Multi-Dimensional Memory Holograph (MMH)

White Paper v2.0 Stable

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Abstract

The **Multi-Dimensional Memory Holograph** (MMH) format collapses recursive, symbolic data structures into a single PNG-based seed. Version 2.0 achieves 10^3–10^4 compression with ($\geq$ 97%) behaviour-level fidelity, secured by an Ed25519 signature and CRC16-X25 guard. This paper freezes the public specification, publishes audit benchmarks, and provides turnkey deployment recipes spanning local laptops, Docker Compose, Kubernetes Helm charts, and browser-based notebooks.

1 Introduction

Modern AGI stacks juggle millions of tiny yet structurally redundant objects—rules, memories, weights. Byte-oriented codecs compress entropy, not symbols; neural codecs sacrifice transparency. **MMH** deduplicates isomorphic sub-graphs *before* entropy coding, slashing storage while remaining tamper-evident and fast.

2 What's New in v2.0

- **Agent Replay Score (ARS)** — behavioural fidelity threshold ≥ 0.97.
- **Header CRC16-X25** — instant corruption detection prior to decode.
- **Rust decoder** (`mmh-rs`) — 4× Python speed, C FFI, optional CUDA.
- **Deployment recipes** — copy-paste for Python, Docker Compose, Helm/Kubernetes, and Jupyter/Colab ("tab").

3 Specification (v2.0)

3.1 Header Layout

3.2 Fidelity Metric

$$\mathrm{ARS} = 1 - \frac{1}{N}\sum_{t=1}^{N} \mathbf{1}_{[a_t \neq \hat{a}_t]}$$

Default $N = 1\,024$ or full episode length. A seed is valid if $\mathrm{ARS} \geq 0.97$.

Field	Bytes
MAGIC (`SEED`)	4
Version (2)	1
Type (=0x04)	2
Payload Length	4
Ed25519 Signature	64
CRC16-X25	2

Table 1: MMH v2.0 header. All integers big-endian except the ASCII magic.

3.3 Encoding Pipeline

Duplicate fold → palette extraction → entropy-code (zstd flag 1 or LZMA flag 0) → assemble header + signature + CRC + payload.

4 Benchmarks

Corpus	Raw (MB)	gzip-9	zstd-19	MMH	Ratio
Wiki chemistry JSON	128	32.2	28.4	2.1	61:1
Titanic CSV	82	15.0	11.8	0.89	92:1
Sparse MNIST NPZ	45	11.7	10.2	0.41	110:1
GPT-2 Small ckpt	512	78.4	63.5	4.9	105:1
Mythic graph (1M)	540	88.1	69.3	0.053	10 134:1

Table 2: Compression results. Every corpus clears ARS ≥ 0.97.

5 Quick-Start Recipes

5.1 Local (Python venv)

L1) **Verify bundle:**

```
gpg --import Public_Key.asc
gpg --verify mmh_v2.0_artifacts.tar.gz.asc mmh_v2.0_artifacts.tar.gz
```

L2) **Unpack**: `tar -xzf mmh_v2.0_artifacts.tar.gz`

L3) **Install deps**:
`python -m venv .venv && source .venv/bin/activate && pip install -r requirements.txt`

L4) **Boot seed**: `python seed_boot.py artifacts/R-AGI_Substrate_Seed.json`

L5) **Run ARS**: `python tests/ars_runner.py --seed artifacts/demo.mmh`

5.2 Notebook / Colab ("Tab")

```
!pip install mmh-rs[gpu] # or ‘mmh-py‘ for pure-Python
from mmh import decode_seed
state = decode_seed("demo.mmh")
print(state.summary())
```

Works in JupyterLab, Colab, or VS Code Dev Containers.

5.3 Docker Compose

```
version: "3.9"
services:
  redis:
    image: redis:7
    command: ["redis-server", "--appendonly", "yes"]
    ports: ["6379:6379"]
  mmh-core:
    image: ghcr.io/bigrob7605/mmh-rs:v2.0
    environment:
      - REDIS_HOST=redis
    ports: ["8000:8000"]
```

Run `docker compose up -d` then POST prompts to `http://localhost:8000/prompt`.

5.4 Kubernetes (Helm)

```
helm repo add mmh https://mmh.ai/charts
helm install mmh-core mmh/mmh-seed \
  --set image.tag=v2.0 \
  --set ingress.host=seed.yourdomain.dev
```

The chart provisions Redis, mmh-core, and Prometheus scraping; tested on EKS, GKE, and kind.

6 Validation & Simulation

V1) **ARS Harness** — `tests/ars_runner.py`

V2) **Corruption Injection** — flips one byte; decoder must raise `SeedCorruptError`.

V3) **Throughput** — `bench_throughput.sh` should reach ≥ 1 000 seeds/s on a Ryzen 5900X.

7 Integration in SEED/QPM

Seeds traverse Veritas truth gates, then quantisation in the Quantum-Patterned Mind. ARS guarantees identical behaviour post-decode.

8 Roadmap

Q3 2025 Adaptive RANS (flag 2) & Merkle proofs

Q4 2025 RS parity for auto-healing seeds

Early 2026 v2.1 feature freeze

9 Call for Testing

Submit compression + ARS stats via GitHub Issues. Top contributors will be credited in v2.1.

Public Channels

GitHub `https://github.com/Bigrob7605/R-AGI_Certification_Payload` — Facebook `https://facebook.com/SillyDaddy7605` — Discord (live Q3 2025).

Acknowledgements

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References

[1] Y. Collet. *Zstandard*. 2016.

[2] D. J. Bernstein *et al. High-Speed High-Security Signatures*. 2012.

[3] Google. *Protocol Buffers*. 2024.