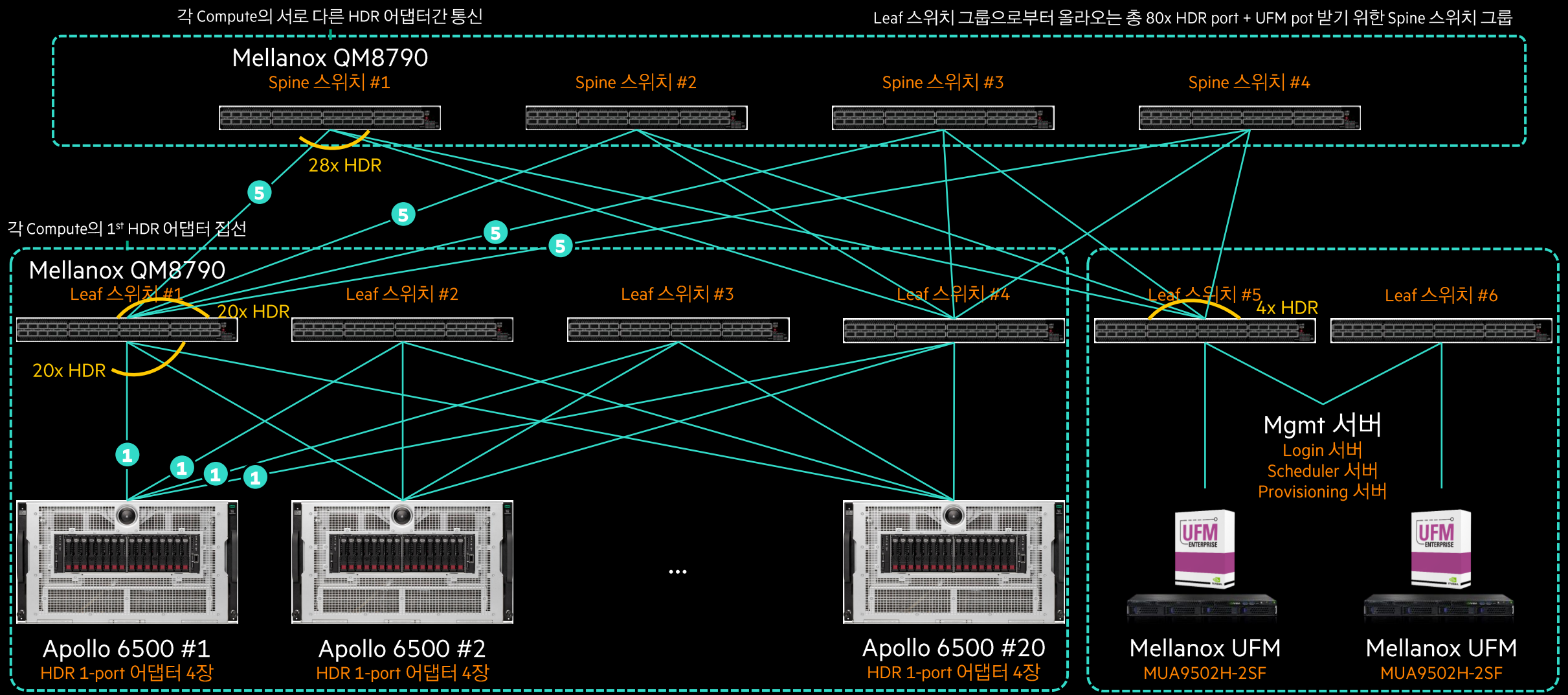
4x Mellanox ConnectX-6 1-port VPI
Compute Fabric (InfiniBand - HDR)



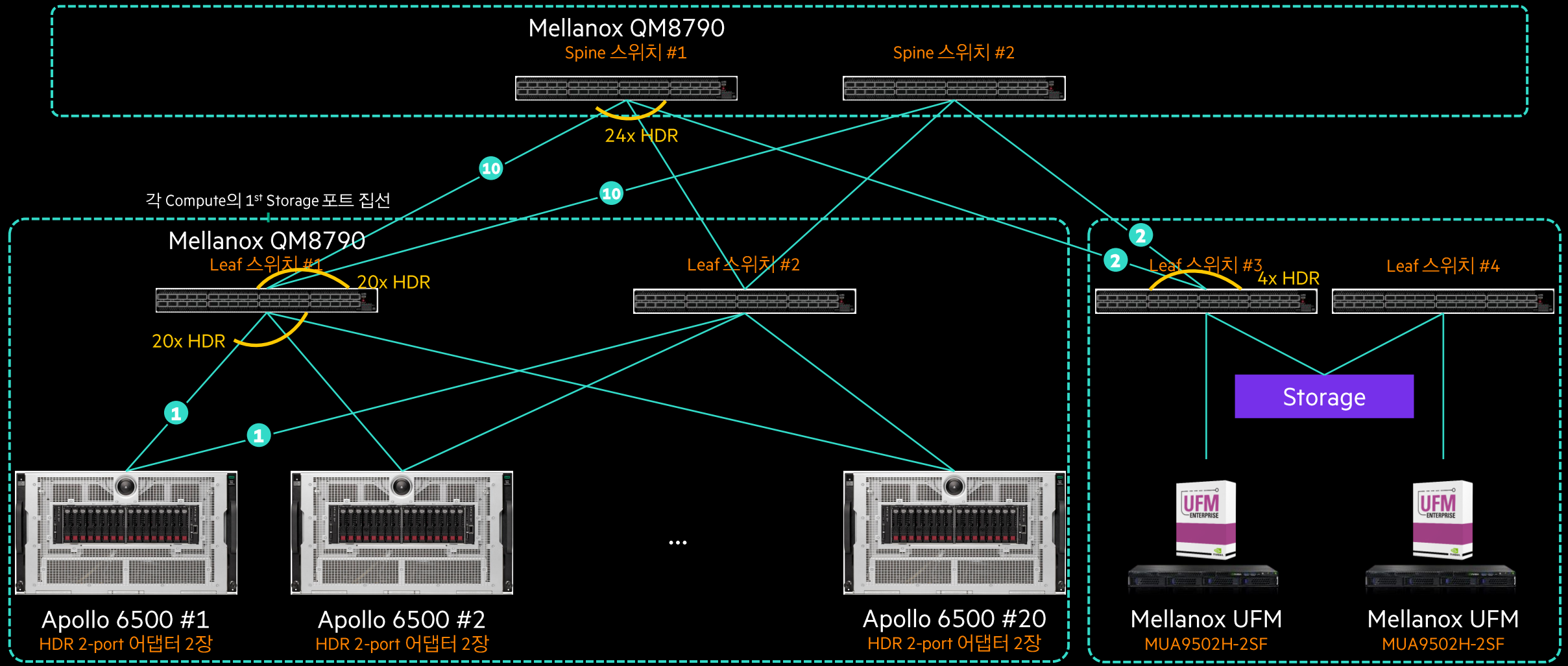
2x Mellanox ConnectX-6 2-port VPI
Storage Fabric (InfiniBand - HDR)
In-band management (Ethernet 100Gb)

iLO management port
Out-of-band management (1GbE)

대규모 – 20대+ GPU 서버 구성시 COMPUTE FABRIC ARCHITECTURE



대규모 – 20대+ GPU 서버 구성시 STORAGE FABRIC ARCHITECTURE



THANK YOU