STORAGE SOLUTIONS FOR AI WORKLOADS

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Every enterprise is different, but four challenges appear across the board

#1

Complexity

- Uncertainty and difficulty of DIY infrastructure
- Fast evolving software stack

Scaling AI projects

- Scaling across multiple AI projects
- Handling multiple data sources especially across clouds

#2

#3

Data Integration Trials

- AI Environment troubleshooting, ROI, visibility-monitoring
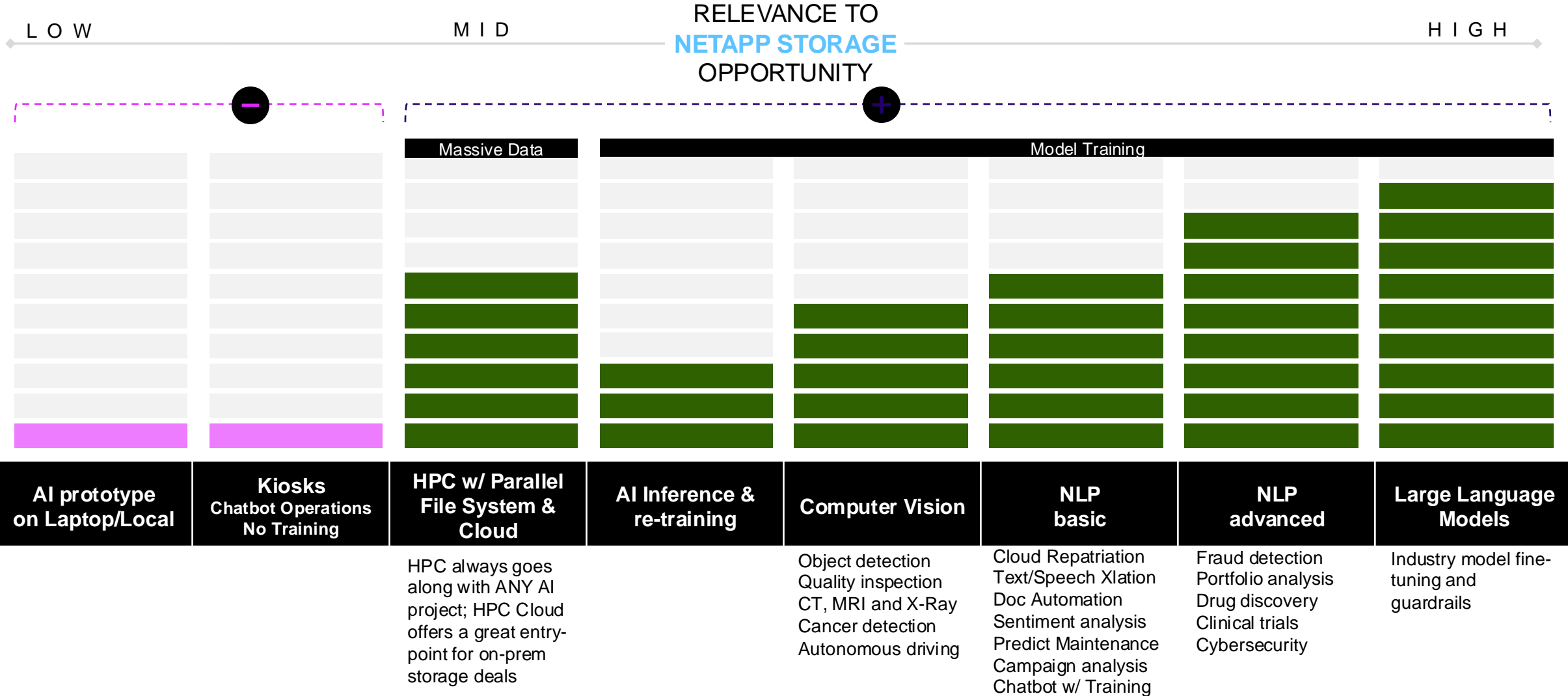- Support for multivendor technology stack

Data Security

- Outdated policies and frameworks
- Tools that find attacks rather than prevent them
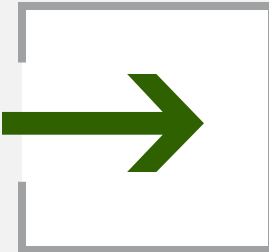
#4

FASTEST GROWING CY2022

Key Target AI Use Cases

RELEVANCE TO
NETAPP STORAGE
OPPORTUNITY

L O W   M I D   H I G H

AI prototype on Laptop/Local	Kiosks Chatbot Operations No Training	HPC w/ Parallel File System & Cloud	AI Inference & re-training	Computer Vision	NLP basic	NLP advanced	Large Language Models
		HPC always goes along with ANY AI project; HPC Cloud offers a great entry-point for on-prem storage deals		Object detection Quality inspection CT, MRI and X-Ray Cancer detection Autonomous driving	Cloud Repatriation Text/Speech Xlation Doc Automation Sentiment analysis Predict Maintenance Campaign analysis Chatbot w/ Training	Fraud detection Portfolio analysis Drug discovery Clinical trials Cybersecurity	Industry model fine-tuning and guardrails

Massive Data

Model Training

NetApp's Portfolio spans the data pipeline

EDGE

CORE

CLOUD

Ingest

Data Prep **Training Cluster** **Deployment**

Analysis / Tiering

- Data collection
- Edge-level AI
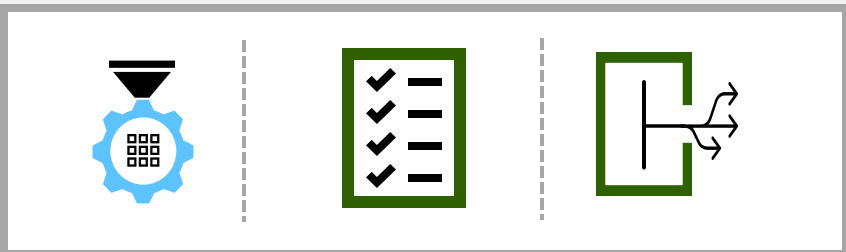
- Aggregation
- Normalization

- Exploration
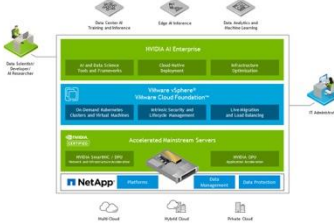- Training

- Deployment
- Model serving
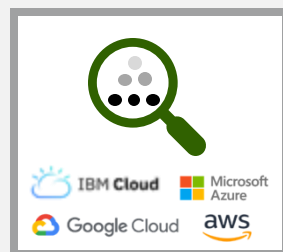
- Cloud AI (GPU instances)
- Cloud tiering / bursting

ONTAP Select

StorageGRID

SnapMirror
FlexCache

E-Series AI
(SuperPOD)

FlexPod AI

ONTAP AI

ONTAP AI
Tools

Anthos

DGX Foundry

Colos

NetApp and NVIDIA portfolio

Deploy the industry's leading AI infrastructure, your way

NetApp AI		DGX Cloud NetApp / Equinix US	NVIDIA DGX SuperPOD with NetApp	NVIDIA AI Enterprise with NetApp

NetApp AI

Reference architecture

Certified for success with maximum flexibility

(Others: FlexPOD AI, E-Series AI, ONTAP with Lenovo, ONTAP with Fujitsu)

Integrated solution

Easy to procure and installed onsite with premium support

DGX Cloud NetApp / Equinix US

Fully managed

Subscription-based service for AI development infrastructure

Premium development experience

NVIDIA DGX SuperPOD with NetApp

World-Class AI infrastructure

Certified for success with HPC/NLP workloads

Massive scale supercomputing

NVIDIA AI Enterprise with NetApp

AI for any organization

Mainstream AI for a wide variety of enterprise workloads

AI for enterprise operations

Turnkey solution for rapid deployment

Existing and greenfield deployments

Field-proven design formula

Storage "Building Blocks" for SuperPOD

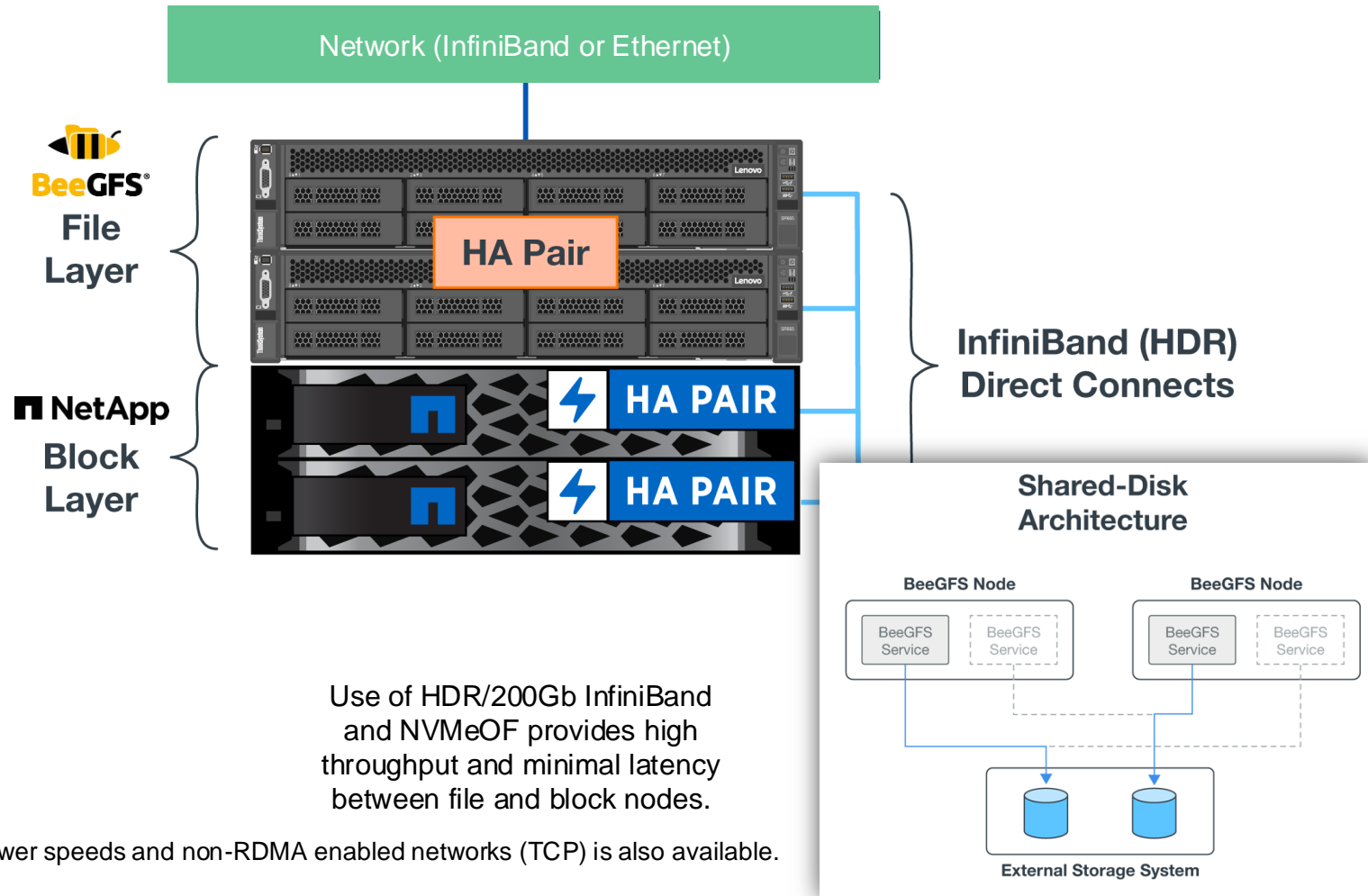## BeeGFS on NetApp Verified Architecture

Highlights

Building blocks provide high availability in a two-tier design that separates fault domains for file and block layers.

BeeGFS services fail over between two file nodes directly connected to two block nodes.

BeeGFS metadata and data protected by NetApp E-Series technology with up to 99.9999% reliability.

Interfaces for the client network support InfiniBand (EDR/HDR) and RDMA over Converged Ethernet (RoCE -100Gb/200Gb).*

Network (InfiniBand or Ethernet)

BeeGFS File Layer

HA Pair

NetApp Block Layer

HA PAIR

HA PAIR

InfiniBand (HDR) Direct Connects

Shared-Disk Architecture

BeeGFS Node

BeeGFS Service · BeeGFS Service

BeeGFS Node

BeeGFS Service · BeeGFS Service

External Storage System

Use of HDR/200Gb InfiniBand and NVMeOF provides high throughput and minimal latency between file and block nodes.

*Support for slower speeds and non-RDMA enabled networks (TCP) is also available.

Typical Deployment Steps

Step-by-step details or automate end-to-end deployment using <u>Ansible</u>.

E-Series/Server Preparations:

- Create E-Series volumes and map to servers.

- Setup frontend/backend networking including server/E-Series connections (e.g., NVMe-IB).

- Format and mount E-Series block devices used as BeeGFS metadata/storage targets.

BeeGFS Installation:

- Add the BeeGFS package repository file.

- Install services using a package manager.

- Configure BeeGFS services starting with the management service and ending with clients:

- Tune additional parameters /etc/beegfs (optional).

- Start/enable BeeGFS services with systemd.

Beegfs Installation

- Add the BeeGFS package repository file.
  - x86-64 packages provided for RHEL 8.x. and 9.3, SLES 15.1, Debian 10- 12 and Ubuntu 20.04 or 22.04 (or build BeeGFS from source).
    Eg yum install beegfs-xx where xx are services

- Install services using a package manager.
  - yum install beegfs-mgmtd
  - yum install beegfs-meta libbeegfs-ib
  - yum install beegfs-storage libbeegfs-ib
  - yum install beegfs-client beegfs-helperd beegfs-utils

- Configure BeeGFS services starting with the management service and ending with clients:
  - Setup scripts in /opt/beegfs/sbin/ to set management IP on other services and initialize storage/metadata targets.
  - /opt/beegfs/sbin/beegfs-setup-mgmtd -p /data/beegfs/beegfs_mgmtd
  - /opt/beegfs/sbin/beegfs-setup-meta -p /mnt/meta -s 2 -m node01
  - /opt/beegfs/sbin/beegfs-setup-storage -p /mnt/myraid1 -s 3 -i 301 -m node01
  - /opt/beegfs/sbin/beegfs-setup-storage -p /mnt/myraid2/ -s 3 -i 302
  - /opt/beegfs/sbin/beegfs-setup-client -m node01

- Tune additional parameters /etc/beegfs (optional).
  - If using RDMA update beegfs-client-autobuild.conf.

- Start/enable BeeGFS services with systemd.
  - systemctl start beegfs-mgmtd
  - systemctl start beegfs-meta
  - systemctl start beegfs-storage
  - systemctl start beegfs-helperd
  - systemctl start beegfs-client

- Verification with system status

```
root@admin1-Express5800-R120a-2-N8100-1501E:~# systemctl status  beegfs-storage
● beegfs-storage.service – BeeGFS Storage Server
     Loaded: loaded (/lib/systemd/system/beegfs-storage.service; enabled; vendor preset: enabled)
     Active: active (running) since Sat 2023-04-01 17:58:12 CEST; 1min 35s ago
       Docs: http://www.beegfs.com/content/documentation/
   Main PID: 85274 (beegfs-storage/)
      Tasks: 2 (limit: 14266)
     Memory: 1.0M
        CPU: 341ms
     CGroup: /system.slice/beegfs-storage.service
             └─85274 /opt/beegfs/sbin/beegfs-storage cfgFile=/etc/beegfs/beegfs-storage.conf runDaemonized=false

abr 01 17:58:12 admin1-Express5800-R120a-2-N8100-1501E systemd[1]: Started BeeGFS Storage Server.
root@admin1-Express5800-R120a-2-N8100-1501E:~# systemctl status  beegfs-meta
● beegfs-meta.service – BeeGFS Metadata Server
     Loaded: loaded (/lib/systemd/system/beegfs-meta.service; enabled; vendor preset: enabled)
     Active: active (running) since Sat 2023-04-01 17:58:00 CEST; 1min 59s ago
       Docs: http://www.beegfs.com/content/documentation/
   Main PID: 85205 (beegfs-meta/Mai)
      Tasks: 2 (limit: 14266)
     Memory: 372.0M
        CPU: 3.714s
     CGroup: /system.slice/beegfs-meta.service
             └─85205 /opt/beegfs/sbin/beegfs-meta cfgFile=/etc/beegfs/beegfs-meta.conf runDaemonized=false

abr 01 17:58:00 admin1-Express5800-R120a-2-N8100-1501E systemd[1]: Started BeeGFS Metadata Server.
root@admin1-Express5800-R120a-2-N8100-1501E:~#
```
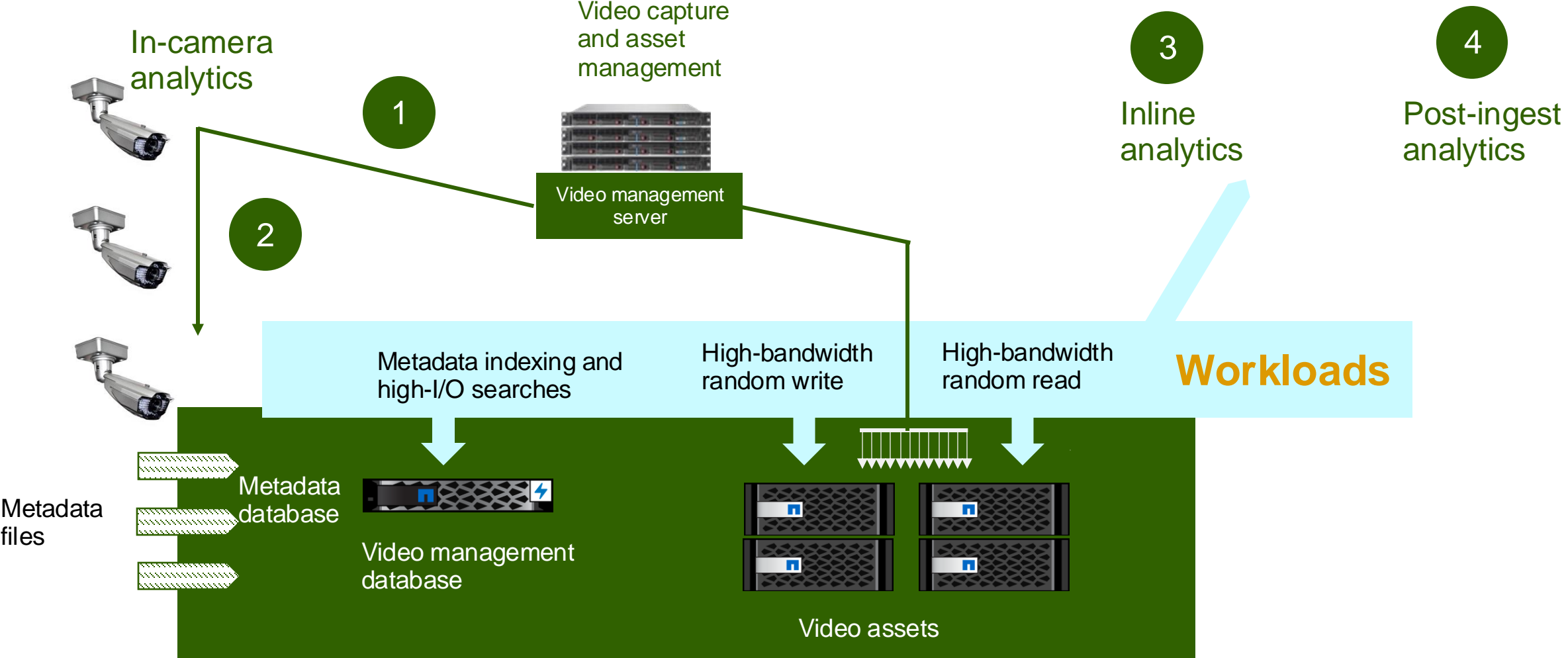
ANSIBLE scripts using for deployment

- GitHub / ANSIBLE GALAXY

- santricity: 1.4.0
  - Santricity OS: RCB_11.80GA_6000_64cc0ee3.dlp

- beegfs: 3.2.0
  - BeeGFS 7.4.3

- host: 1.3.3
  - Lenovo Server SR665v3
    - RHEL 9.3
    - Connectx-7 dual-port NICs
    - Min. MOFED v23.10 LTS RHEL 9.3 drivers for the IB NICs
    - OpenSM MOFED v23.10 LTS based

- Install collections and dependencies on ansible control node:

- ansible-galaxy collection install netapp_eseries.beegfs

- Repository

- on the ONTAP NAS S3 via http/https

Ansible : HW installation/ configuration Automatization

```
[root@ictm1625h1a hsl_automation]#
[root@ictm1625h1a hsl_automation]# ./ansible-playbook.sh -i inventories/beegfs_rhel_e5760.yaml playbooks/golden_configs/beegfs.yaml
```

Example 1: AI in Video Surveillance

In-camera analytics

Video capture and asset management

1

2

3
Inline analytics

4
Post-ingest analytics

Video management server

Metadata indexing and high-I/O searches

High-bandwidth random write

High-bandwidth random read

Workloads

Metadata files

Metadata database

Video management database

Video assets

Video Analytics and an Example of Deep Learning Application

NVIDIA's DeepStream SDK

Three Steps of Video Analytics
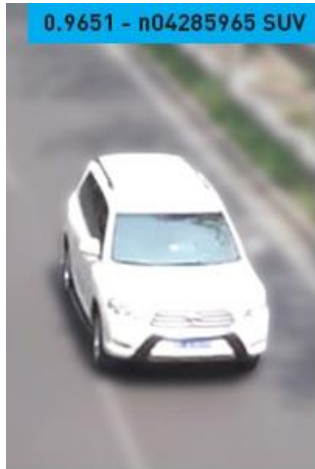
Image
Classification
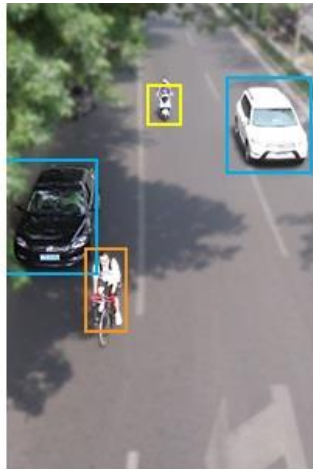
Object
Detection

Object
Tracking

NVIDIA DeepStream Workflow (Pipeline)
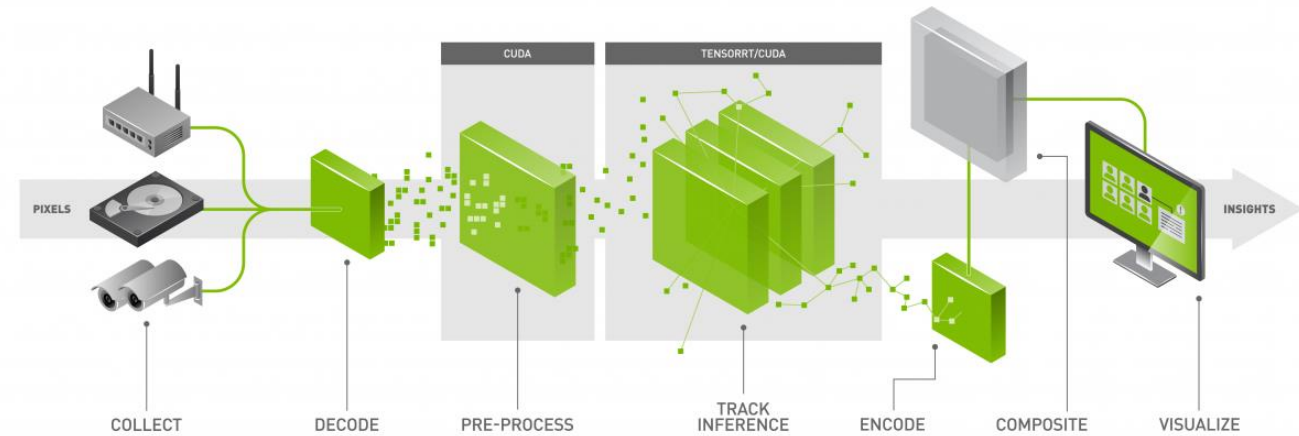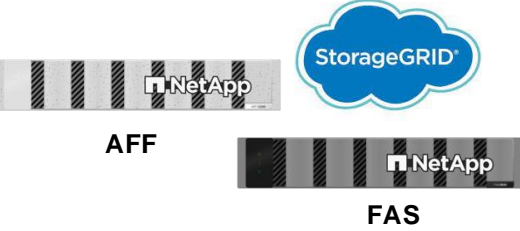
Sample Object Detection Pipeline - Output

Comes with DeepStream

Summary : NetApp AI/HPC workloads

	High Performance Model Training	Enterprise AI (Building Center of Excellences)		
		Data Prep/Data Lake Modernization	Model Training & Fine Tuning	RAG & Inferencing
Use Case	▪ Build and Train Large Foundational models ▪ Parallel file system and/or InfiniBand requirements	▪ Modernizing Data Lakes ▪ Build Data Staging platform for AI workflow	▪ Build Models and Train them on enterprise data in an iterative process ▪ Produce models ready for inferencing ▪ Fine Tune pre-trained models with proprietary data	▪ Augment open-source models with proprietary data ▪ Storing Gen AI output data
Solutions	**EF-Series with BeeGFS** for NVIDIA DGX SuperPOD	StorageGRID® NetApp **AFF** NetApp **FAS**	**AFF A-Series or C-Series** for NVIDIA DGX BasePOD and OEM Servers with GPUs NetApp NetApp	FSx instaclustr NetApp Lenovo FlexPod
Key Points	▪ Enterprise level support ▪ Competitive price/performance ▪ High availability	One Platform | Cloud Connected | NVIDIA Certified | Ecosystem integrated | Secure & Efficient		

THANK YOU