



GPU Memory Snapshot Recovery for Inference: Compatibility

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Executive Summary

Graphics processing unit (GPU) memory snapshot recovery for inference can replace repeated engine initialization with restoration of a prepared process, but its usefulness depends on the exact hardware, software, storage, and request path. The CUDA checkpoint facility preserves GPU state as part of a larger process-checkpoint solution; it does not independently preserve an entire deployment. (docs.nvidia.com) Restore remapping requires the **same chip type** and sufficient GPU memory. Ordinary CUDA application compatibility therefore does not establish that a saved process will restore across GPU architectures or driver versions. (docs.nvidia.com)

The published latency evidence is encouraging but configuration-specific. **Ramp** reports **60 to 120 seconds** before the first token when starting its Gemma 27B deployment from scratch, versus **5 to 12 seconds** with Modal GPU snapshots. (labs.ramp.com) **Modal** reports a Qwen2.5-0.5B-Instruct example moving from **45 seconds to 5 seconds**, explicitly labeled **P0**, rather than a tail-latency distribution. (modal.com) The standalone **Dynamo Snapshot** benchmark reports **GPT-OSS 120B at 85.3 seconds cold versus 31.135 seconds restored**, with image pull and container startup excluded. These observations do not establish a portable improvement factor. (github.com)

Status and integration details matter as much as speed. Dynamo's release history records **v1.5.0** introducing a standalone Snapshot operator, while its migration guidance changes the installation and checkpoint-resource model. (docs.dynamo.nvidia.com) The standalone project says it is **not yet recommended for production-critical workloads**. (github.com) vLLM v0.31.0 also documents **experimental initialized engine snapshots**. (docs.vllm.ai) The earlier vLLM checkpoint/restore RFC body remains marked **Draft**; its design discussion identifies application programming interface (API) socket handling, consistent compilation-cache paths, and communicator-dependent graph state as qualification concerns. (github.com)

The decision is to qualify a specific restore configuration against a **service-level objective (SLO)**. Compare fresh startup, cached weights, prewarmed replicas, process snapshots, and vLLM sleep using the same arrival trace. Sleep retains a running server, whereas persistent recovery must also recreate the surrounding process and service environment. (docs.vllm.ai) Measure readiness separately from the first valid token: Kubernetes

traffic admission and an open port do not demonstrate a correct model response. (kubernetes.io) Approve a pilot only when latency distributions, output checks, artifact handling, restart behavior, and a tested standard-startup fallback satisfy the deployment's acceptance criteria.

Introduction and Background

Private inference teams searching for **GPU checkpoint restore** are usually trying to avoid repeating expensive preparation whenever a replica starts. The relevant state extends beyond model weights. A working restore must account for prepared execution state as well as the files used to create it. NVIDIA's CUDA interface supplies the GPU portion of a complete process checkpoint. Host memory, threads, files, and deployment coordination require additional machinery. (docs.nvidia.com) The useful question is which repeated work a particular snapshot actually removes.

Several meanings of “checkpoint” must be separated. A serialized tensor checkpoint is a model-loading artifact; PyTorch documents loading tensors on the central processing unit (CPU) before applying a state dictionary to avoid a GPU memory surge. (docs.pytorch.org) A Hugging Face cache “snapshot” is a revision directory linking downloaded file blobs. It is not a suspended inference engine. (huggingface.co) Similarly, restarting a Ray actor reruns its constructor and does not automatically restore application-level state. (docs.ray.io)

This report treats GPU Smith's position as that of an **independent engineering advisor**. Its purpose is to help platform engineers and technical buyers decide whether an owned deployment merits a snapshot pilot. It does not assign the consultancy a competing runtime or snapshot product.

The research cutoff is **October 19, 2026**. The evidence consists of official interfaces, maintainer documentation, a draft design, and attributed deployment measurements. The report contributes a qualification method and decision worksheet, not newly measured GPU performance. Each private deployment needs an explicit boundary between prepared reusable state and request-specific state. Request-specific initialization belongs in the qualification record rather than being assumed to survive capture.

The CUDA utility's documented driver feature progression matters: support starts at **550**, **570** adds **Checkpoint/Restore in Userspace (CRIU)** process-tree integration, **580** adds migration, **595** adds Arm support, and **610** adds the documented legacy CUDA **interprocess communication (IPC)** capability. (github.com) These are feature milestones, not a guarantee that an artifact created under one driver can be restored under another.

Installation guidance also needs a version. Dynamo's **v1.5.0** migration moved Snapshot to a standalone operator and replaced the earlier checkpoint-resource model with **PodSnapshot**. (docs.dynamo.nvidia.com) Instructions based on the earlier bundled operator must therefore be checked against the installed release. The standalone repository's production-critical qualification caveat remains material. (github.com)

Methodology and Startup Accounting

The measurement boundary should start with the event the buyer actually cares about: an arrival that needs new capacity. Instrument the complete path, then separately report the portion affected by restoration.

OpenTelemetry supports nested spans and recommends child spans for individual suboperations, making it suitable for separating startup stages. (opentelemetry.io) Do not sum stage durations indiscriminately when work overlaps.

Use the following decomposition as the proposed measurement schema:

- **Scheduling and image availability:** Record capacity assignment, image pull, unpacking, and container launch separately.
- **Weight access:** Measure remote download, local reads, decompression, and deserialization. SageMaker's documented startup path, for example, copies model artifacts from object storage into the inference container. (docs.aws.amazon.com)
- **GPU preparation:** Measure device initialization, allocation, and host-to-device transfer separately from file access.
- **Engine preparation:** Identify kernel loading, compilation, warmup requests, and graph capture. These are among the initialized states Modal describes preserving. (modal.com)
- **Distributed registration:** Record communicator setup, peer discovery, and service registration. NVIDIA's original Dynamo design checkpoints after engine initialization but before distributed runtime startup. (developer.nvidia.com)
- **Serving validation:** Record traffic admission, the first valid generated token, and complete replay results as distinct events.

This prevents a common boundary error: treating infrastructure availability as application availability. Google describes GPU-equipped Cloud Run instances starting in approximately **5 seconds**, after which container processes can begin using the GPU. That statement does not measure a fully initialized language model. (docs.cloud.google.com) Modal likewise notes that some work occurs only on the first invocation. (modal.com)

A readiness probe should match the intended service contract. Kubernetes defines readiness as the signal controlling whether a container can accept traffic. Its Transmission Control Protocol (TCP) probe succeeds when the port is open. (kubernetes.io) SageMaker's guidance goes further by checking that the model artifact is loaded and ready and that lightweight inference succeeds. (docs.aws.amazon.com) A private inference qualification should similarly reject a restored process that opens its listener but cannot complete its expected model operation.

For language models, distinguish **time to first token (TTFT)** from **time per output token (TPOT)** and total response time. MLCommons treats first-token latency and subsequent token generation as separate measurements. (mlcommons.org) Its benchmark compliance discussion also requires the first token reported for timing to match the first token actually generated. (mlcommons.org) This is useful measurement discipline even when the deployment is not running that benchmark.

Report both request-arrival-to-first-valid-token and restore-command-to-ready. The former answers the user-facing question; the latter helps diagnose the mechanism. Preserve individual trial records so another engineer can reconstruct exactly what each published percentile includes.

State Persistence and Startup Alternatives

Choose an alternative by the state it retains and the resources it continues to occupy. A file cache can eliminate repeated download without preserving a running process: Hugging Face explicitly describes its cache as downloaded files, while KServe provides node-local model storage. (huggingface.co) (kserve.github.io) A process-preserving mechanism addresses a different part of startup.

Table 1 compares the techniques using documented behavior. The qualification action and rollback columns are proposed engineering practice.

Technique	State and location	Prerequisite and restore concern	Qualification evidence	Rollback
Cached weights	Model files on local or shared storage; KServe can share a warmed local volume among pods. (kserve.github.io)	All required revision files must exist. Offline Hub access errors when the cache lacks a file. (huggingface.co)	Start with network access disabled and verify the exact model revision.	Use the approved artifact-loading path.
Prewarmed replica	A running service and its initialized resources. Modal documents the resource-cost tradeoff of keeping containers warm. (modal.com)	Capacity must stay available during idle periods.	Replay the arrival trace against the warm pool.	Start additional standard replicas.
CPU memory snapshot	Prepared host process state; Modal distinguishes this from additional GPU-state capture. (modal.com)	GPU initialization remaining outside the snapshot still needs measurement.	Compare restored readiness with first-request timing.	Recreate the container normally.
GPU process checkpoint	GPU state plus host-process checkpoint artifacts. (docs.nvidia.com)	GPU and host restoration must both meet their compatibility requirements.	Restore onto an allowed destination and replay model requests.	Reject the artifact and run normal startup.
vLLM initialized engine snapshot (v0.31.0)	Commands: <code>vllm snapshot create</code> , <code>vllm snapshot inspect</code> , and <code>vllm snapshot restore</code> . (docs.vllm.ai)	Restore reloads model files and KV cache before binding HTTP. (docs.vllm.ai)	Verify the recorded canary; restore reproduces it or tears down the restored tree.	Use an explicit standard-startup fallback.
vLLM level 1 sleep	Weights offloaded to CPU memory; key-value cache discarded. (docs.vllm.ai)	The server remains running; wakeup needs the retained process. (docs.vllm.ai)	Measure sleep, wakeup, and post-wakeup correctness.	Reload through the normal server lifecycle.

Technique	State and location	Prerequisite and restore concern	Qualification evidence	Rollback
vLLM level 2 sleep	Weights and key-value cache discarded; selected buffers retained on CPU. (docs.vllm.ai)	Weight reload and application coordination are part of recovery.	Check reloaded weights and replay outputs.	Restart and load the model normally.

The main distinction is **persistence scope**. vLLM sleep is useful when the process is meant to remain alive; it should not be treated as evidence that a terminated pod can recover from a durable process image.

(docs.vllm.ai) Docker's checkpoint commands depend on **Checkpoint/Restore in Userspace (CRIU)**; its documentation calls the feature experimental and focuses on single-host use cases. That alone does not establish complete GPU recovery. (docs.docker.com)

Cache deployment also requires explicit configuration. KServe documents model caching as disabled by default. (kserve.github.io) For offline environments, **HF_HUB_OFFLINE** disables Hub Hypertext Transfer Protocol (HTTP) calls and uses cached files, so the qualification must verify artifact completeness before network isolation. (huggingface.co) The report recommends pinning tokenizer, configuration, adapter, and weight revisions together rather than treating “weights present” as the full artifact contract.

Prewarming remains a valid control. Cloud Run documents charging GPU minimum instances at the full rate while idle. (docs.cloud.google.com) That is a provider-specific billing fact, not a universal price for an owned cluster, but it illustrates why warm capacity and restore-on-demand have different cost structures. On owned hardware, compare capacity opportunity cost, measured power, and reservation constraints instead.

Versioned Compatibility and Restore Qualification

A compatibility matrix should describe **tested source-to-destination pairs**, not just installed components. Record the capture environment and restore environment independently. Where the evidence does not establish portability, use an unchanged stack as the baseline and qualify each proposed change separately.

Table 2 turns the documented boundaries into a versioned acceptance matrix. Blank deployment-specific values are items the operator must fill, not implied support.

Dimension to pin	Documented boundary	Required acceptance evidence
GPU chip, memory, identity	Remapped targets need the same chip type and enough memory. (docs.nvidia.com)	Source and target chip identifiers, available memory, mapping, and successful replay.
CUDA restore initialization	The API requires persistence mode or prior cuInit execution. (docs.nvidia.com)	Capture persistence configuration and initialize the target as required before restore.
Driver and CUDA toolkit	CUDA minor-version compatibility has feature limitations; application compatibility is a different question from checkpoint-format compatibility. (docs.nvidia.com)	Exact driver/toolkit builds; separate restore results for every proposed driver change.

Dimension to pin	Documented boundary	Required acceptance evidence
Memory and IPC allocation	The utility excludes unified virtual memory and IPC allocations created with <code>cuMemExportToShareableHandle</code> . (github.com)	Allocation paths and actual engine configuration; no inference from model size alone.
Kernel, runtime, node agent	Standalone Snapshot lists Linux kernel 5.13+, containerd or CRI-O, GPU Operator 26.3+, driver 580+, Multi-Instance GPU (MIG) disabled, ReadWriteMany (RWX) storage, and privileged node-agent permission. (github.com)	Kernel/runtime/image digests, policy approval, mounts, and target-node restoration.
CPU and node topology	Standalone Snapshot lists Linux x86_64 and arm64; single-node support, with multinode on its roadmap. (github.com)	Separate artifacts and tests for each allowed CPU and placement configuration.
Native vLLM v0.31.0 snapshot	Requires one NVIDIA GPU on Linux x86-64, TP1, and the same host, GPU, driver, kernel, Python, PyTorch, installed vLLM version, model revision, engine arguments, selected environment variables, and CRIU plugin binaries. Only dense float16 TP1 is validated; NCCL state is not restored. Its unauthenticated plaintext HTTP server requires a trusted host/network boundary or external controls. (docs.vllm.ai)	Pin the documented environment and preserve package, library, model, and generated-cache paths. Qualify this implementation separately from the RFC design rows below.
Framework, engine, model	The RFC requires consistent <code>torch.compile</code> cache paths between capture and restore. (github.com)	Framework/engine versions, model and tokenizer hashes, precision, adapters, graph settings, and cache paths.
Tensor parallelism and NCCL	The RFC identifies old collective references in CUDA graphs; current NVIDIA Collective Communications Library (NCCL) suspension requires no outstanding operations. (github.com) (docs.nvidia.com)	Exact tensor-parallel degree, communication transport, quiescence, communicator handling, and graph replay.
Network sockets	The RFC proposes dropping API-server sockets and rebinding after restore. CRIU established-TCP restoration has its own IP/network requirements. (github.com) (criu.org)	New service identity, listener rebinding, peer discovery, and clean client reconnection.
Storage and mutable files	Continuing a checkpointed task can leave saved state inconsistent with external files or connections. (criu.org)	Immutable artifact identity, required file paths, permissions, and restore under storage contention.
Pod restart and remapping	Standalone limitations describe one restore per pod, requiring a new pod for another restore, and note that device-path remapping does not relax compatibility. (github.com)	Restored-process exit, pod replacement, checkpoint selection, and standard-startup fallback.

Kubernetes also notes that checkpoint archive contents depend on the underlying container runtime implementation, so archive creation alone is not a portable image-format guarantee. (kubernetes.io)

The table separates mechanisms that are easily conflated. NCCL now documents communicator suspend/resume functionality, so a blanket assertion that NCCL has no such capability would be inaccurate. (docs.nvidia.com) That API does not by itself establish that a framework's graphs, transport, and checkpoint orchestration work together.

Treat model, engine, driver, and storage changes as events requiring explicit artifact review. Modal documents that changing a Volume does not update a memory snapshot. (modal.com) The broader operational recommendation is to bind every artifact to a manifest and reject a mismatched restore before it receives traffic.

Runnable Validation and Acceptance Protocol

This **proposed qualification protocol** requires the start and restore actions implemented by the selected runtime. Modal's documented GPU snapshot example requires deployed Functions. (modal.com) Do not assume a universal framework restore flag.

Use explicit command contracts. Start launches the service and returns; readiness waits for the declared gate; first_valid_token submits a fixed request, checks its first generated token, and returns; replay checks complete responses. Reset terminates the previous worker and creates the declared trial environment.

The runner accepts a JavaScript Object Notation (JSON) file with command arrays reset, fresh_start, restore_start, ready, first_valid_token, and replay, plus runs and timeout_s. Run **python3 qualify.py qualification.json results.jsonl**. Python provides elapsed-time measurement unaffected by wall-clock adjustments. (docs.python.org)

```
import json, subprocess, sys, time

cfg = json.load(open(sys.argv[1], encoding="utf-8"))
def run(key):
    subprocess.run(cfg[key], check=True,
                   timeout=cfg["timeout_s"])

with open(sys.argv[2], "a", encoding="utf-8") as out:
    for trial in range(cfg["runs"]):
        modes = ("fresh", "restore") if trial % 2 == 0 else ("restore", "fresh")
        for mode in modes:
            record = {"mode": mode, "trial": trial, "ok": False}
            try:
                run("reset")
                t0 = time.perf_counter()
                run(mode + "_start")
                run("ready")
                record["ready_s"] = time.perf_counter() - t0
                run("first_valid_token")
                record["first_valid_token_s"] = time.perf_counter() - t0
                run("replay")
                record["ok"] = True
            except Exception as exc:
                record["error"] = type(exc).__name__
            out.write(json.dumps(record) + "\n")
            out.flush()
```

This runner records the **first valid token after readiness**, so its result includes the chosen readiness gate before request submission. Add an independently arriving request client if the real router queues requests earlier. Reset behavior determines whether a trial has cold storage caches, cached files, or reusable node state; name those cohorts explicitly.

Record the following evidence for every accepted matrix cell:

- **Manifest:** Save model hashes, image digests, driver, device identifiers, engine flags, and artifact identity.
- **Capture point:** Warm representative input shapes before capture. Modal recommends sample forward passes to expose initialization work early. (modal.com)
- **Cache treatment:** Declare whether the key-value (KV) cache is retained, discarded, or recreated. Modal recommends considering removal of an initial unfilled KV cache. (modal.com)
- **Fresh cohort:** Repeat standard startup with the same image, model, and resource limits.
- **Restore cohort:** Alternate trial order and repeat on every allowed destination class.
- **Readiness proof:** Record the actual restored workload, not merely artifact availability. Dynamo's walkthrough explicitly distinguishes the two. (docs.dynamo.nvidia.com)
- **Correctness:** Check weight/artifact checksums and full output semantics; use a predeclared tolerance for nondeterministic outputs.
- **Request replay:** Include short and long prompts, configured adapters, concurrency, and streaming termination.
- **Restart and rollback:** Exercise process exit, pod replacement, artifact rejection, and standard startup.
- **Resource accounting:** Capture artifact bytes, read bytes, storage throughput, host-memory peaks, and GPU idle duration.
- **Distribution context:** Group results by destination, cache cohort, and restore concurrency before comparing distributions.
- **Storage saturation:** Run simultaneous restores and check artifact-read time against the declared storage budget.
- **Expiry triggers:** Record the decision to recapture whenever an accepted manifest changes.

The vLLM RFC calls for validating available host memory before GPU checkpointing. (github.com)

Publish **p50, p95, and p99**, trial counts, unsuccessful restores, and timeout counts separately. The 95th percentile is the 0.95 quantile; percentile estimates depend on the measurement method and histogram resolution. (prometheus.io) Retain raw observations and avoid averaging precomputed percentiles across replicas, which Prometheus explicitly warns against. (prometheus.io) Histograms allow aggregation before percentile calculation when the instrumentation is configured appropriately. (prometheus.io)

Analysis of Key Deployment Segments

The same snapshot mechanism can produce different operational decisions across private deployments. The segmentation below is an analyst decision framework. It does not imply published benchmark coverage for every configuration.

Bursty, single-node inference is a reasonable pilot candidate when repeated engine preparation dominates startup and the accepted delay leaves room for restoration. Ray Serve documents that scaling from zero introduces waiting while replicas start. (docs.ray.io) Compare that path with a small warm pool under the actual arrival trace. Ramp's stated motivation, avoiding an idle warm GPU fleet for an experimental service, illustrates one demand pattern rather than a universal production policy. (labs.ramp.com)

Storage-bound initialization deserves a cache-first control experiment. KServe can place model files on node-local storage for reuse. (kserve.github.io) Modal GPU Memory Snapshots are **Alpha** and generally incompatible with practical multi-GPU workloads. These are Modal-specific limits, separate from standalone Dynamo Snapshot and native vLLM requirements. Modal explicitly says GPU snapshots do not accelerate model loading from storage and may add overhead when that dominates startup. (modal.com) If the measured benefit disappears once weights are locally cached, the buyer should compare snapshot maintenance with the simpler cached startup path.

Continuously running, multi-model processes should include vLLM sleep as a separate option. Level 1 preserves weights in CPU memory while discarding the KV cache. (docs.vllm.ai) That can address GPU-memory reuse while retaining the server process, but it does not answer a requirement to recover after node loss. (docs.vllm.ai) Keep lifecycle control private: vLLM documents that its sleep/wake serving endpoints require development mode and should not be exposed to users. (docs.vllm.ai)

Distributed inference needs its own acceptance plan. Tensor-parallel degree, communicator transport, graph capture, and network identity belong in the manifest. Quiescence must be demonstrated under load; NCCL's suspend operation requires no outstanding operations. (docs.nvidia.com) A single-GPU result cannot qualify a multi-GPU deployment by multiplication, and the current standalone Snapshot project places multinode support on its roadmap. (github.com)

Air-gapped deployment changes the artifact-completeness test. Verify every required file before enabling offline Hub behavior, because missing cache entries produce errors rather than a network fallback. (huggingface.co) The same principle applies to the container image and restore tooling: the operator should demonstrate a complete restore without external downloads.

Sensitive private inference adds an artifact-handling requirement. Kubernetes warns that checkpoint archives can contain process memory, including private data and encryption keys. (kubernetes.io) Restrict who can read, copy, or restore them; use the organization's storage protection and retention controls. Capture reusable engine state before request-specific content where the implementation allows it, then validate post-restore initialization explicitly.

Data Analysis and Evidence

The quantitative evidence is a collection of attributed observations, not a pooled benchmark. *Table 3* preserves workload, timing scope, and source rather than ranking providers by incomparable numbers.

Originator and workload	Reported baseline	Reported snapshot path	Scope and qualification limit
Modal Parakeet	About 20 s, P0	As low as 2 s, P0	Provider-reported Function startup; not a p95 result. (modal.com)
Modal vLLM Qwen2.5-0.5B-Instruct	45 s, P0	5 s, P0	Provider/workload example, using the source's P0 label. (modal.com)
Ramp Gemma 27B serving	60 to 120 s before first token	5 to 12 s cold start	Ramp's own implementation using Modal snapshots; ranges have no stated sampling distribution in the cited serving account. (labs.ramp.com)
Standalone Snapshot: Qwen3 0.6B; GPT-OSS 120B; Qwen2.5 72B	52.4 s; 85.3 s; 97.8 s	3.506 s; 31.135 s; 40.867 s	Single-GPU vendor benchmark; image pull and container startup excluded; no percentile distribution supplied. Values correspond by row order. (github.com)
NVIDIA May GPU Memory Service (GMS) proof of concept, gpt-oss-120b	Source reports 21-fold startup reduction	Under 5 s	Prototype using GPU Memory Service and weights striped across eight local Non-Volatile Memory Express (NVMe) drives; distinct from the standalone table. (developer.nvidia.com)

The standalone benchmark identifies a **B200**, **driver 595**, **vLLM 0.20**, and **VAST Network File System (NFS) persistent-volume storage**, with the KV cache discarded before capture. Its timing excludes infrastructure work that a user may still wait for. (github.com) NVIDIA's earlier **May 27, 2026** article describes a different GMS experiment and separately notes CRIU optimizations that had not shipped at publication. (developer.nvidia.com) The sub-five-second prototype and the standalone GPT-OSS result therefore answer different configuration questions.

These source summaries provide ranges or point values rather than the trial records required to reconstruct a deployment-wide latency distribution. Avoid pooling them or relabeling the source's P0 observations as tail-latency estimates. The absence of published trial counts in these specific reports limits confidence estimates, not the existence of the reported measurements.

For the private pilot, compare identical prompt distributions and output lengths. MLCommons explains why throughput depends on input and output token lengths. (mlcommons.org) Preserve those lengths, concurrency, cache state, and request-arrival timing alongside startup measurements.

A proposed cost model compares incremental overhead using measured inputs. Hold productive serving hours constant and charge the warm-capacity alternative only for otherwise idle capacity:

- **Warm capacity:** $C_{\text{warm}} = \text{idle warm GPU-hours} \times \text{internal hourly opportunity cost}$.
- **Snapshot path:** $C_{\text{snap}} = \text{restore GPU-hours} \times \text{the same rate} + \text{artifact storage} + \text{measured read charges} + \text{engineering allocation}$.
- **Latency exposure:** Report arrival-weighted SLO misses and queued-request time separately from monetary cost.
- **Decision rule:** Prefer restoration only when its measured operational benefit justifies C_{snap} and its accepted failure/recovery behavior.

For owned infrastructure, the hourly rate is an explicit accounting assumption, not an invented cloud price. A pilot should show both opportunity-cost and incremental-power views if those lead to different decisions. Prewarming and snapshots may also coexist: evaluate a warm base with restore-driven bursts against both extremes.

Implications and Future Directions

The evidence supports maintaining a **restore qualification record**, rather than publishing a single compatibility verdict for an entire inference framework. The document should name its source and destination environments, artifact lineage, benchmark boundary, observed distributions, correctness criteria, and expiry triggers. This is a recommended operating practice derived from the variation in documented requirements.

Version tracking is particularly important while orchestration changes. Dynamo's migration guidance moved snapshot handling into a separately installed operator. (docs.dynamo.nvidia.com) The current standalone project warns that its interfaces may change and limits its production-critical recommendation. (github.com) Buyers should therefore ask for reproducible manifests and rollback demonstrations before treating an integration as a durable platform dependency.

There is also progress below the orchestration layer. The current CUDA utility documents driver-specific additions, including **driver 610** support for the named legacy CUDA IPC mechanism. (github.com) NCCL documents communicator resume as an API operation. (docs.nvidia.com) These developments justify retesting previously excluded configurations; they do not retroactively qualify older artifacts or every engine integration.

An independent advisor such as GPU Smith can frame procurement around the buyer's measured arrival trace, capacity plan, and recovery requirements without treating snapshots as a separate hardware category. A GPU purchase should still satisfy steady-state memory, throughput, power, and networking requirements under the chosen deployment plan. Snapshot feasibility becomes an additional acceptance criterion.

The go/no-go worksheet should answer:

- **SLO fit:** Do first-valid-token percentiles pass under the intended queue and routing behavior?
- **Correctness:** Do replay and model-identity checks pass after every accepted restore?
- **Compatibility:** Is every allowed destination explicitly covered by a tested matrix cell?
- **Capacity:** Do simultaneous restores stay within host-memory, GPU, and storage budgets?
- **Recovery:** Does a rejected artifact trigger a working standard-startup path?
- **Ownership:** Are capture, invalidation, retention, upgrades, and rollback assigned to an operator?
- **Economics:** Does the arrival-trace comparison justify the implementation and maintenance effort?

A failed criterion should result in a narrower pilot or a different startup strategy. Keep cached weights and prewarmed replicas in the comparison throughout qualification so the snapshot mechanism is judged against realistic operating alternatives.

Conclusion

GPU memory snapshot recovery is useful when a deployment can preserve expensive initialized state and restore it within a clearly defined compatibility boundary. The published observations establish credible use cases, but their workloads, storage paths, orchestration, and timing endpoints differ. They should inform pilot design without becoming promised private-cluster performance.

The decisive artifact is a versioned source-to-destination qualification record. It should distinguish tensor files from process images, readiness from the first valid token, and a living sleeping server from a recoverable terminated process. It should also connect latency results to output correctness, memory demand, artifact identity, and actual restart behavior.

A practical evaluation starts with standard startup and cached weights, adds restoration under the same conditions, and compares both with the required warm capacity. Preserve raw trial records and publish the unsuccessful attempts alongside latency distributions. Treat driver changes, engine changes, model updates, and topology changes as explicit decisions about whether the existing artifact remains eligible.

Proceed when the measured SLO, correctness, operational ownership, and cost comparison all support the same deployment choice. Otherwise, retain the simpler startup or warm-capacity strategy and revisit snapshots when a specific documented capability changes. The purpose of the pilot is an evidence-backed operating decision for one inference service, with a working rollback, rather than a general claim of snapshot compatibility.

Source links

Links cited in this article, in order of first appearance. Full addresses are provided for readers using extracted text.

1. https://docs.nvidia.com/cuda/cuda-driver-api/cuda_driver_api/group__CUDA__CHECKPOINT.html
2. <https://labs.ramp.com/research/how-we-built-steer>
3. <https://modal.com/blog/gpu-mem-snapshots>
4. <https://github.com/ai-dynamo/snapshot/blob/main/docs/development/benchmarks.md>
5. <https://docs.dynamo.nvidia.com/dynamo/v1.5.1/reference/releases>
6. <https://github.com/ai-dynamo/snapshot>
7. https://docs.vllm.ai/en/v0.31.0/features/initialized_snapshots
8. <https://github.com/vllm-project/vllm/issues/34303>
9. https://docs.vllm.ai/en/v0.31.0/features/sleep_mode
10. <https://kubernetes.io/docs/concepts/workloads/pods/probes>
11. <https://docs.pytorch.org/docs/stable/generated/torch.load.html>
12. https://huggingface.co/docs/huggingface_hub/guides/manage-cache
13. https://docs.ray.io/en/latest/ray-core/fault_tolerance/actors.html
14. <https://github.com/NVIDIA/cuda-checkpoint/blob/main/README.md>
15. <https://docs.dynamo.nvidia.com/dynamo/reference/releases/deprecations>
16. <https://opentelemetry.io/docs/specs/otel/trace/api>

17. <https://docs.aws.amazon.com/sagemaker/latest/dg/your-algorithms-inference-code.html>
18. <https://developer.nvidia.com/blog/nvidia-dynamo-snapshot-fast-startup-for-inference-workloads-on-kubernetes>
19. <https://docs.cloud.google.com/run/docs/configuring/services/gpu>
20. <https://modal.com/docs/guide/cold-start>
21. <https://mlcommons.org/2024/03/mlperf-llama2-70b>
22. <https://kserve.github.io/website/docs/model-serving/generative-inference/modelcache/localmodel>
23. https://huggingface.co/docs/huggingface_hub/main/package_reference/environment_variables
24. <https://modal.com/docs/guide/memory-snapshots>
25. <https://docs.vllm.ai/en/v0.31.0/api/vllm/entrypoints/cli/snapshot>
26. <https://docs.docker.com/reference/cli/docker/checkpoint>
27. <https://docs.nvidia.com/deploy/cuda-compatibility/minor-version-compatibility.html>
28. <https://docs.nvidia.com/deeplearning/ncccl/user-guide/docs/api/comms.html>
29. https://criu.org/TCP_connection
30. https://criu.org/Advanced_usage
31. <https://github.com/ai-dynamo/snapshot/blob/main/docs/limitations.md>
32. <https://kubernetes.io/docs/reference/node/kubelet-checkpoint-api>
33. https://modal.com/docs/examples/gpu_snapshot
34. <https://docs.python.org/3/library/time.html>
35. <https://docs.dynamo.nvidia.com/dynamo/dev/kubernetes/model-deployment/model-loading/dynamo-snapshot-experimental>
36. <https://prometheus.io/docs/practices/histograms>
37. <https://docs.ray.io/en/latest/serve/advanced-guides/advanced-autoscaling.html>

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About GPU Smith

GPU Smith provides independent engineering and research for private AI infrastructure. We help technical buyers and operators reason about GPU workload sizing, hardware selection, procurement, deployment and inference operations, from the compute system to the networking, power and cooling requirements around it.

Start with the workload

Useful infrastructure decisions begin with the models, data, throughput, latency and operating constraints a team actually has. GPU Smith helps connect those requirements with system design and deployment choices. The goal is a privately controlled AI environment whose capacity and operational demands are understood before a purchasing decision.

Hardware and supplier research

Our public reference library covers GPUs, complete systems and networking components. The server-vendor directory and manufacturing research help teams investigate suppliers, compare options and follow sources behind technical claims. We distinguish manufacturer specifications from measured benchmarks and advertised capabilities from tested configurations. Reference pages are research resources, not a live inventory listing or a binding equipment quote.

Deployment and operations

GPU Smith's engineering scope includes infrastructure integration, networking, power, cooling and the practical operation of inference workloads. Our published articles explain the tradeoffs behind deployment, procurement and ongoing operations so teams can ask better questions and document decisions.

Work with GPU Smith

Explore the [hardware library](#), [GPU references](#), [networking references](#) and [vendor research](#). [Contact GPU Smith](#) with your workloads and deployment constraints to discuss a project and confirm current scope, pricing and availability.

Inclusion of a manufacturer or product in our research does not imply a partnership, certification or endorsement.

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