



OPEN

Compute Project





Designing Hardware at the speed of Software

Vijay Rao

Technologist, Facebook

OPEN HARDWARE.

OPEN SOFTWARE.

OPEN FUTURE.





An aerial photograph of a modern urban plaza with a geometric tile pattern, overlaid with a semi-transparent green filter. Several people are visible walking and cycling in the plaza. A large white text '7.5 Billion' is centered over the image.

7.5 Billion

An aerial photograph of a modern urban plaza with a geometric tile pattern, overlaid with a semi-transparent green filter. Several people are visible walking and cycling on the plaza. The text "7.5 Billion" is centered in white.

7.5 Billion

An aerial photograph of a modern urban plaza with a geometric tile pattern, overlaid with a semi-transparent green filter. Several people are visible walking and cycling on the plaza. The text "Give people the power to share and make the world more open and connected" is centered in white.

Give people the power to
share and make the world
more open and connected





1.86 Billion
on Facebook each month



1.2 Billion
on WhatsApp each month



1 Billion
on Messenger each month



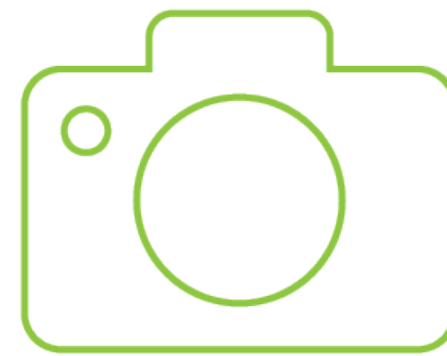
600 Million
on Instagram each month



Engagement at Scale



Videos



Photos



Messages

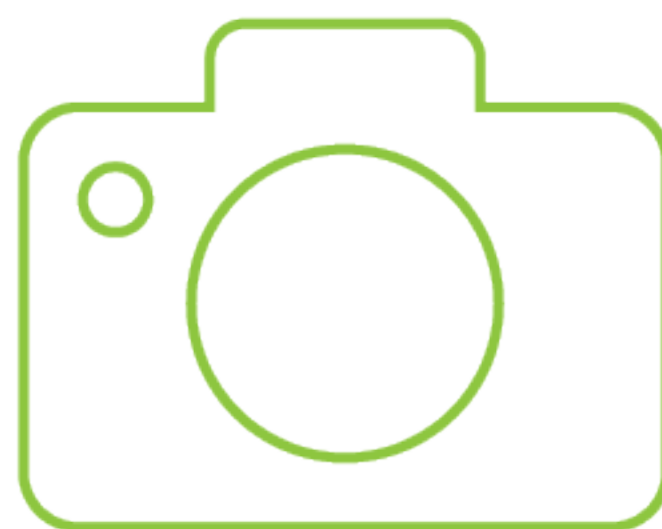


Comments



Likes

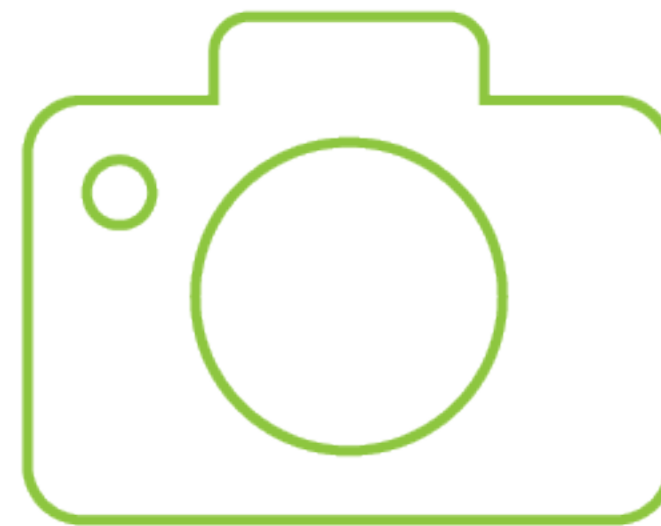






100 Million

hours of video watched
on Facebook daily



95+ Million

photos and videos posted
to Instagram daily

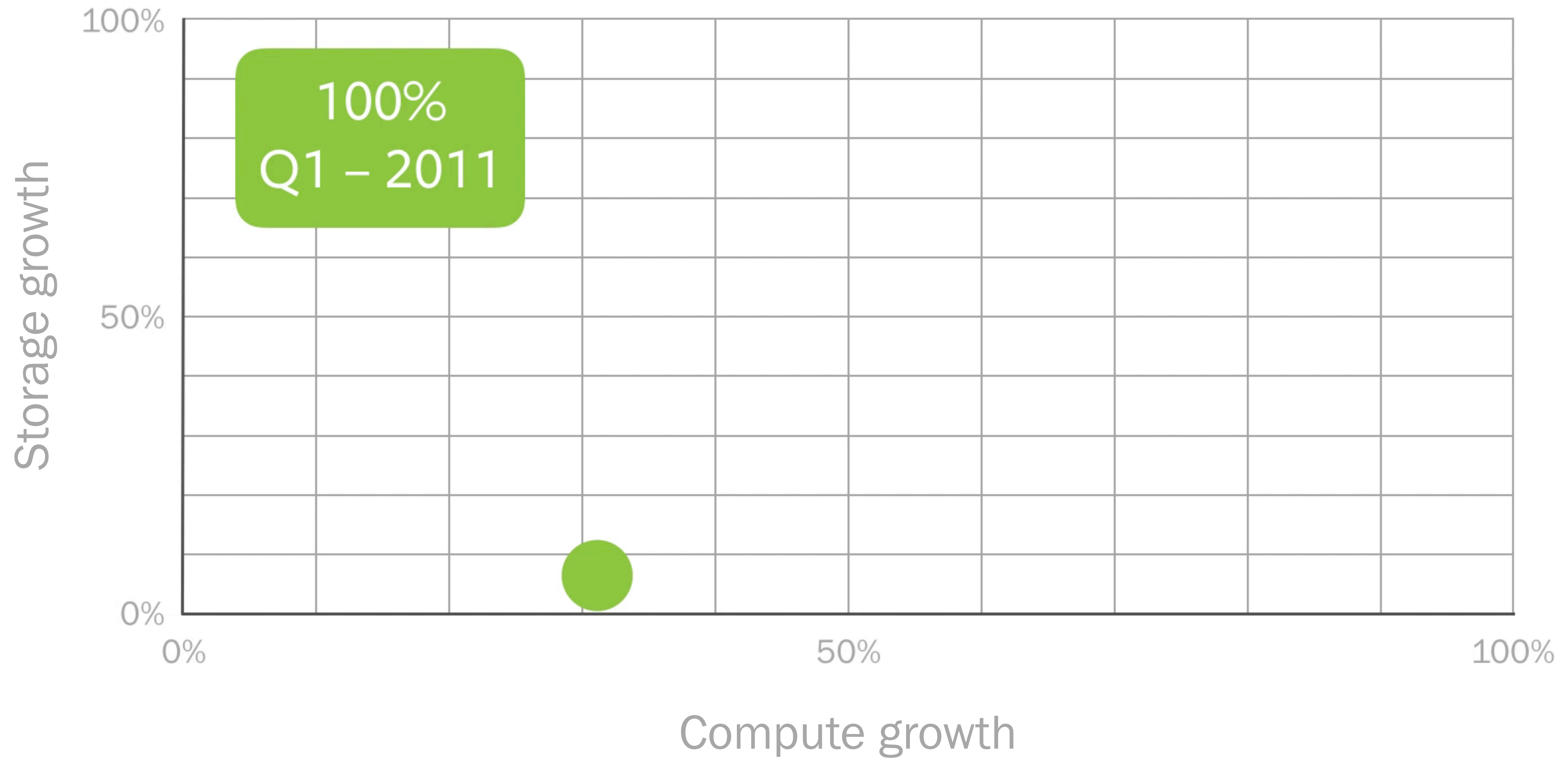


400 Million

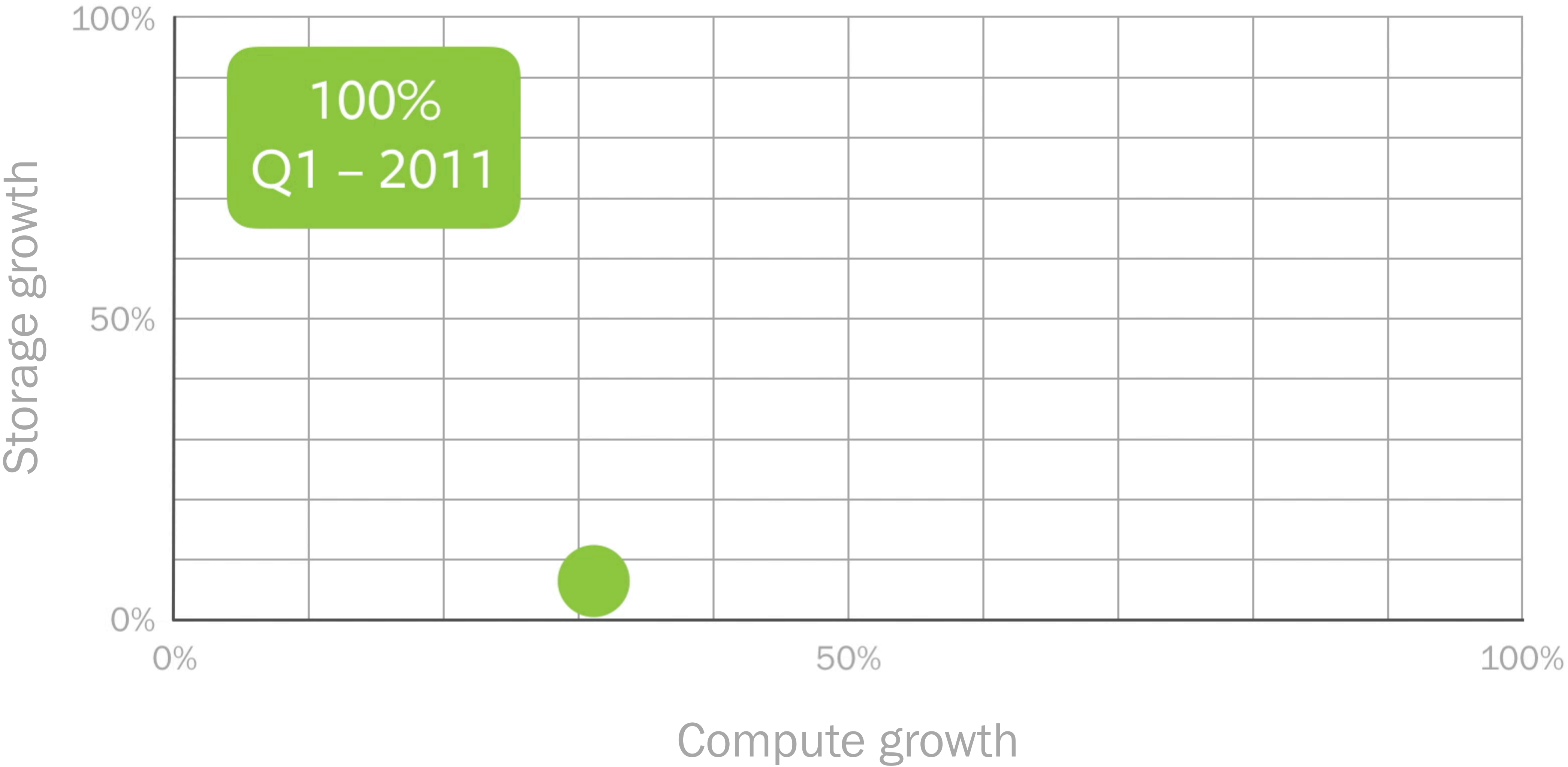
voice and video chat
on Messenger monthly



Video Growth



Video Growth



Oct 26

Nov 2

Nov 9

Nov 16

Nov 23

Nov 30

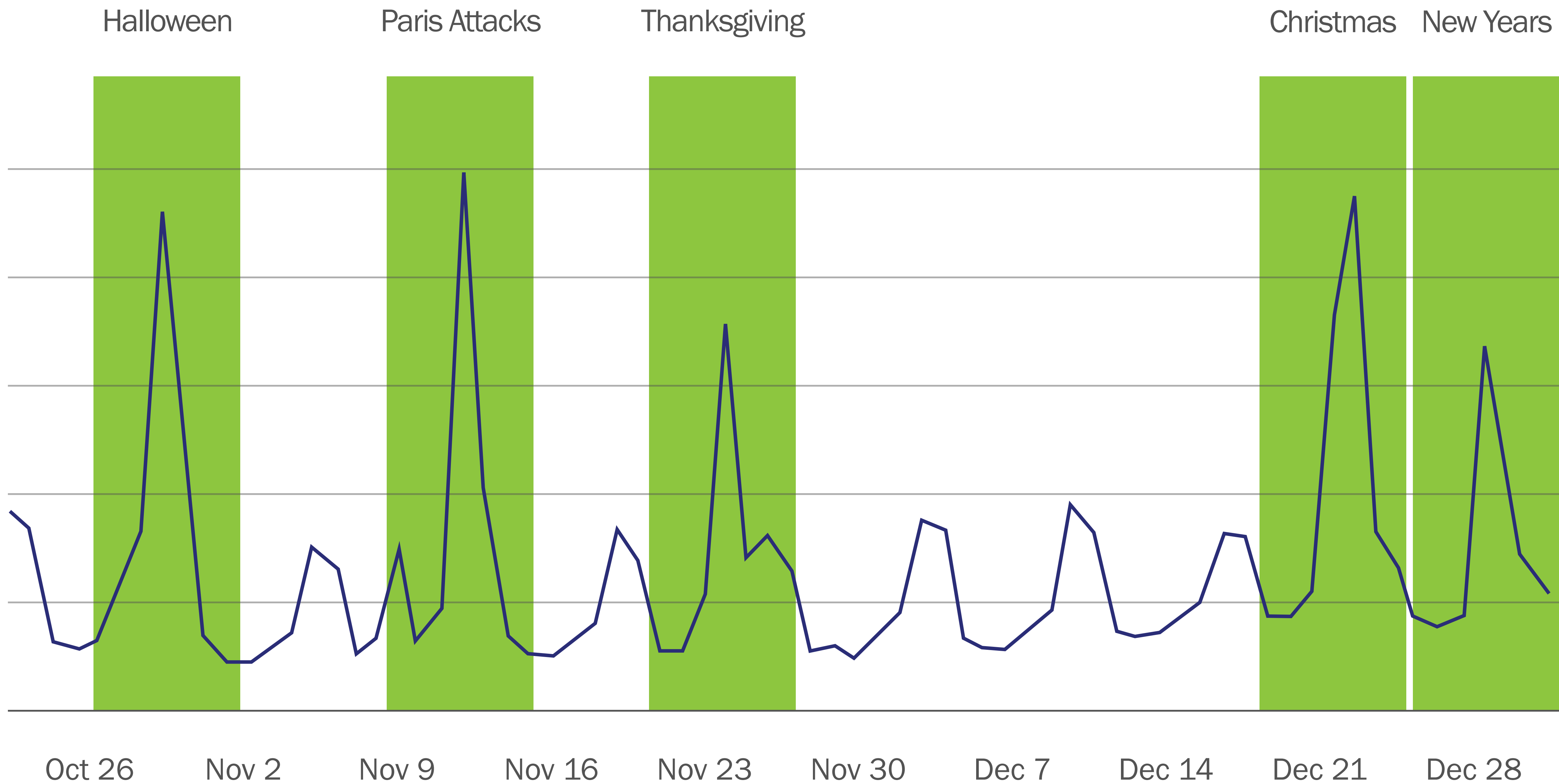
Dec 7

Dec 14

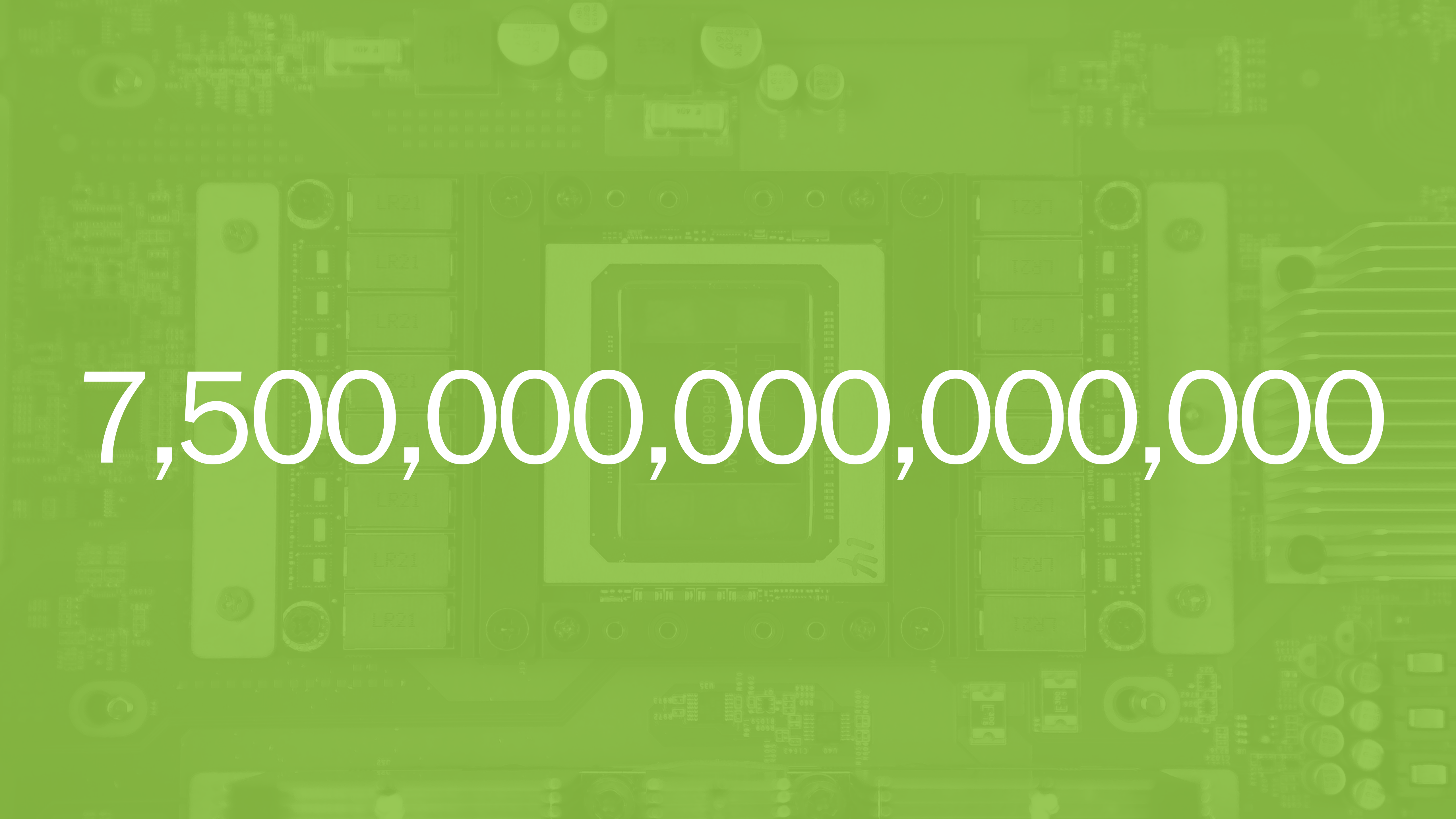
Dec 21

Dec 28

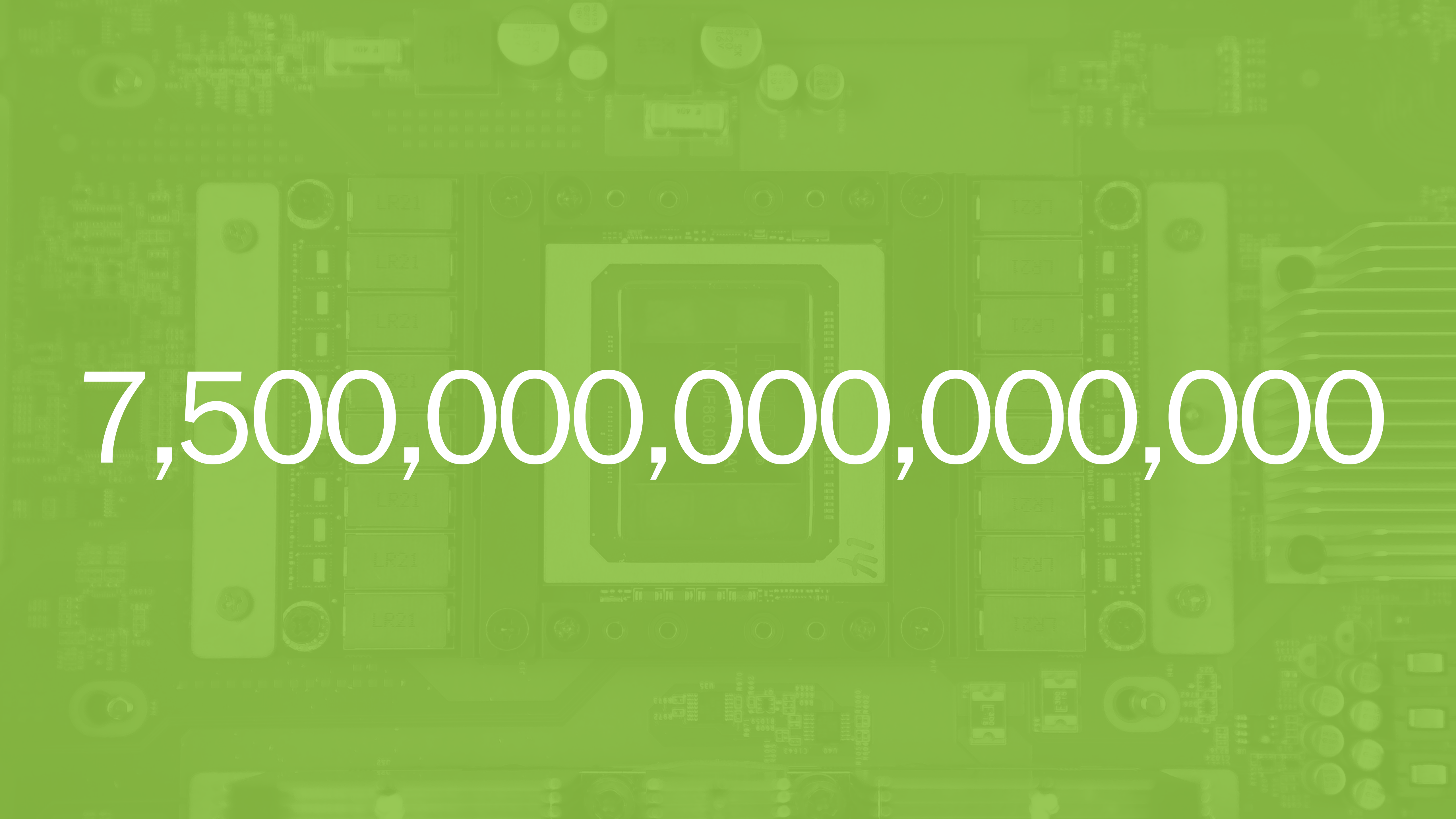
*Q4-2015



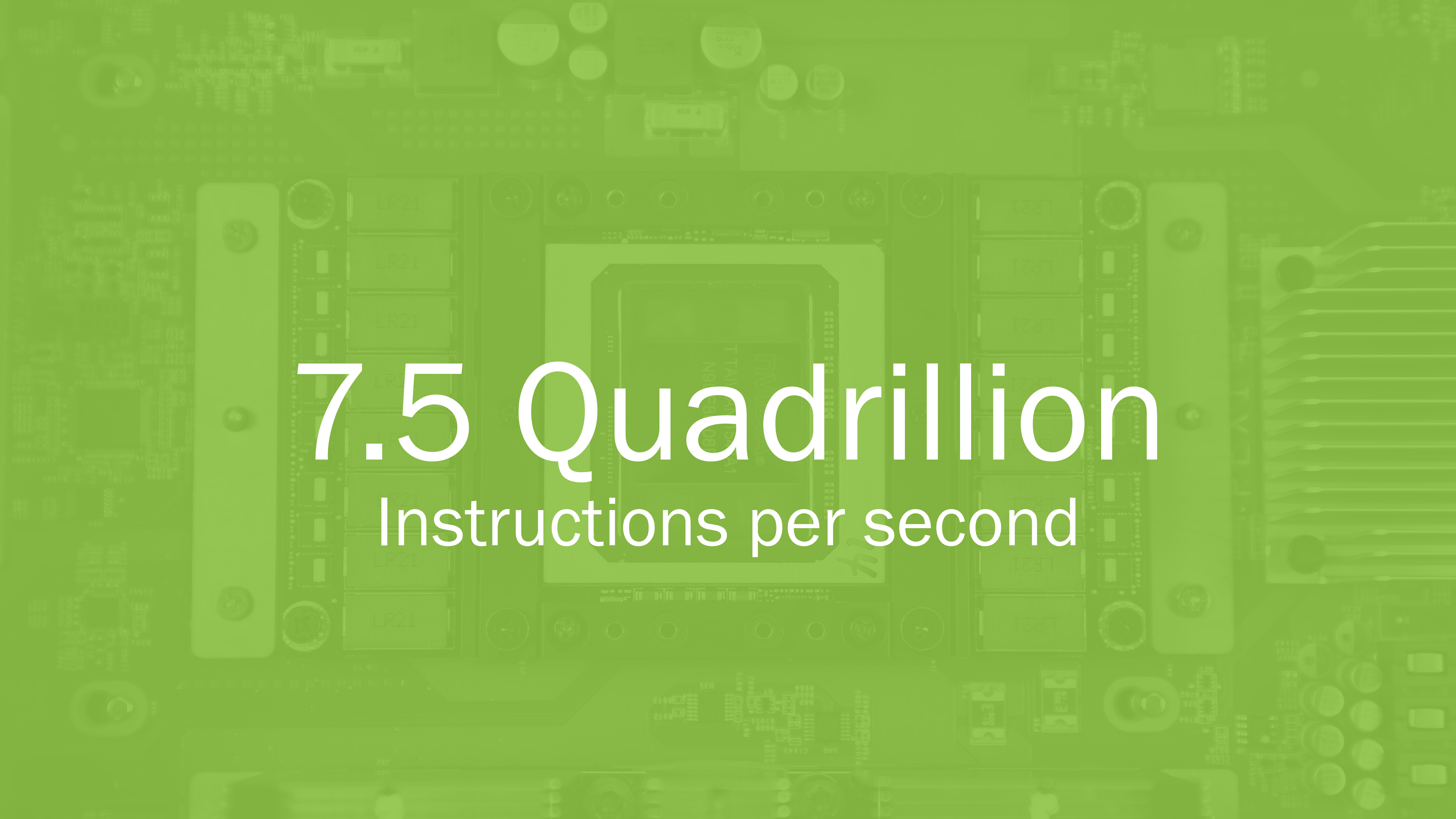
*Q4-2015



7,500,000,000,000,000,000



7,500,000,000,000,000,000



7.5 Quadrillion

Instructions per second



facebook

10 YEAR ROADMAP



Why OCP works



Why OCP works



Unlocks Hardware



Increase Innovation



Unlock Software from Hardware

NOS for OCP
networking devices

Software Defined
Storage on OCP gear

OpenStack and Linux
OS for OCP gear

NOS for OCP
networking devices

Software Defined
Storage on OCP gear

OpenStack and Linux
OS for OCP gear

 CUMULUS

 snaproute

NOS for OCP
networking devices

Software Defined
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Software Defined
Storage on OCP gear



NetApp™



OpenStack and Linux
OS for OCP gear

NOS for OCP
networking devices

 CUMULUS

 snaproute

Software Defined
Storage on OCP gear



NetApp™



OpenStack and Linux
OS for OCP gear

NOS for OCP
networking devices

 CUMULUS

 snaproute

Software Defined
Storage on OCP gear



NetApp™



OpenStack and Linux
OS for OCP gear

CANONICAL





Data Center



Triplet Rack



Battery Cabinet



Freedom Servers



Spitfire Server (AMD)



Power Supply



Windmill (Intel)



Watermark (AMD)



Mezzanine Card v1



Knox



Group Hug



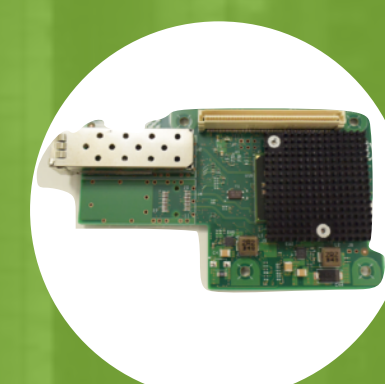
Open Rack v1



Winterfell



Open Rack v2



Mezzanine Card v2



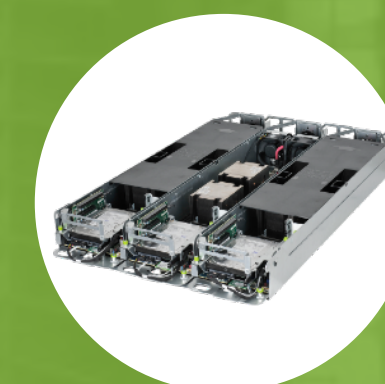
Cold Storage



Micro Server (Panther)



BluRay



Leopard



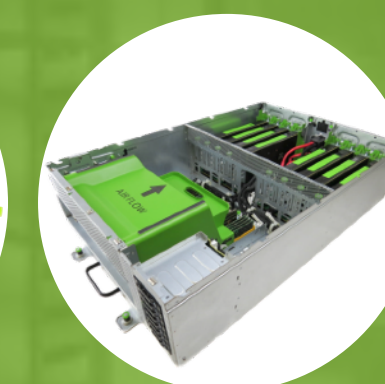
Honey Badger



Wedge



Wedge 100



Big Sur



6-pack



Backpack



Yosemite



Lightning

2011

2012

2013

2014

2015

2016



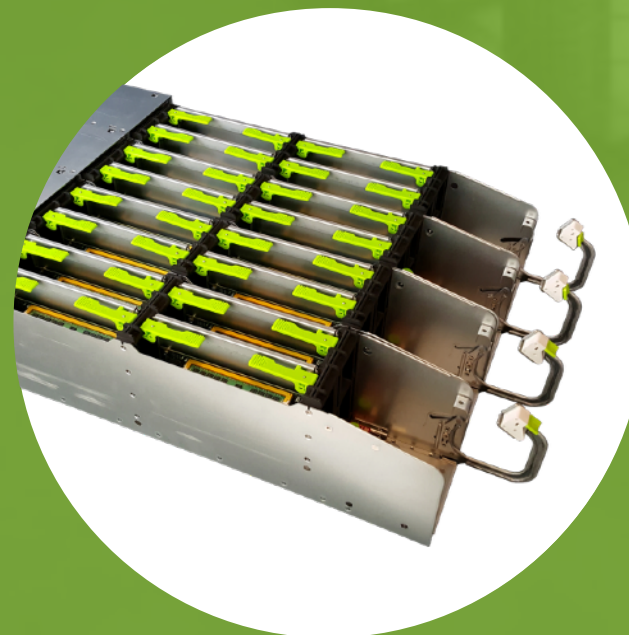
Wedge 100S



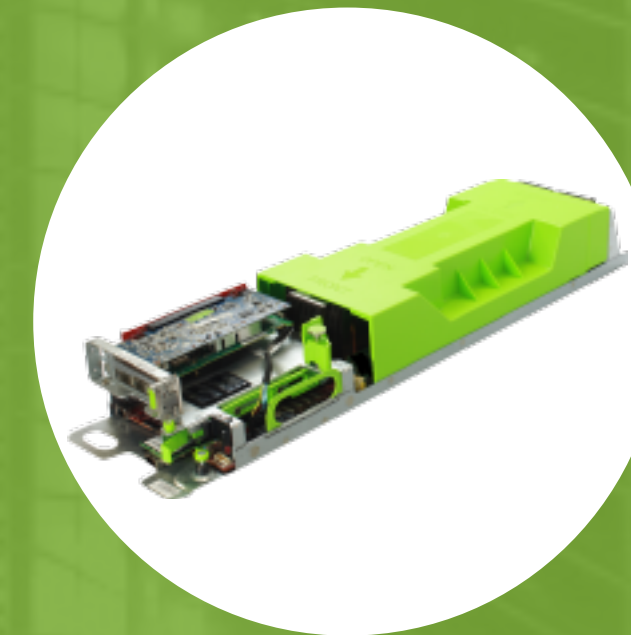
Big Basin



Bryce Canyon



Yosemite V2



Tioga Pass

2017

	TYPE I	TYPE III	TYPE IV	TYPE V	TYPE VI	TYPE VII
	WEB	DATABASE	HADOOP	PHOTOS	MULTIPLE SERVICES	COLD STORAGE
CPU	4 x Xeon D-proc	2 x Xeon E5-proc	2 x Xeon E5-proc	2 x Xeon E5-proc	2 x Xeon E5-proc	2 x Xeon E5-proc
MEMORY	32GB	256GB	128GB	32GB	256GB	256GB
STORAGE	1 x 500GB SATA	2 x 3.2TB PCIe Flash	15 x 4TB SAS	30 x 4TB SAS	1 x 2TB SATA	240 x 4TB SATA



Bryce Canyon

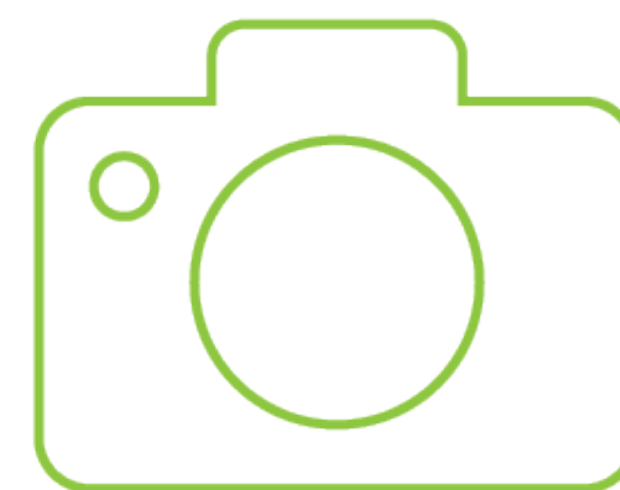
TYPE V

PHOTOS

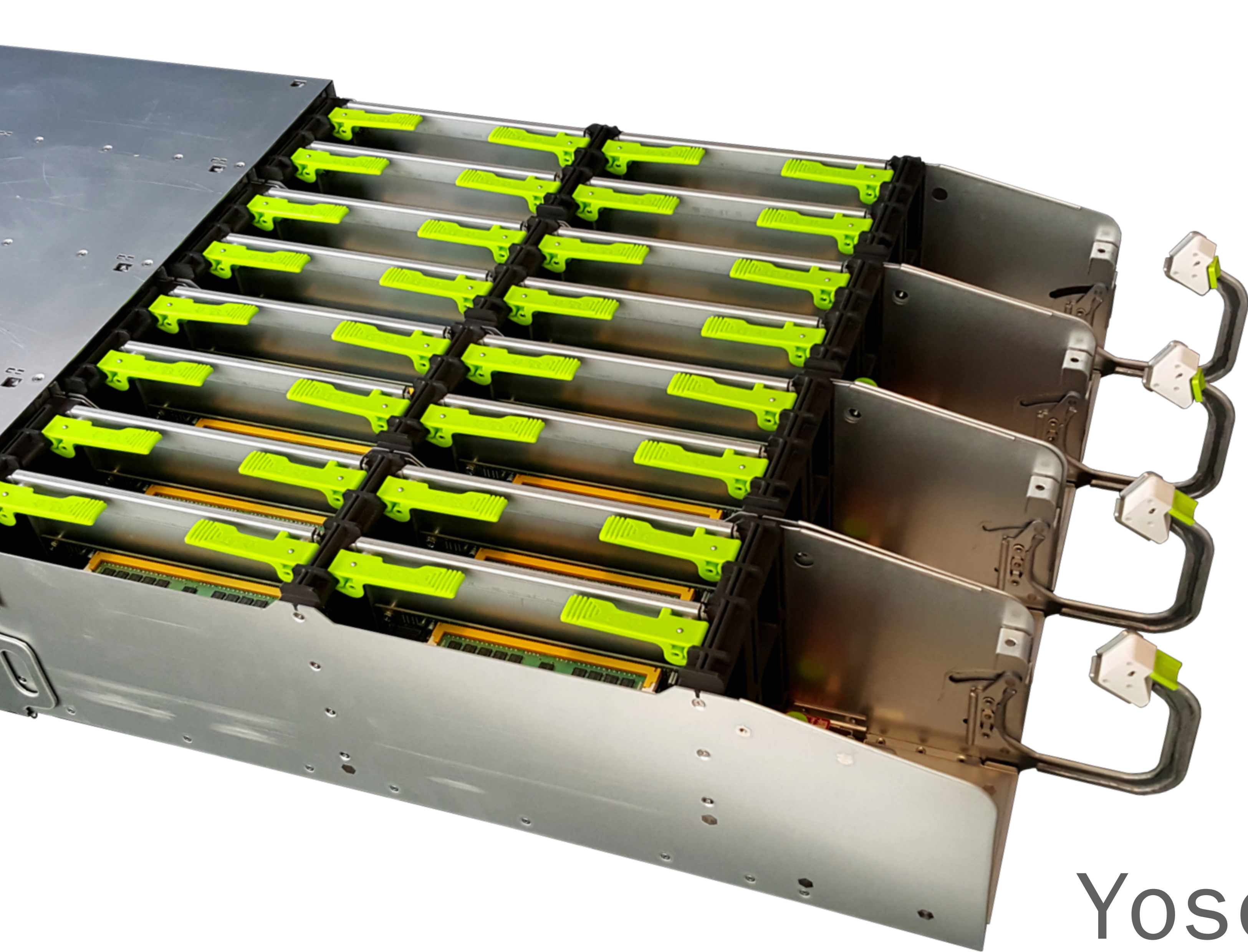
2 x Xeon
E5-proc

32GB

30 x 4TB
SAS







Yosemite

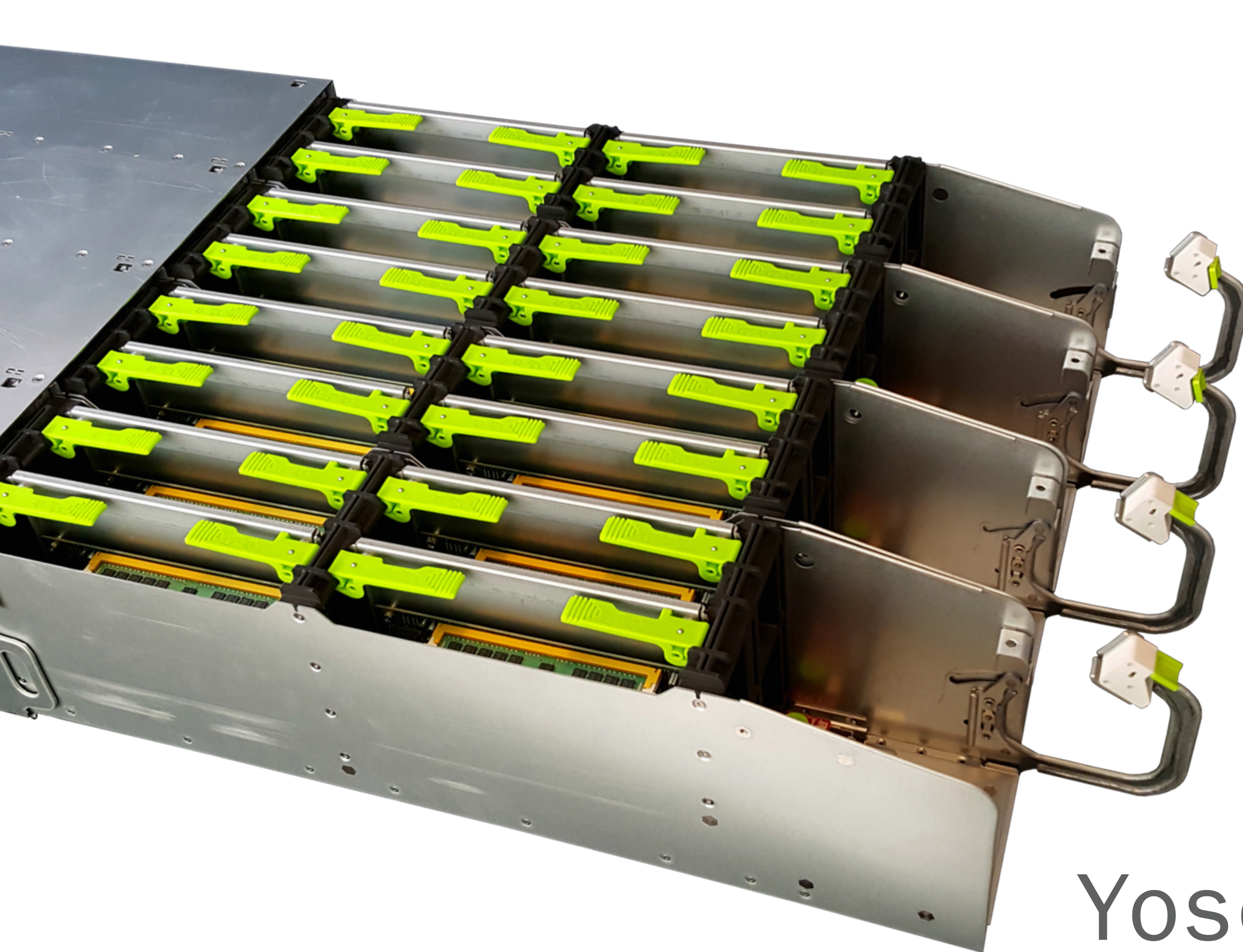
TYPE I

WEB

4 x Xeon
D-proc

32GB

1 x 500GB
SATA



Yosemite V.2

TYPE I

WEB

4 x Xeon
D-proc

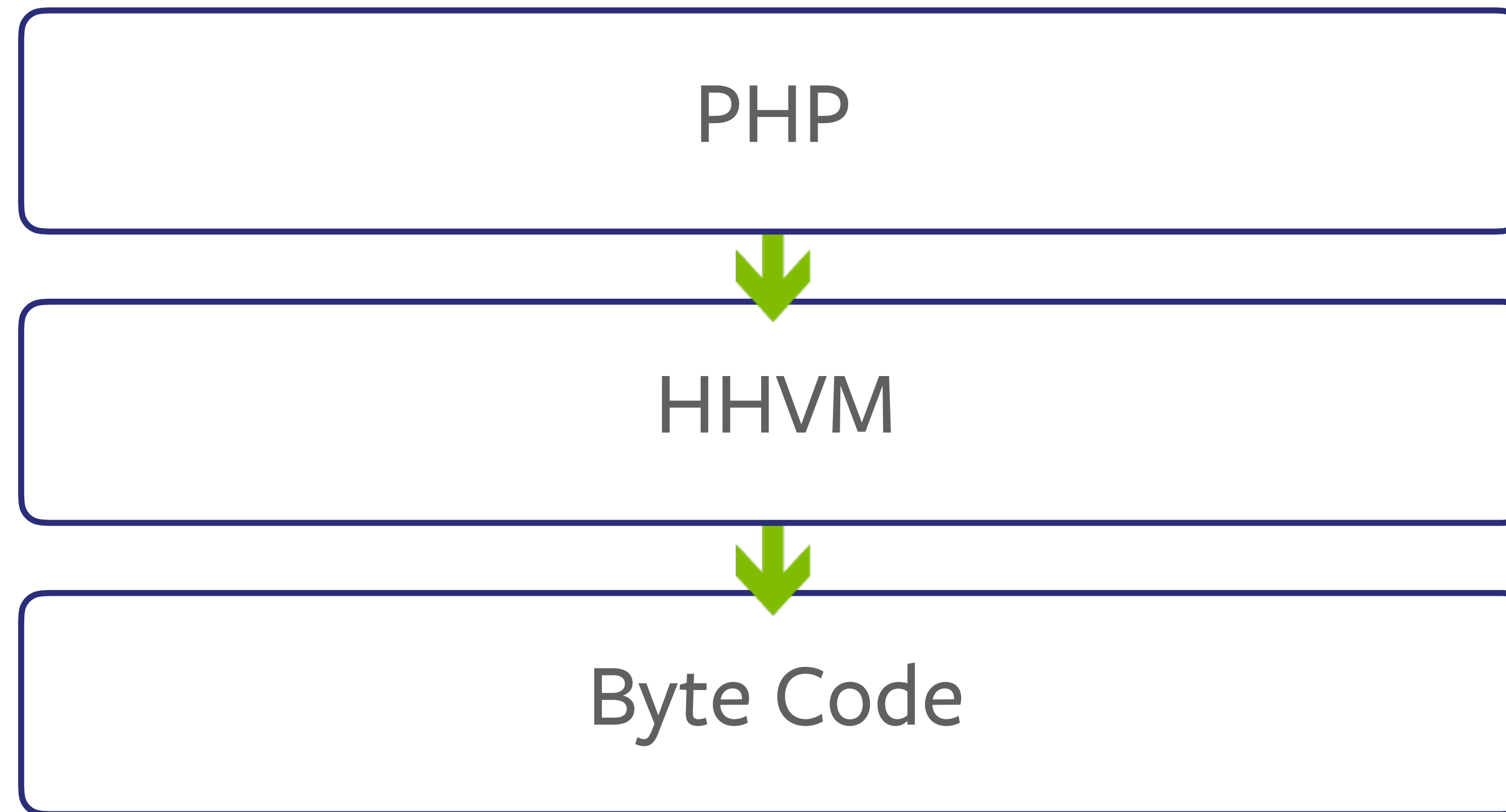
32GB

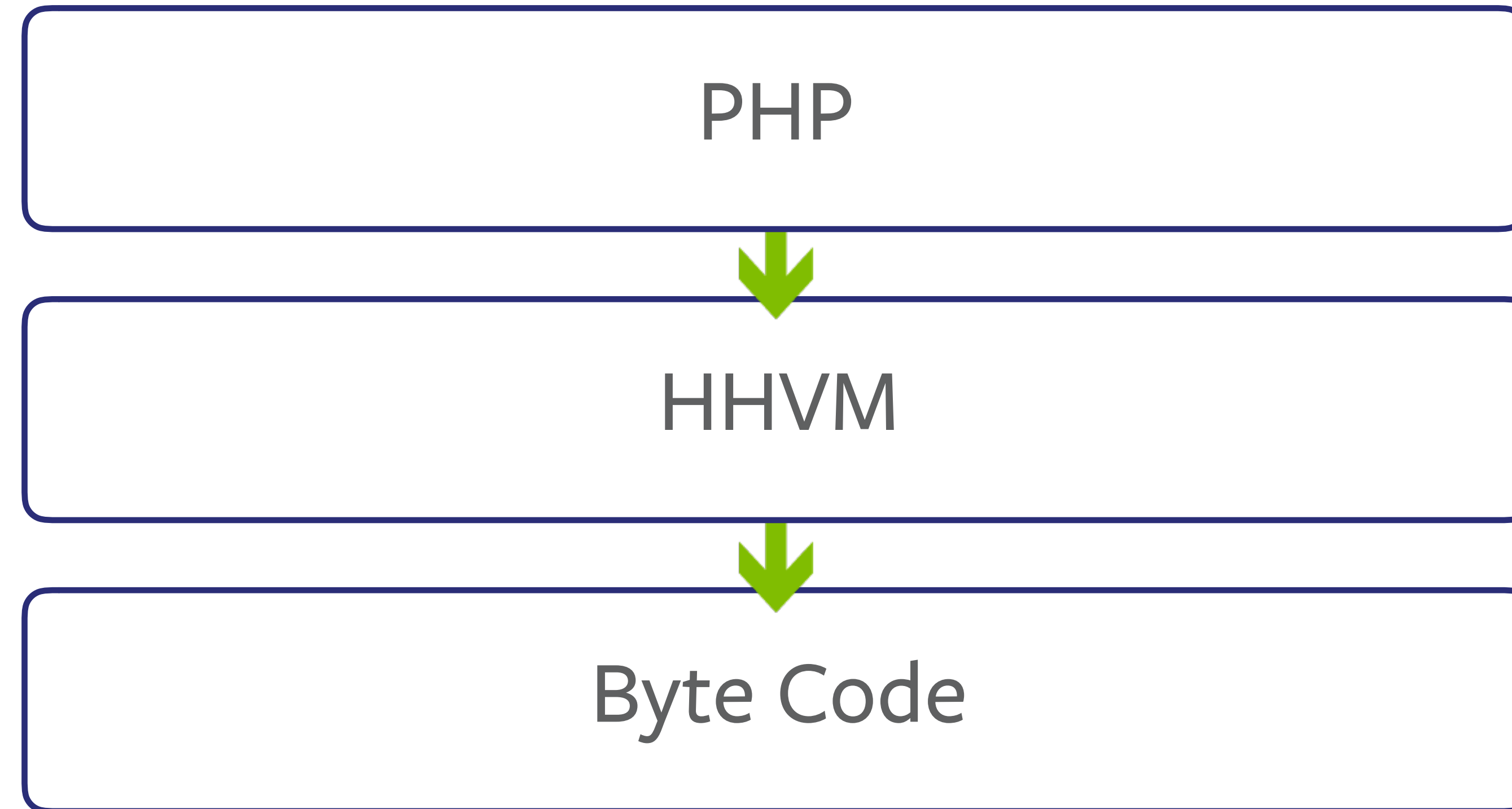
1 x 500GB
SATA

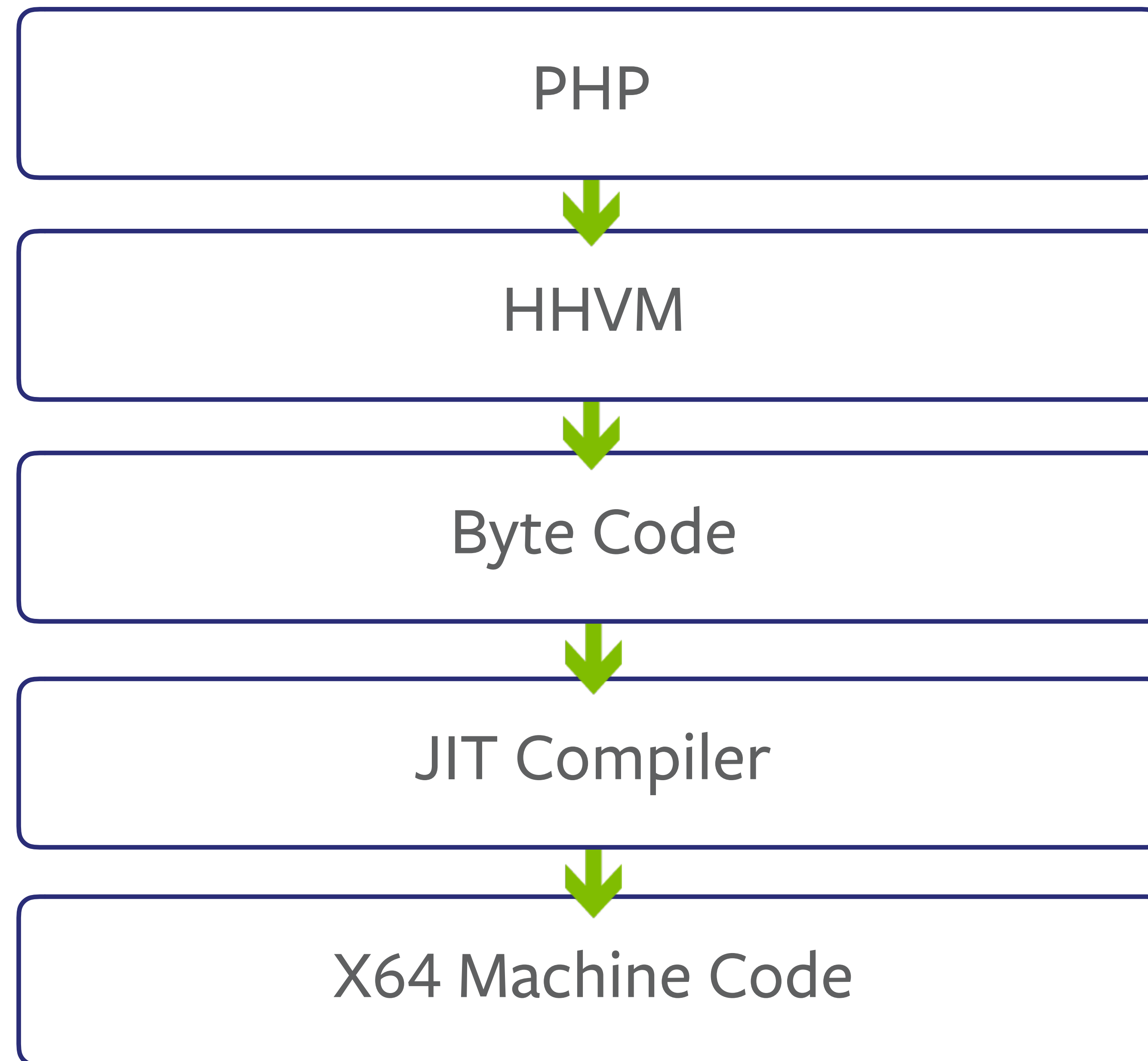


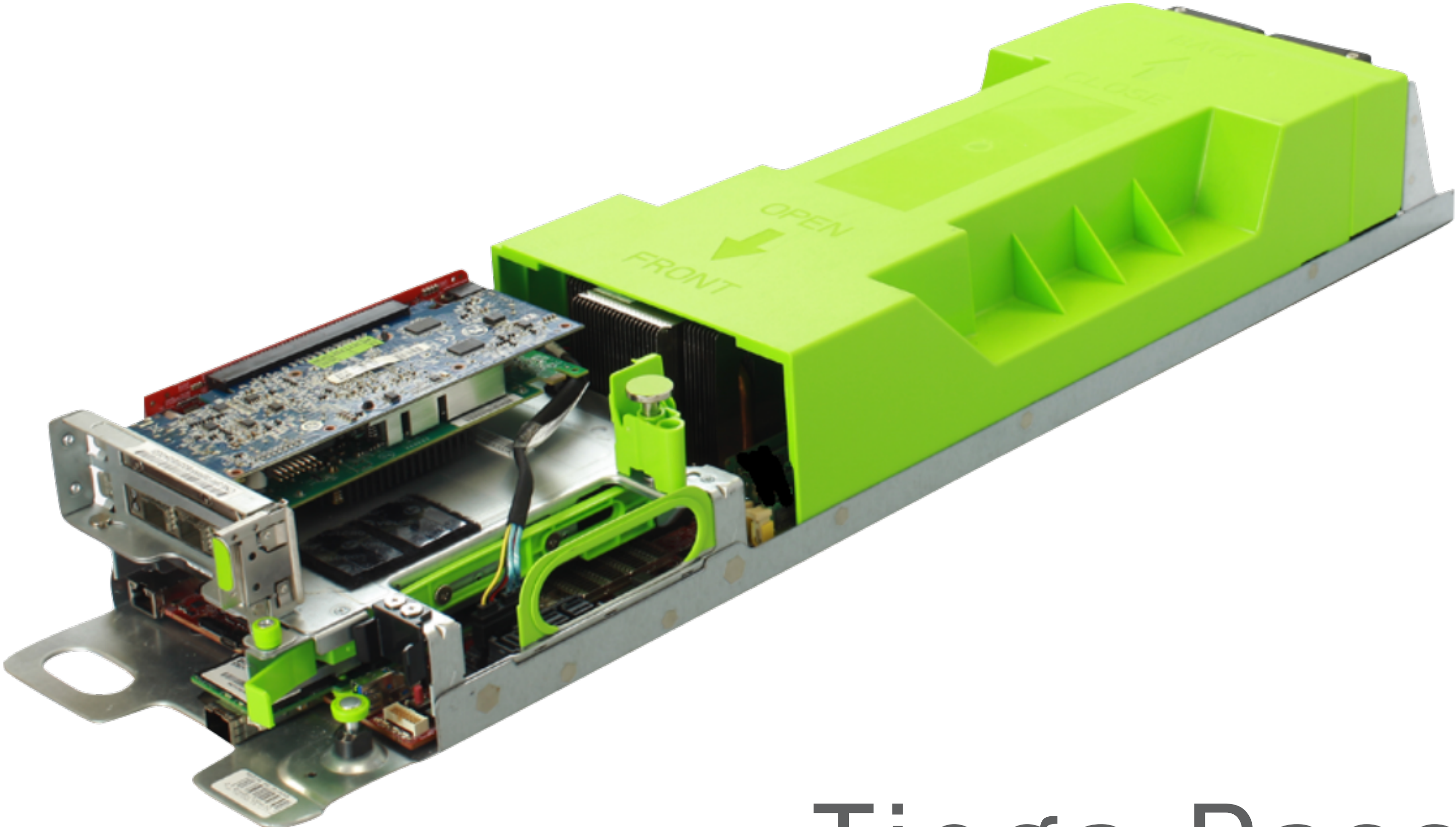
- Web Server
- Stateless
- Multi-Threaded
- Scaled out
- Optimized for Query
Latency & Throughput











Tioga Pass

TYPE III	TYPE VI
DATABASE	MULTIPLE SERVICES
2 x Xeon E5-proc	2 x Xeon E5-proc
256GB	256GB
2 x 3.2TB PCIe Flash	1 x 1.8TB PCIe Flash





RocksDB



- ➔ Low Latency DB access
- ➔ High Memory Capacity
- ➔ Medium Memory B/W
- ➔ Fast-Storage Media Optimized

- ➔ Key-Value Store
- ➔ Multi-Threaded
- ➔ High Network B/W
- ➔ High Compute

TYPE III	TYPE VI
DATABASE	MULTIPLE SERVICES
2 x Xeon E5-proc	2 x Xeon E5-proc
256GB	256GB
2 x 3.2TB PCIe Flash	1 x 2TB SATA

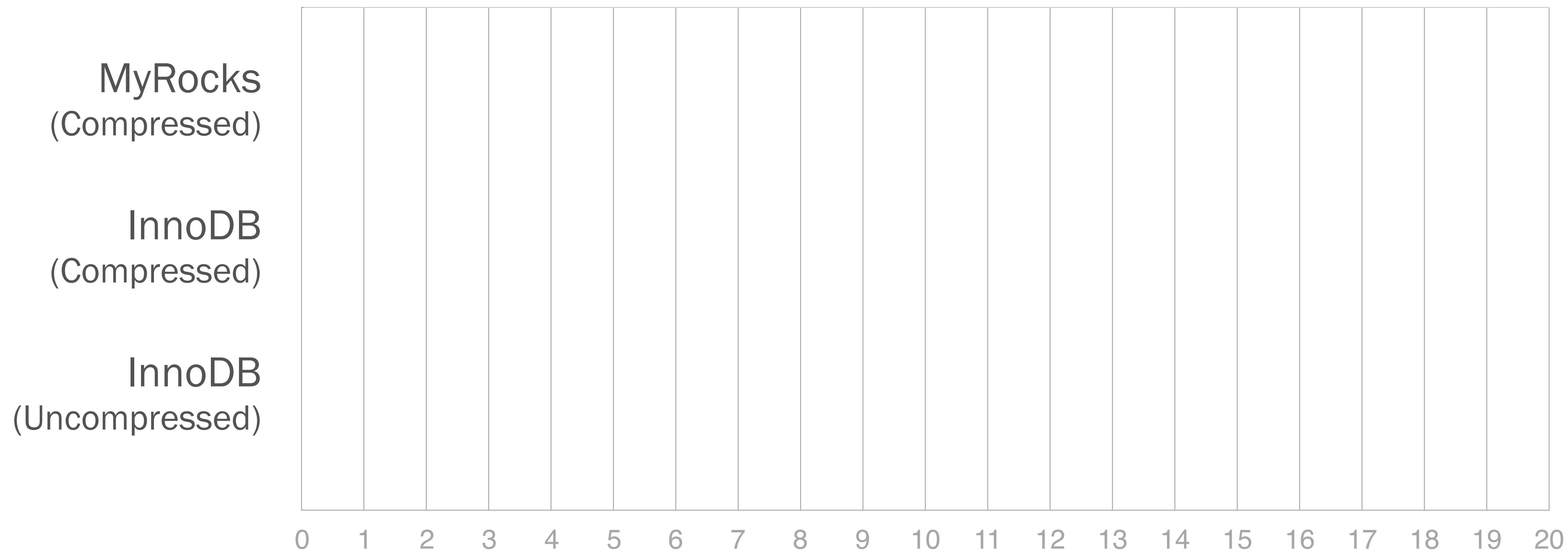


RocksDB



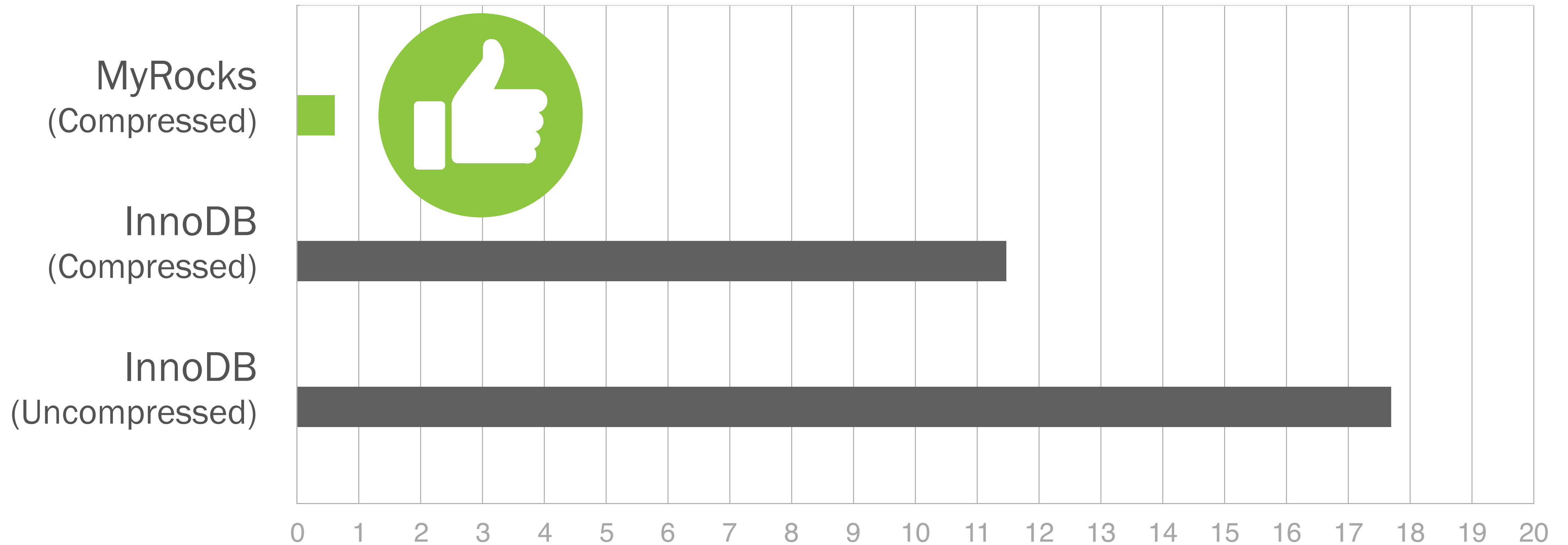
Write Amp (Bytes written per transaction)

Relative KB written per query

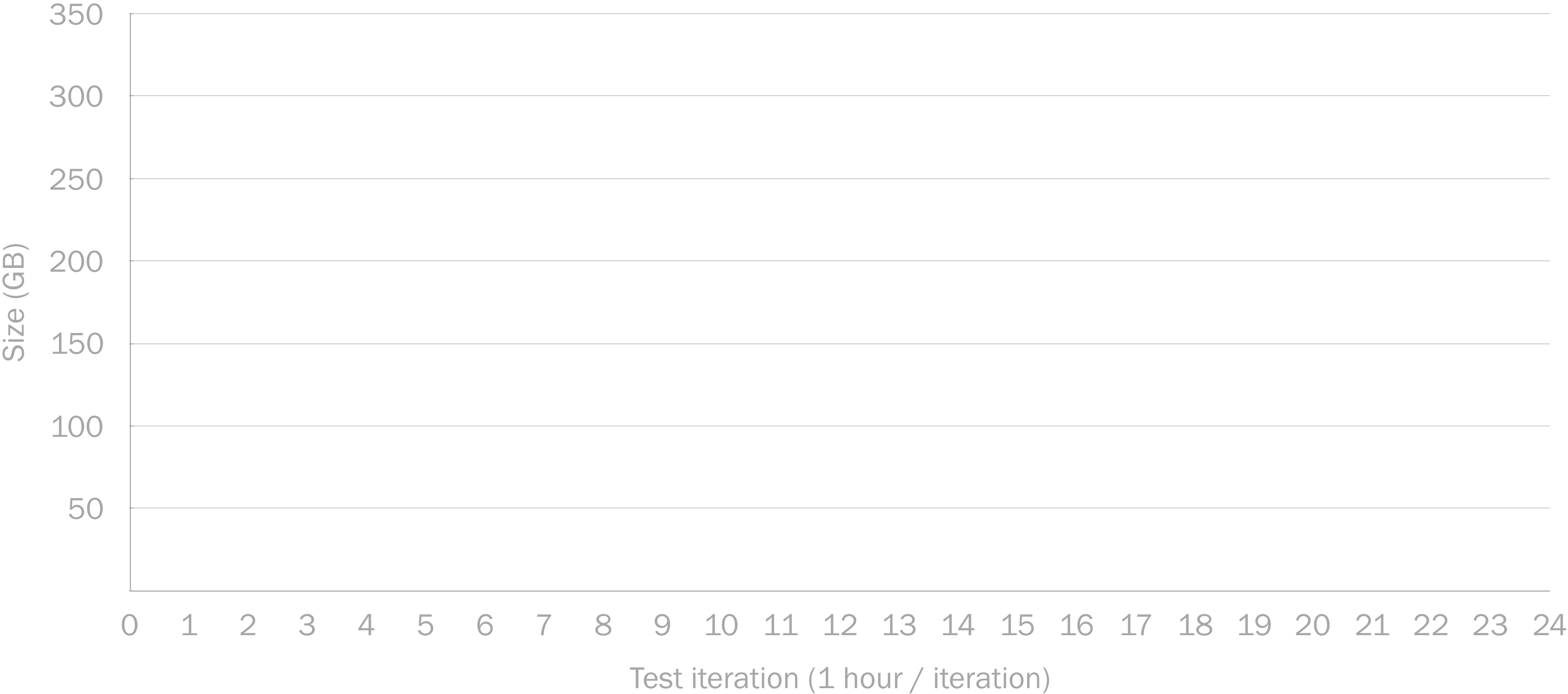


Write Amp (Bytes written per transaction)

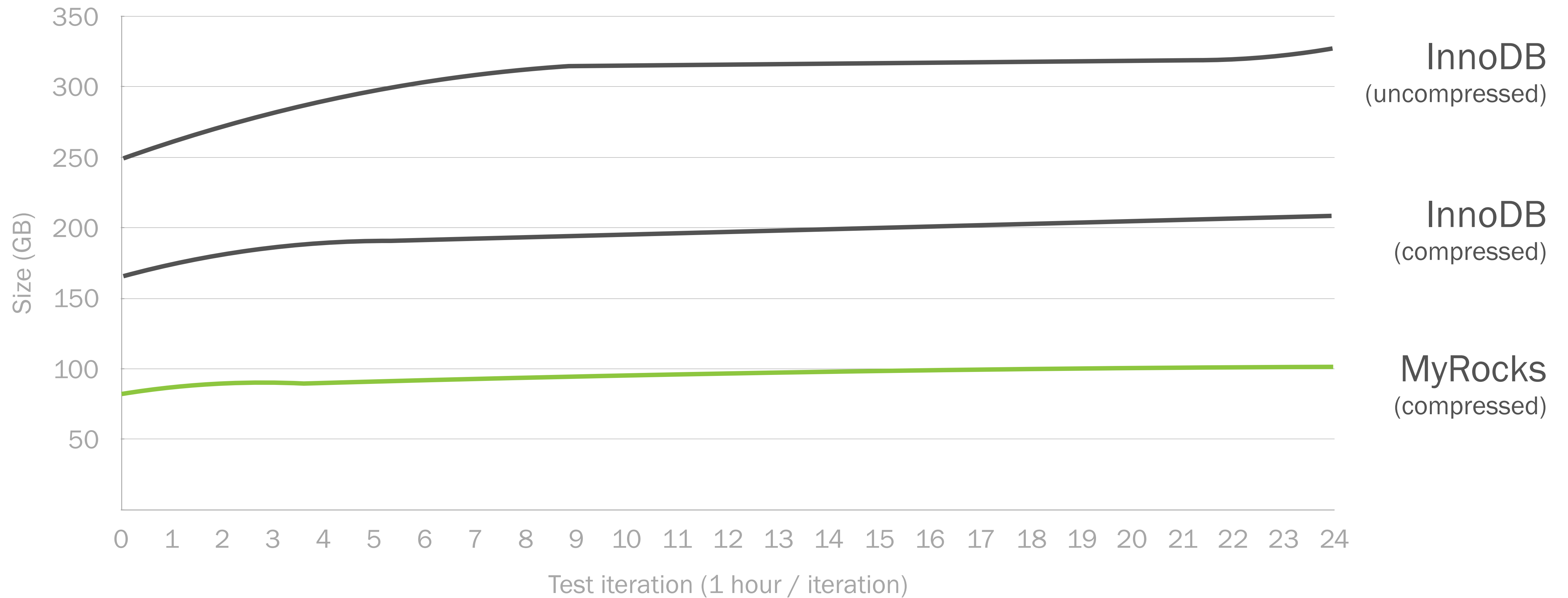
Relative KB written per query



Database Size (Compression)

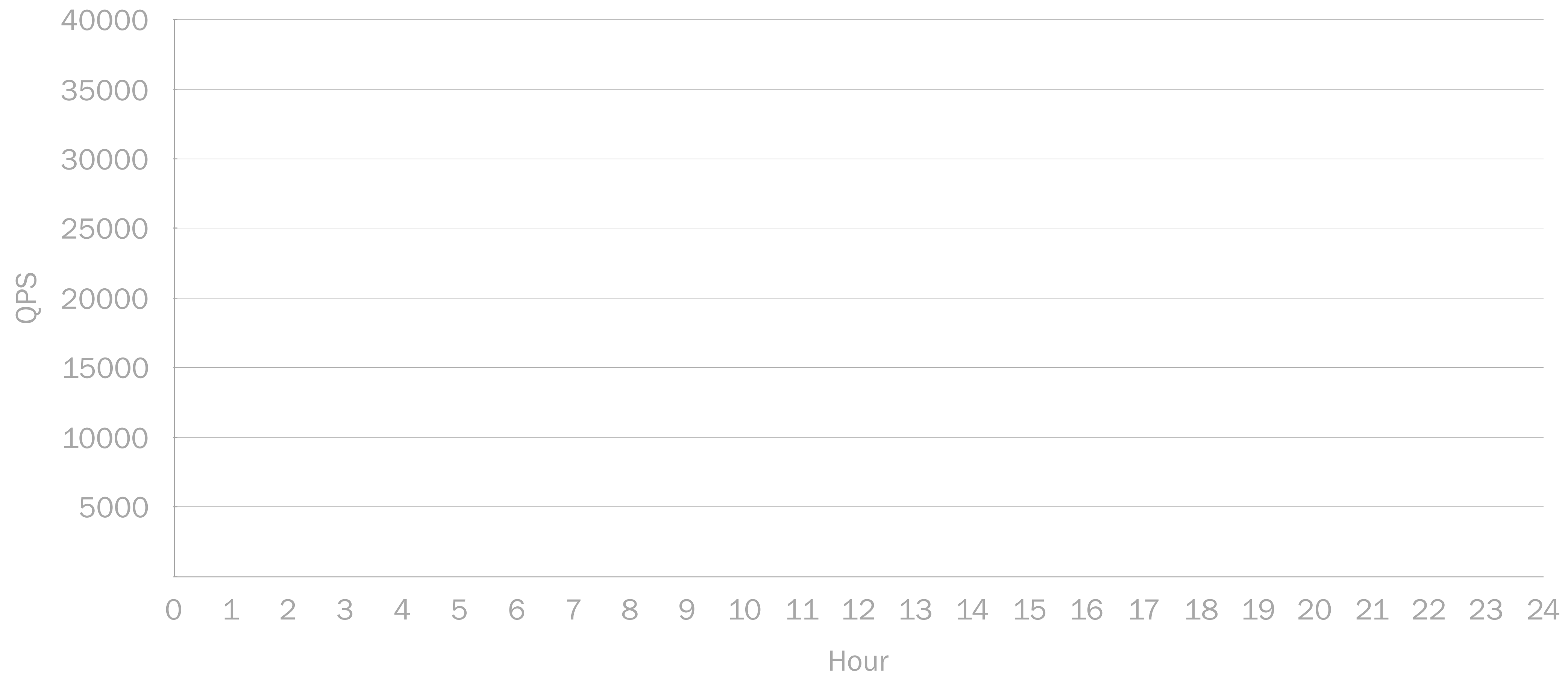


Database Size (Compression)



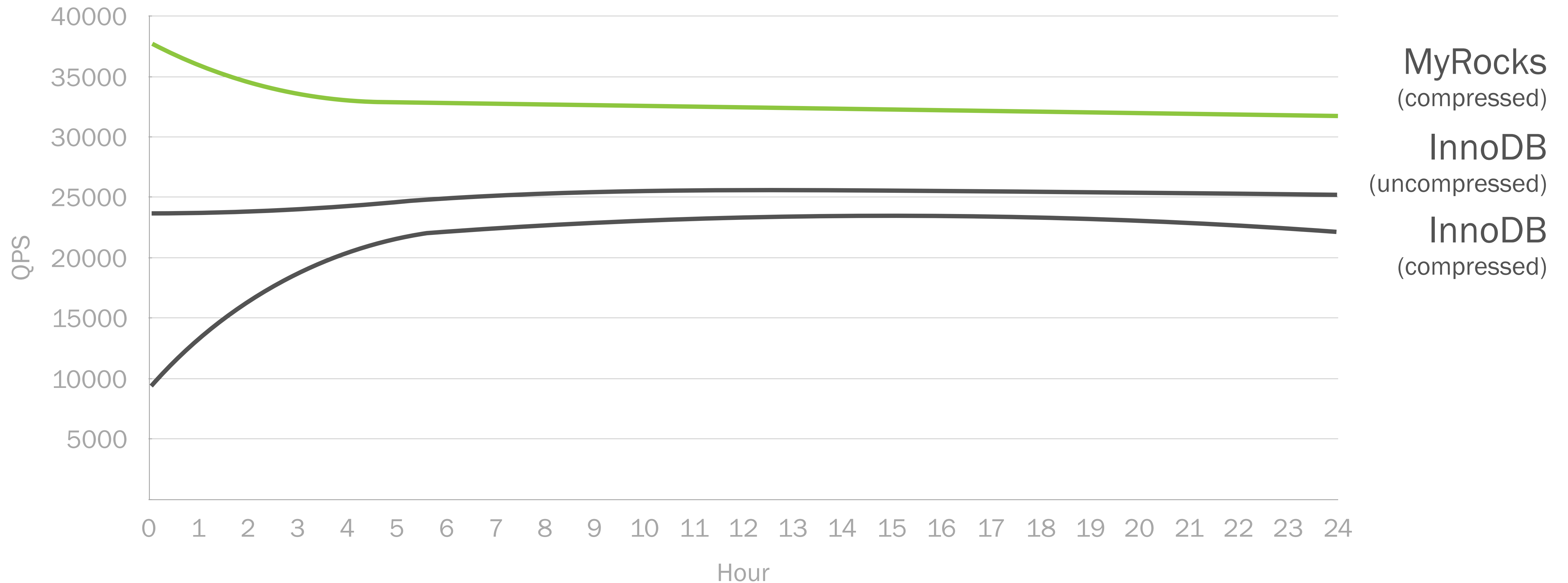
Transactions per second

Query rate, SSD, 20 clients, 24 hours



Transactions per second

Query rate, SSD, 20 clients, 24 hours



Migrating from InnoDB to MyRocks



50%

reduction in storage

Migrating from InnoDB to MyRocks



50%

Migrating from InnoDB to MyRocks



50%

Migrating from InnoDB to MyRocks



50%

reduction in MySQL servers

Why Disaggregate



Why Disaggregate

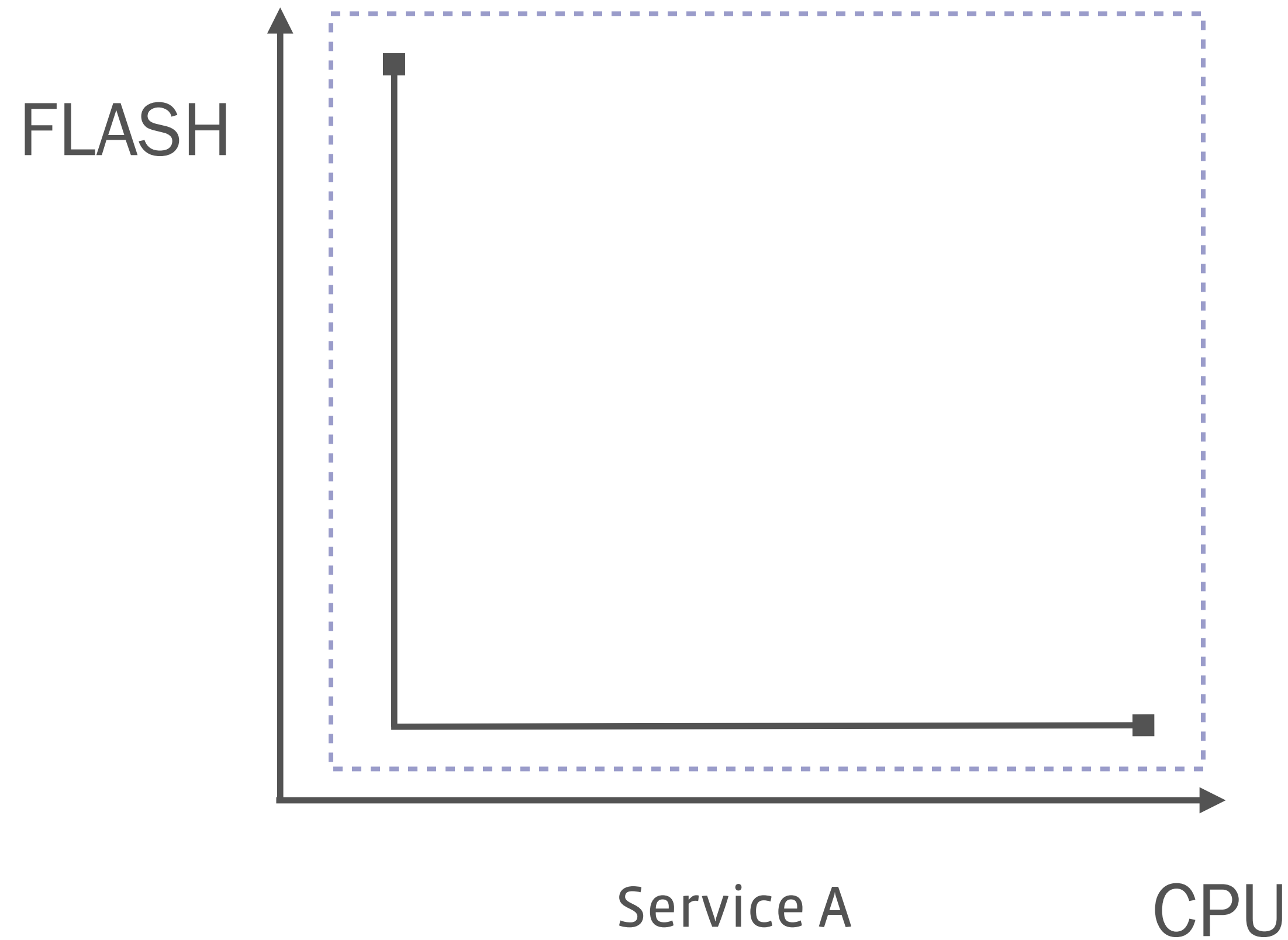


1. Increasing flash density
2. Reducing flash endurance
3. Workloads with varying TB/server

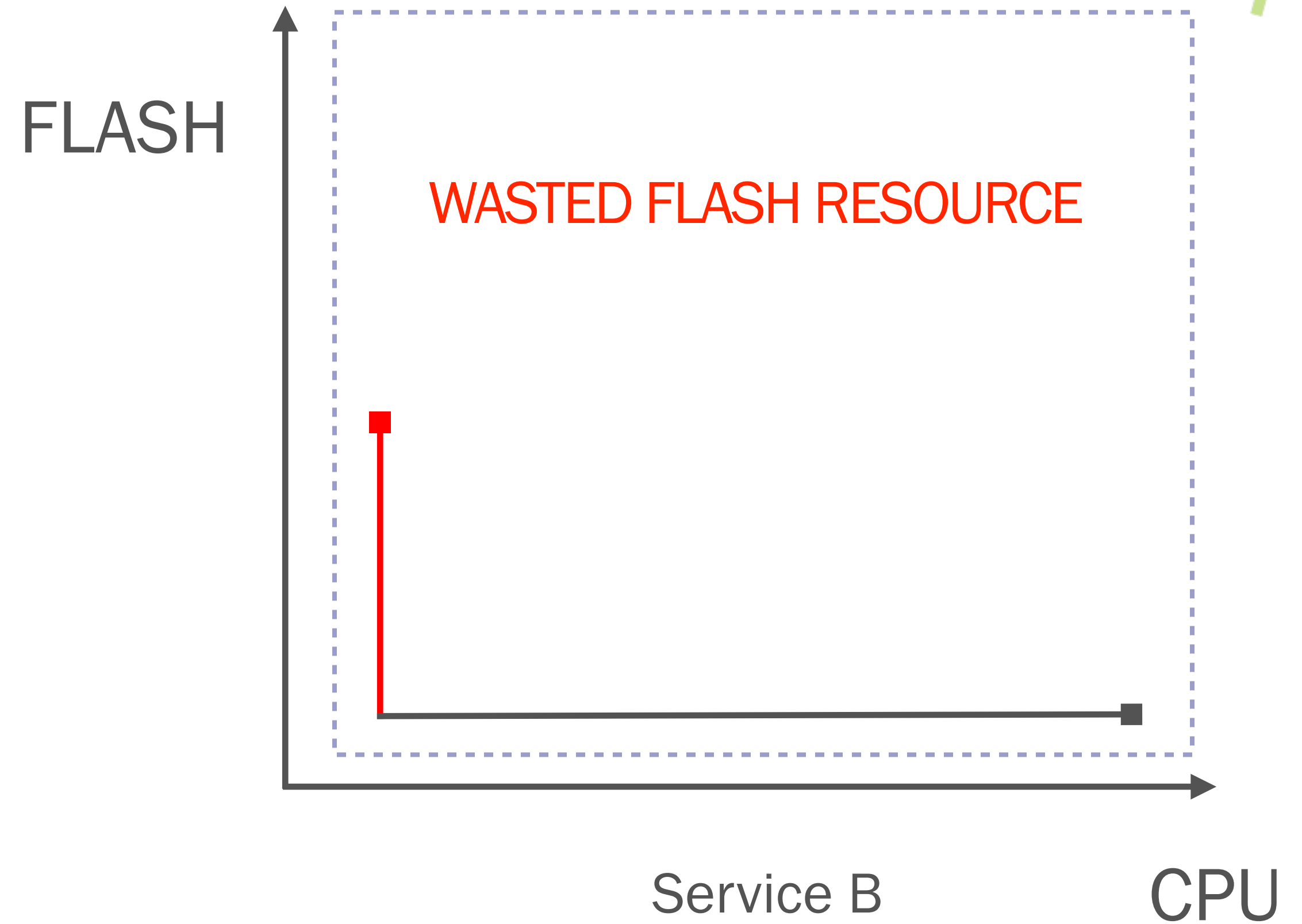
Server/Service Fit - across services



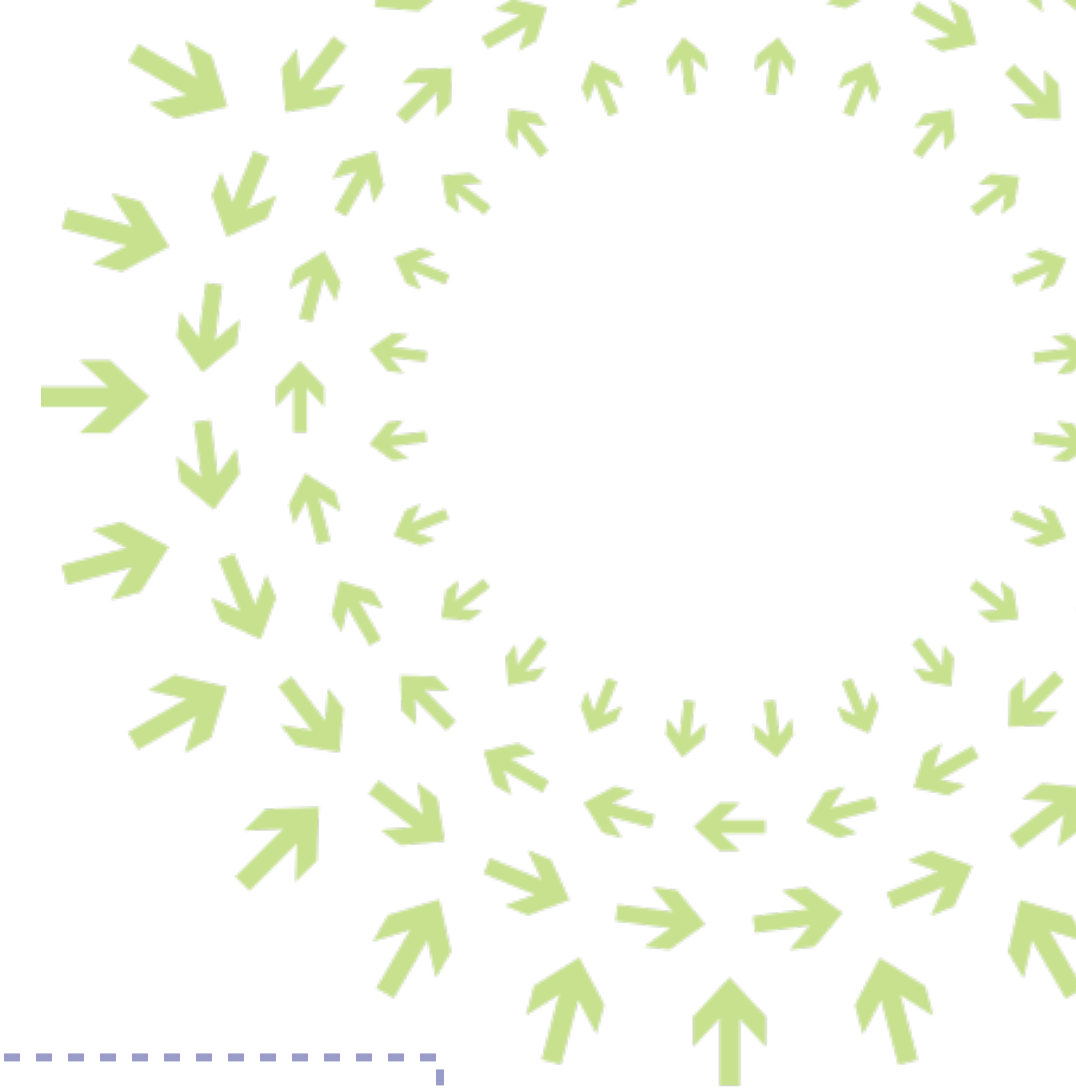
TYPE 6 server



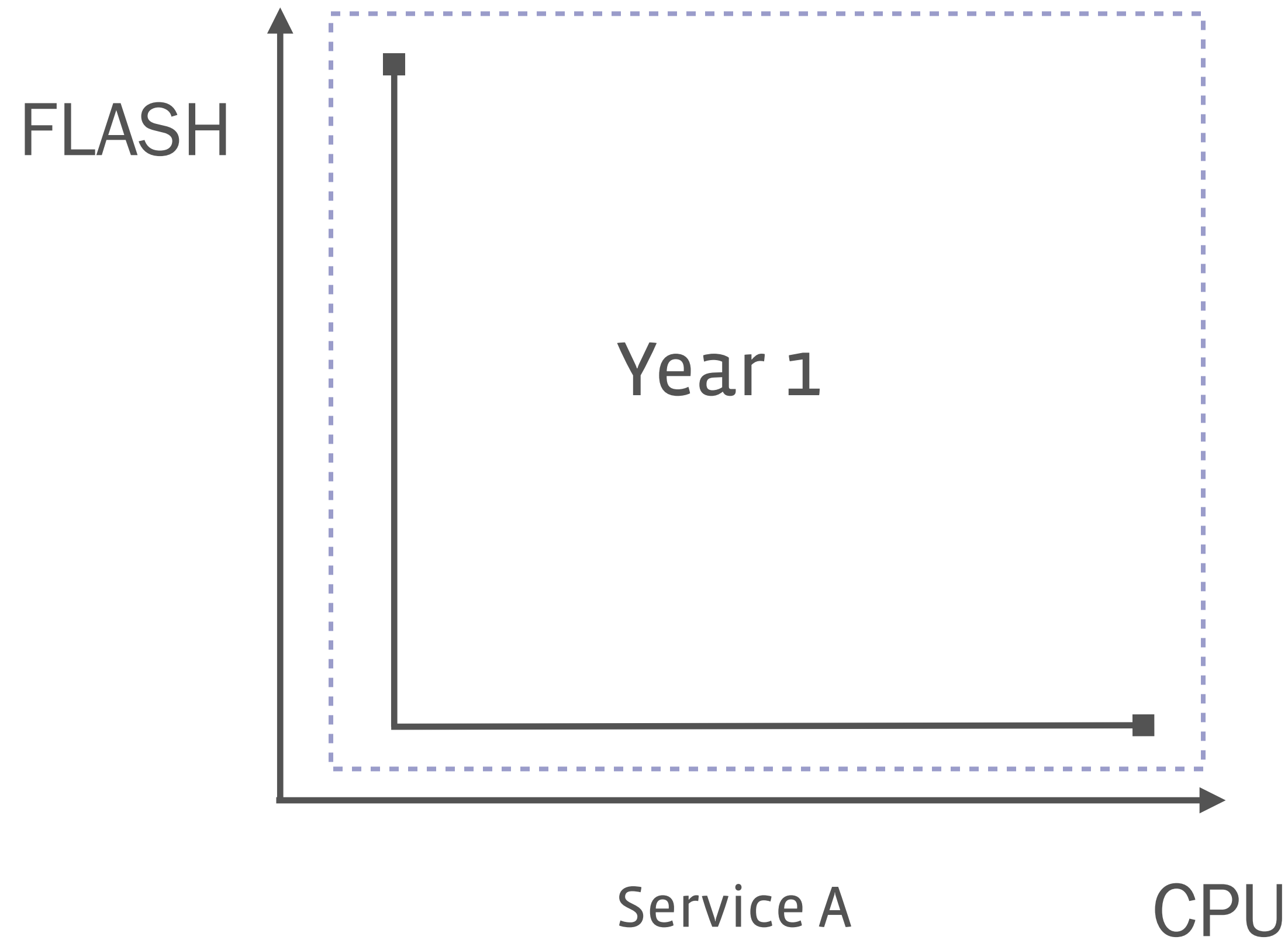
TYPE 6 server



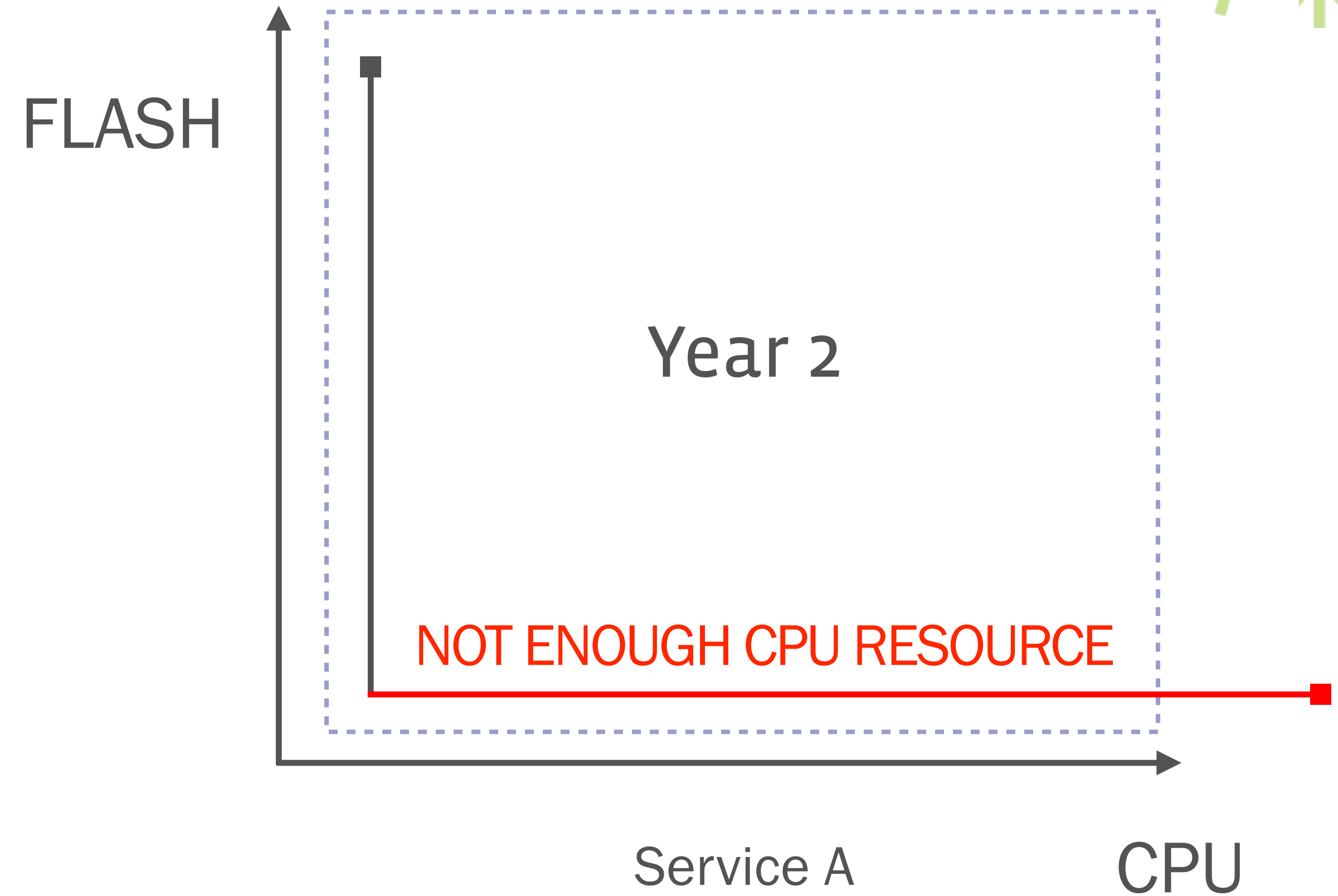
Server/Service Fit - over time



TYPE 6 server



TYPE 6 server

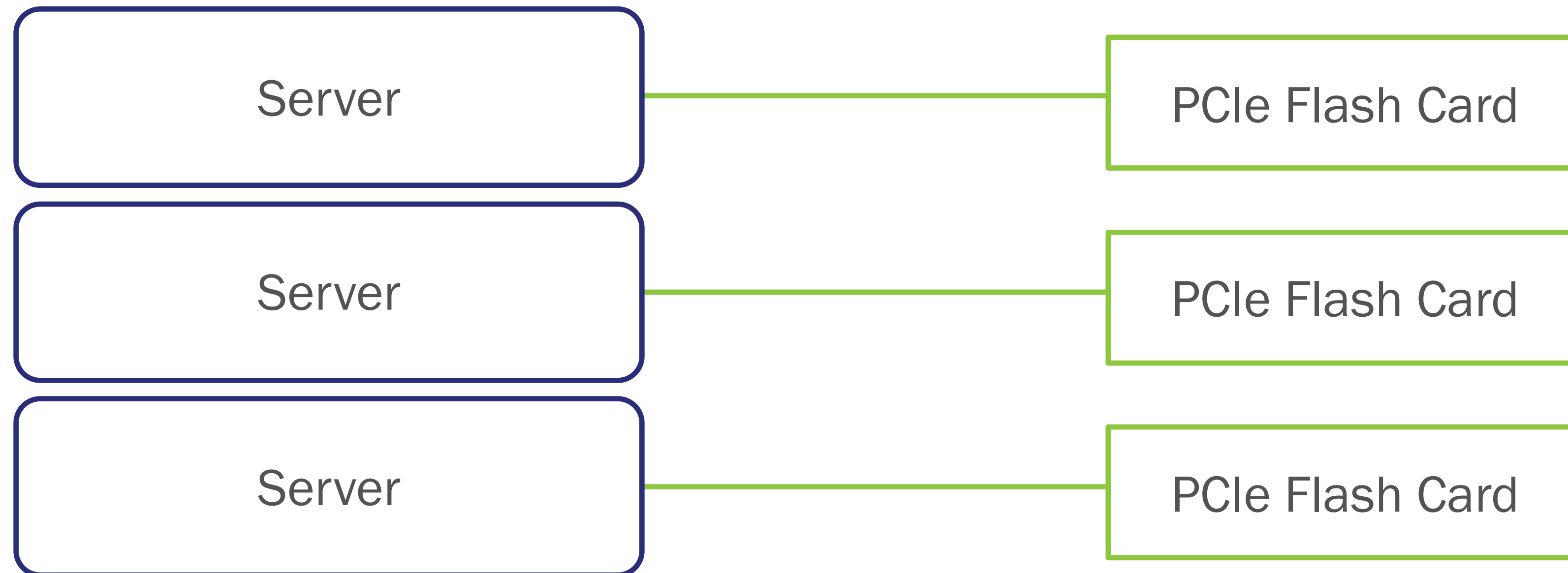


	TYPE I	TYPE III	TYPE IV	TYPE V	TYPE VI	TYPE VII
	WEB	DATABASE	HADOOP	PHOTOS	MULTIPLE SERVICES	COLD STORAGE
CPU	4x Xeon D-proc	2 x Xeon E5-proc	2 x Xeon E5-proc	2 x Xeon E5-proc	2 x Xeon E5-proc	2 x Xeon E5-proc
MEMORY	32GB	256GB	128GB	32GB	256GB	256GB
STORAGE	1 x 500GB SATA	2 x 3.2TB PCIe Flash	15 x 4TB SAS	30 x 4TB SAS	1 x 1.8TB PCIe Flash	240 x 4TB SATA

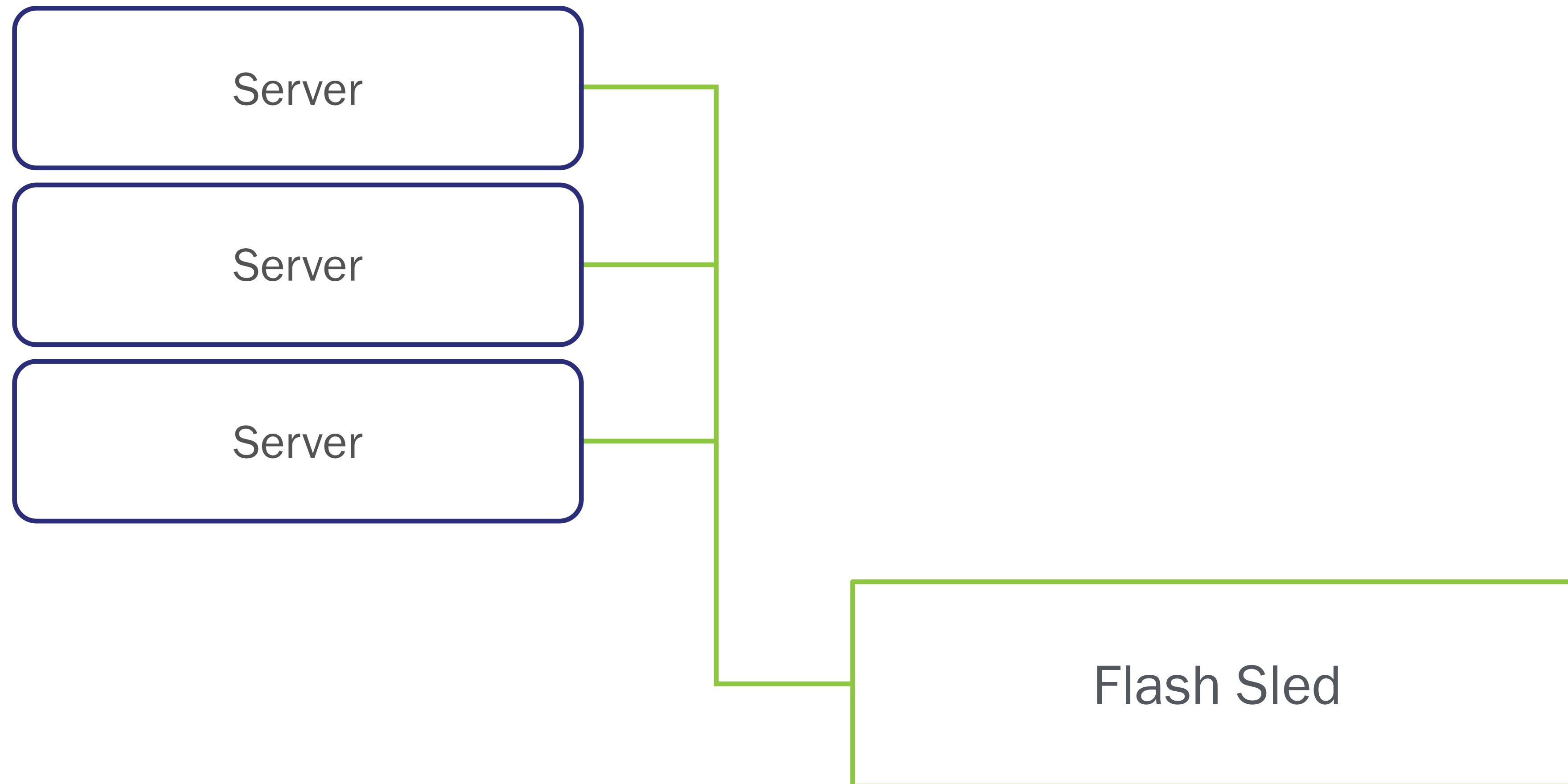
	TYPE I	TYPE III	TYPE IV	TYPE V	TYPE VI	TYPE VII
	WEB	DATABASE	HADOOP	PHOTOS	MULTIPLE SERVICES	COLD STORAGE
CPU	4 x Xeon D-proc	2 x Xeon E5-proc	2 x Xeon E5-proc	2 x Xeon E5-proc	2 x Xeon E5-proc	2 x Xeon E5-proc
MEMORY	32GB	256GB	128GB	32GB	256GB	256GB
STORAGE	1 x 500GB SATA	2 x 3.2TB PCIe Flash	15 x 4TB SAS	30 x 4TB SAS	1 x 1.8TB PCIe Flash	240 x 4TB SATA

	TYPE I	TYPE III	TYPE IV	TYPE V	TYPE VI	TYPE VII	Type VIII
	WEB	DATABASE	HADOOP	PHOTOS	MULTIPLE SERVICES	COLD STORAGE	DISAGGREGATED FLASH
CPU	4 x Xeon D-proc	2 x Xeon E5-proc	2 x Xeon E5-proc	2 x Xeon E5-proc	2 x Xeon E5-proc	2 x Xeon E5-proc	2 x Xeon E5-proc
MEMORY	32GB	256GB	128GB	32GB	256GB	256GB	32GB
STORAGE	1 x 500GB SATA	2 x 3.2TB PCIe Flash	15 x 4TB SAS	30 x 4TB SAS	1 x 1.8TB PCIe Flash	240 x 4TB SATA	15 x 4TB SATA/PCIe

Flash Disaggregation

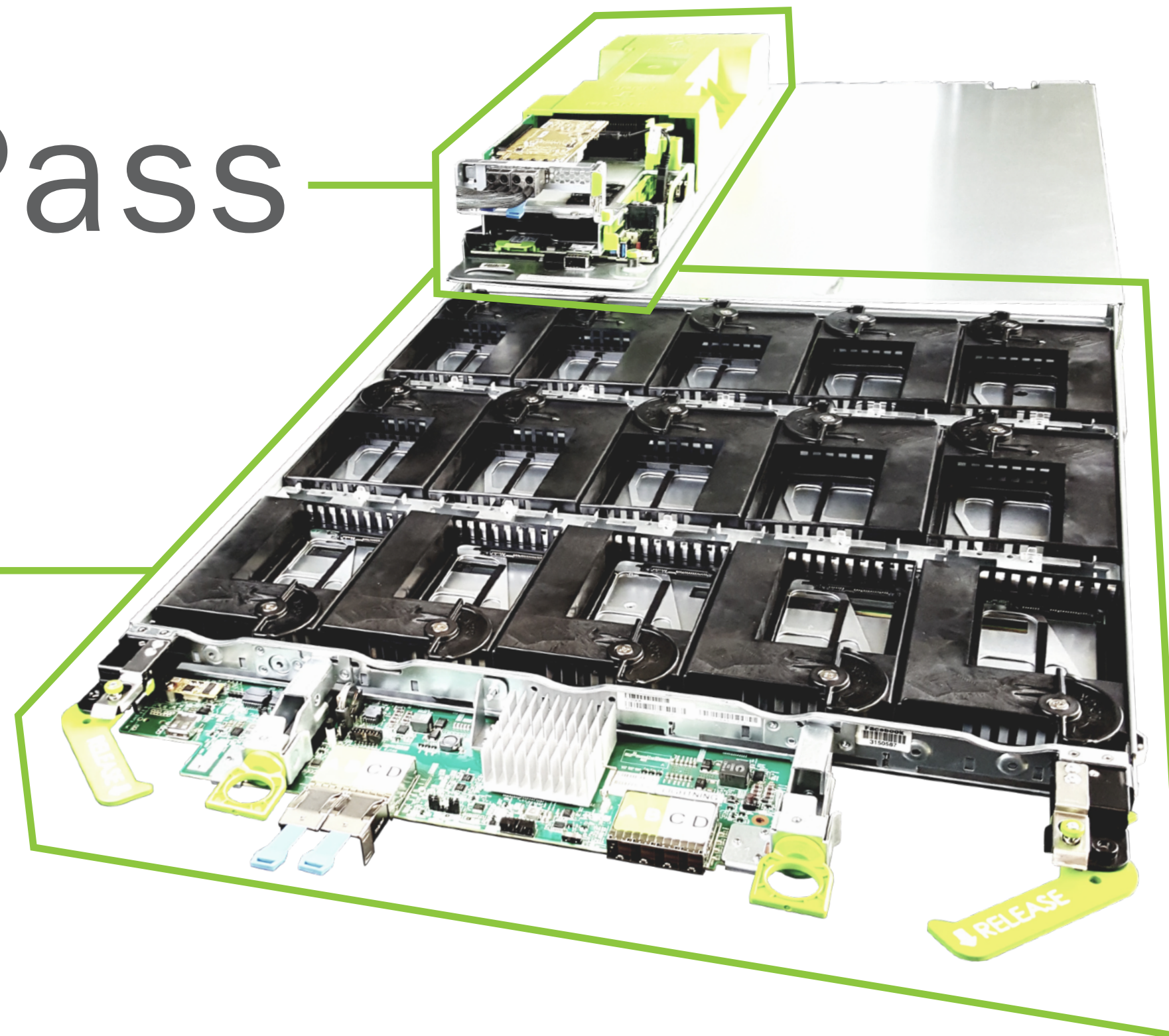


Flash Disaggregation



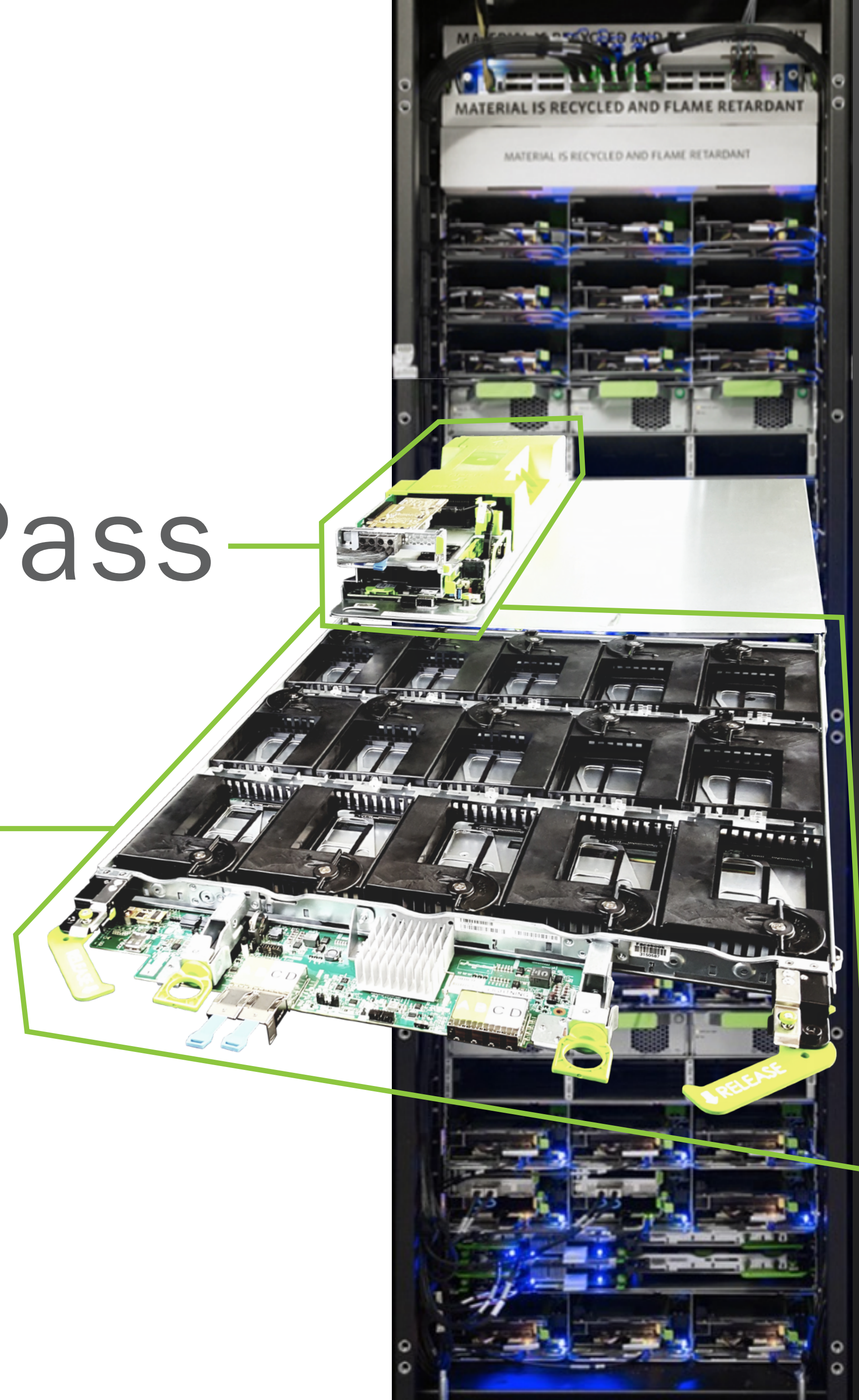
Tioga Pass

Lightning



Tioga Pass

Lightning



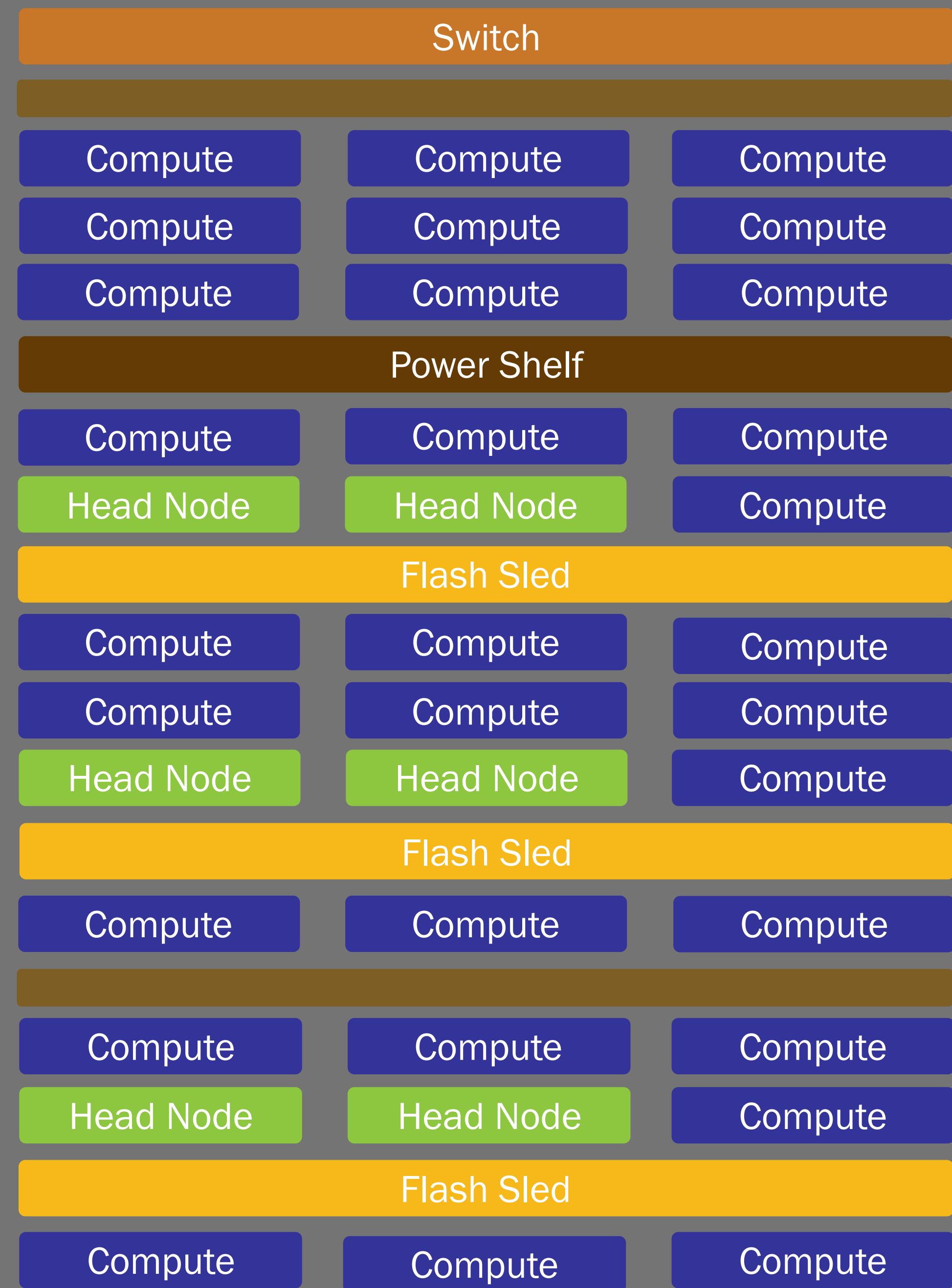


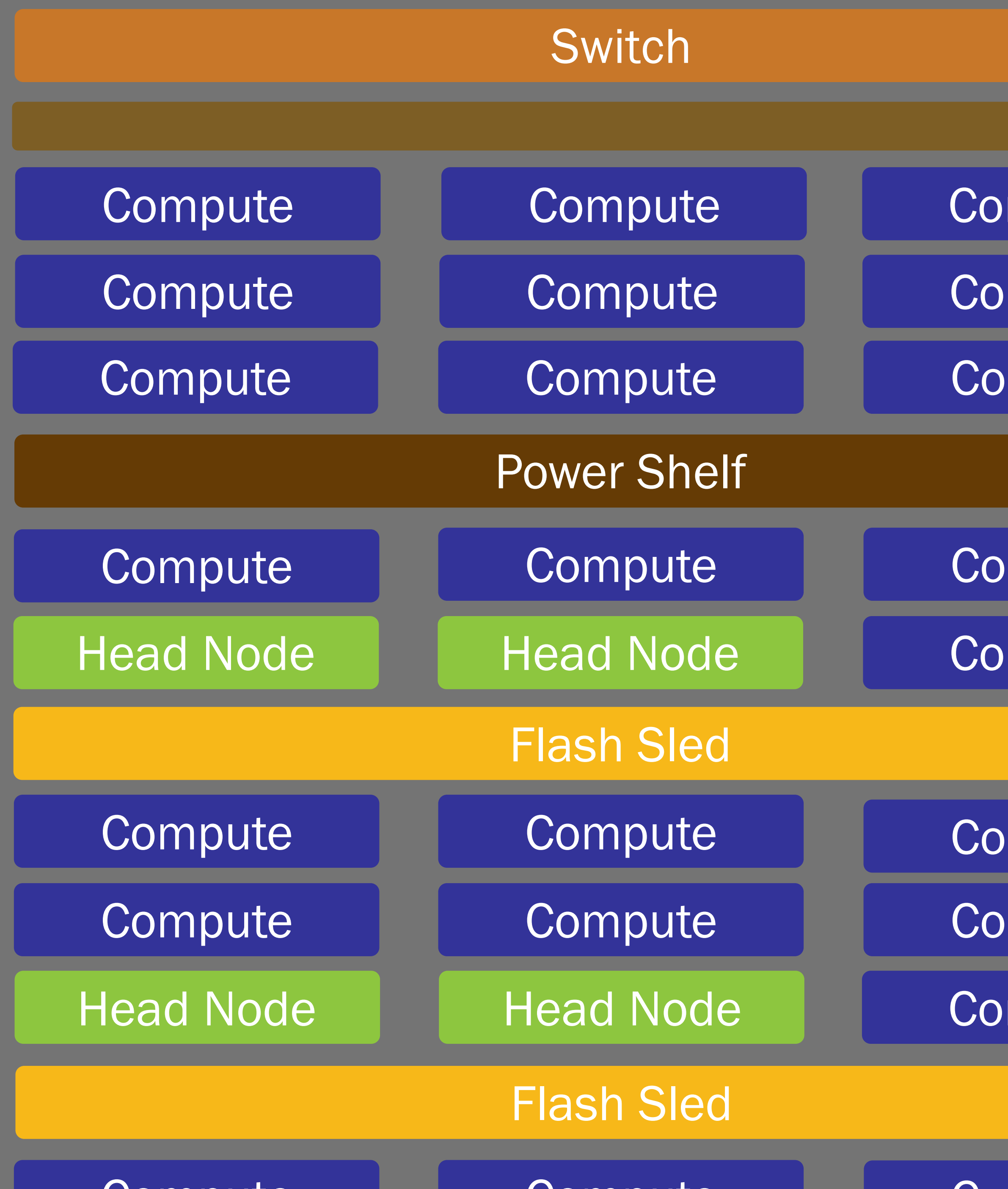
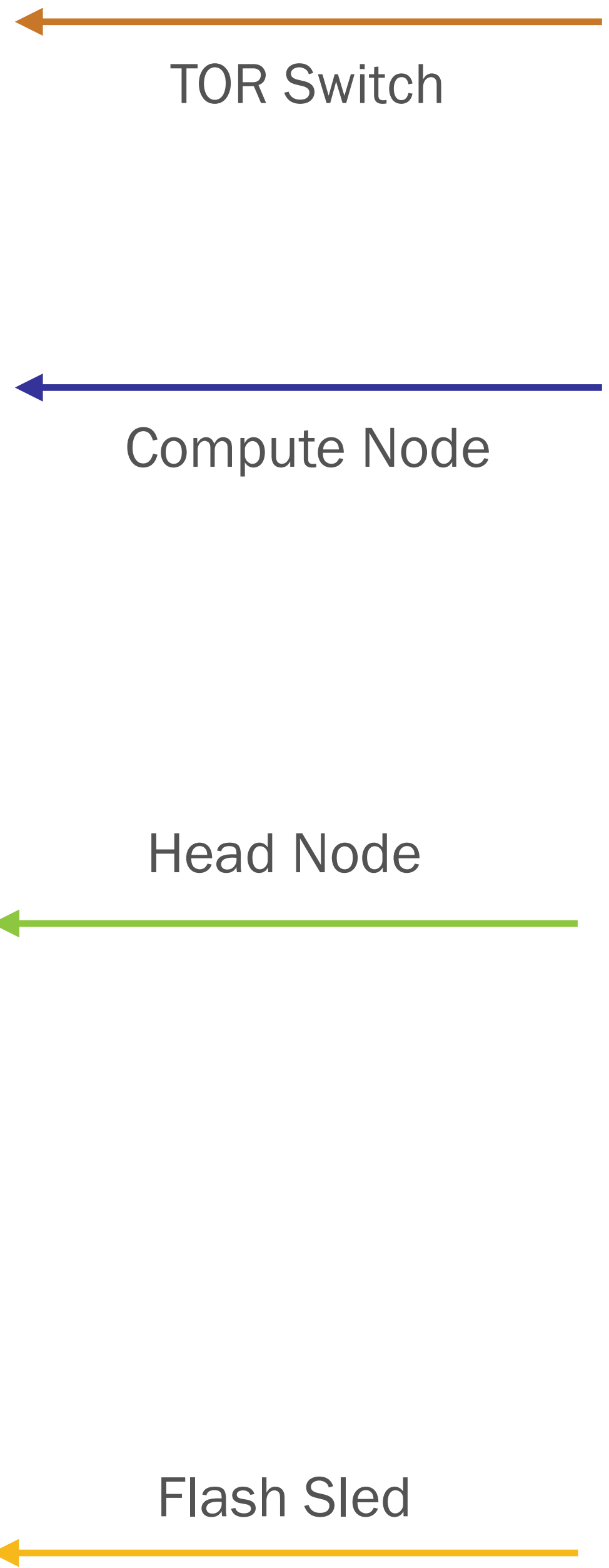






Type VIII
DISAGGREGATED FLASH
2 x Xeon E5-proc
32GB
15 x 4TB SATA/PCIe

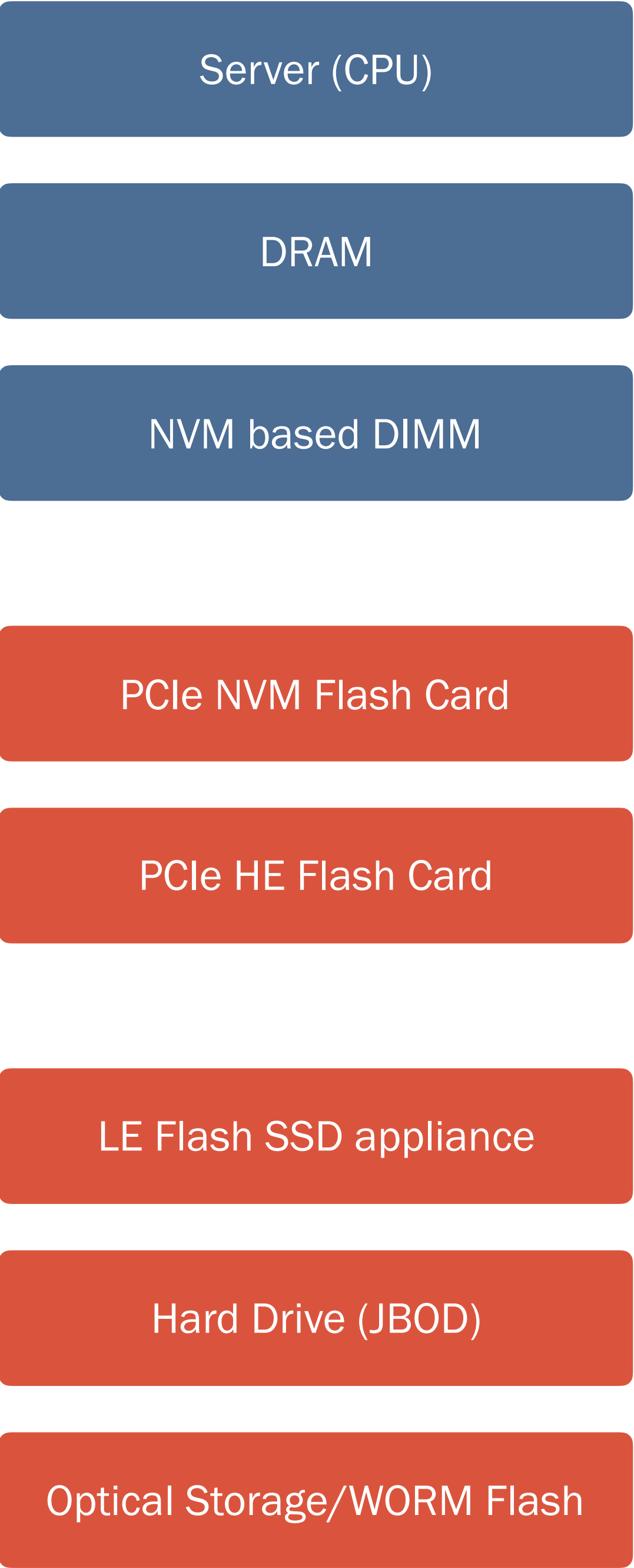




Hierarchical Storage



Hierarchical Storage

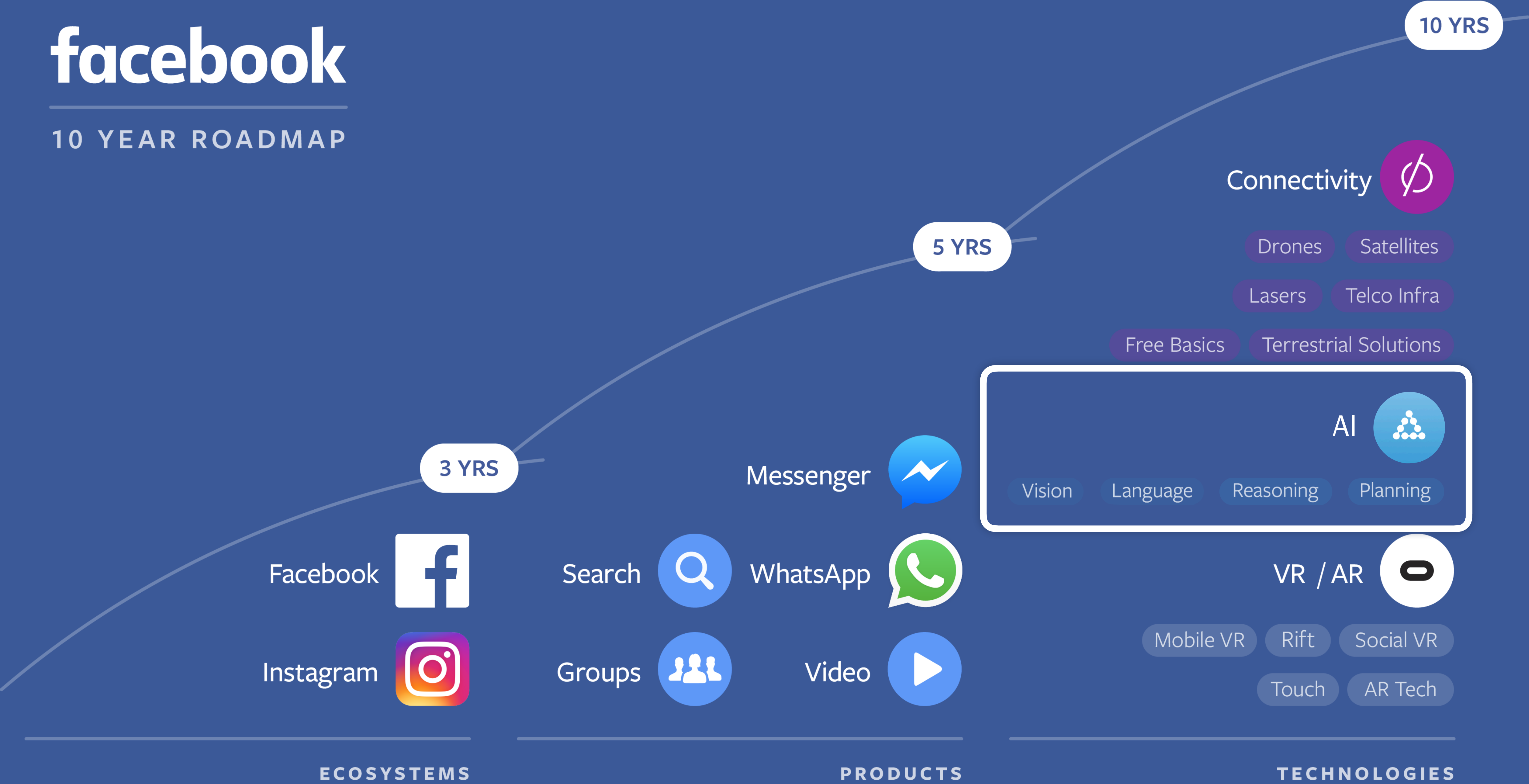


Persistent Read Cache



facebook

10 YEAR ROADMAP





Connectivity 

Drones Satellites

Lasers Telco Infra

Terrestrial Solutions

Facebook 

Instagram 

Search  WhatsApp 

Groups  Video 

VR / AR 

Mobile VR Rift Social VR

Touch AR Tech



Computer Vision

Language Processing

Algorithm Research

Speech Recognition



Computer Vision

Language Processing

Algorithm Research

Speech Recognition



Facebook AI Research



Applied Machine Learning





Facebook AI Research



Applied Machine Learning





Facebook AI Research



Applied Machine Learning

Over 1.2M models trained monthly

2T training examples processed daily

Over 200 visual models trained & deployed

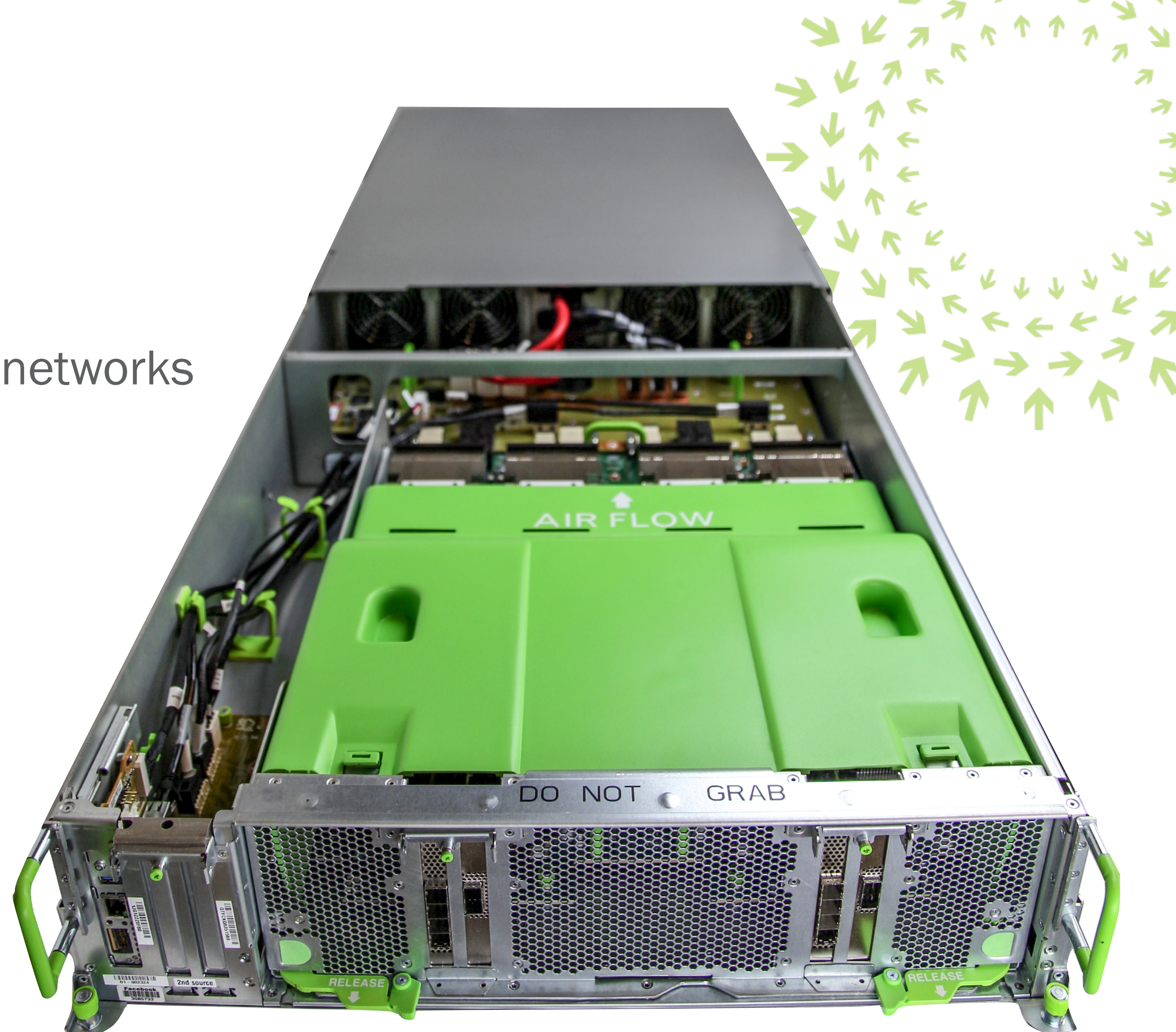




Big Sur

- latest generation GPUs
- train larger and deeper neural networks
- speeds up the training time

Big Basin









Don't Limit Your Challenges



OPEN
Compute Project

Challenge Your Limits



OPEN
Compute Project

The journey is 1% finished!

OPEN HARDWARE.

OPEN SOFTWARE.

OPEN FUTURE.





OPEN

Compute Project

